EMERGING SEED MARKETS, SUBSTANTIVE SEED ECONOMIES AND INTEGRATED SEED SYSTEMS IN WEST AFRICA:
A MIXED METHODS ANALYSIS

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by
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ABSTRACT

Current approaches to the second Green Revolution in sub-Saharan Africa focus on incorporating the needs of smallholder farmers and environmental concerns into a market-based approach to technology development and diffusion. This dissertation analyzes the experiences of farmers in the West African countries of Mali, Burkina Faso and Niger with the recent creation of input markets for improved variety seeds, as a specific example of the interactions between market-oriented agricultural development activities and traditional agricultural production systems. Sahelian West Africa presents a particularly timely example of the initial changes and impacts associated with the establishment of markets for agricultural inputs not previously considered something to be sold. Sorghum and pearl millet are native grain crops integral to the cropping systems of the Sahel, and are crop species that have not been emphasized by private agricultural research. Public national and international agricultural research centers in the region have ongoing research projects to identify, breed and select improved varieties of sorghum and pearl millet, activities into which farmers have been incorporated through participatory plant breeding approaches. With an influx of interest and resources in promoting technology diffusion through market-oriented development approaches, there is now a push to create the formal systems and structures necessary to diffuse these seeds through input markets. These efforts have included establishing seed certification laws to ensure quality at the national level, support for farmer organizations and seed producer unions at the regional level, and the establishment of points of sale through agro-dealers and other local input sellers.

The dissertation uses a theoretical framework of substantive economies and economic habitus, which understands economic actions and institutions as conditioned by their specific social motivations and natural context, to characterize the distinct seed systems present in Sahelian West Africa. Mixed methods, including thematic analysis of qualitative data, growth
curve modeling of a panel data set and visual representation of seed diffusion, are used to analyze seed access activities at different scales, from individual actions to community and regional systems. Themes emerging from qualitative data analysis suggest that there are exchange-based and provisioning-based seed systems present in the region, and that these systems are based on distinct organizing principles but are connected by individual seed access actions. Statistical analysis shows that characteristics of the social and natural context condition individuals’ seed access decision making over time, with significant differences in seed access decisions between men and women, as well as among individuals with different spatial relationships to social infrastructure like weekly markets. Visual data, both digital maps and those drawn by research participants, depict the scale and points of connection of seed systems in the region. By providing mixed methods analysis of which individuals are engaged with which seed systems, and how connections among those systems support seed diffusion, this dissertation project contributes to sociological literature on substantive economies and international agricultural development, and provides feedback for future program development. In addition, the application of critical social science theory to impact assessment data highlights the limitations of market-oriented agricultural development, with the goal of mitigating the potential exclusionary effects of the second Green Revolution.
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Chapter 1 Introduction and dissertation overview

The contemporary dominant discourse of sustainable agricultural development combines modern scientific knowledge with market-oriented poverty-reduction approaches in an effort to integrate rural agricultural communities into the global agricultural system to increase well-being. Feed the Future, the United States Agency for International Development (USAID)-funded food security program, proclaims that “farmers – especially smallholder farmers – need to be integrated into the full chain of production, from farm to fork” (USAID, 2012). In sub-Saharan Africa, the Alliance for a Green Revolution in Africa (AGRA) seeks to apply “the power of knowledge and technology with an environmental touch,” and assumes that “once improved seeds and soils engender higher yields, farmers need access to markets for their surplus,” which then leads to increased economic well-being (AGRA, 2012a; AGRA, 2012b). The rhetoric of market-oriented agricultural development approaches implies that the combinatory power of scientifically and economically efficient approaches to agricultural production is unequivocally preferable to ‘unimproved,’ non-market based inputs and systems. This rhetoric can lead to an either/or framing of current and changing agrarian systems, in which traditional and adaptive actions by farmers and communities are evaluated based on whether or not modern economic arrangements and technologies are present.

This dissertation fits into a contemporary trend in rural sociology toward agrarian political economy (Buttel, 2001) and understandings of how macro-level trends in agricultural development (Busch, 2010) and agri-food systems (Friedmann, 2005) affect individuals, households and communities. I build as well upon critical development theories (Escobar, 1995; McMichael, 1997) to situate the specific case of seed system development into questions about the goals and differential impacts of, and social and economic systems privileged by, current
dominant approaches to international agricultural development. I draw upon sociological theories of alternative economies (Polanyi, 1944; 1957b; Halperin, 1984) and Bourdieu’s (1984; 2005) notion of habitus to deepen understanding of persistent and dynamic local responses to macro-economic trends. I build as well on the argument made in peasant studies that peasant agriculture has distinct organizational forms that relate to current context, as well as social and natural history (Chayanov, 1986; van der Ploeg, 2010). By combining literature on approaches to international agricultural development with sociological theories of the origins and organization of social and economic systems used to meet individuals’ material needs, I create a multi-level analytical framework used to characterize contemporary changes in seed systems in the Sahelian West African countries of Mali, Burkina Faso and Niger.

In Sahelian West Africa over the past five years, market-oriented approaches to seed system development have emphasized the establishment or expansion of formal seed markets and private seed enterprises to disseminate improved varieties of sorghum and pearl millet, local cereal grains not included in previous agro-input market development. In addition, seeds of local grains have not historically been considered economic goods – seeds are not something to be sold (Smale et al., 2008; Siart, 2008). Because of the social role played by seeds, the shift toward formal seed markets challenges the existing configurations of seed systems, and provides an important case study of how peasant agriculture adapts to and incorporates new economic and agronomic realities into existing seed systems. Through mixed-method data gathering and analysis, I combine qualitative, quantitative and visual data to build empirical understanding of Sahelian seed systems, and to deepen critical theories of the logic and internal organizing principles of alternative and peasant economies. The results of this dissertation suggest that distinct seed systems can be identified and characterized based on the primary social or economic principle that organizes them, and that these seed systems connect at key points to create an
integrated seed system better able to meet the seed access needs of all farmers than any single seed system.

**Critical sociological questions in the study of contemporary agrarian change**

Agrarian political economy asks key questions about the goals of agricultural development, for whom projects and systems work, how systems that meet certain goals for certain individuals are instituted by individuals’ actions at a variety of scales, and how these systems are interconnected. Critical analysis of international economic development challenges assumptions about the superiority of capitalist economic and social systems over all others by highlighting the underlying assumptions and differential impacts of classical capitalist economic theory. Implicit in the discourse and projects associated with market-oriented agricultural development are answers to the three basic questions about the nature of agrarian change. The primary goal of agricultural development is food security, which in past moments of international development, like the first Green Revolution, focused on production increases for farmers operating at a large enough scale to implement and benefit from capital-intensive technology like improved variety seeds and fertilizer. The current market-oriented approach emphasizes livelihood strategies and economic well-being that can directly, through agricultural production, or indirectly, through diversified employment strategies, strengthen an individual’s or household’s food security situation (Carr, 2006). As Mooney and Hunt (2009) point out, food security is a contested frame within which different theories of agricultural and economic change can operate, based on assumptions inherent to those theories. The goal of agricultural development, then, is not food security per se, but rather achieving food security through a specific set of activities and approaches based upon extant theories of preferable social and economic systems.
To build a framework that connects global trends in the agri-food system to individual and village-level seed systems and changes within them, I highlight answers to the above questions implicit in the second Green Revolution currently being articulated and implemented for sub-Saharan Africa (Toenniessen et al., 2008). The current global food regime, labeled by Friedmann (2005) as green capitalism, emphasizes the need to incorporate social and environmental concerns into agricultural and economic systems, with the goal of equitably incorporating farmers in developing countries (along with many other under-integrated groups) into the global capitalist system. The goal of agrarian change in this market-oriented sustainable development approach is contextualized market development that can incorporate some of the externalities generated by free-market systems and standardized technologies, in order to ‘make markets work’ for a wider range of people. Djurfeldt (2013) and Busch (2010) argue that observations of differential impacts of the first Green Revolution and the neoliberal era, where certain strata of agricultural systems in the developing world benefitted from new technologies and markets and at the same time economic differentiation worsened conditions in many agricultural communities and regions, have created the potential for more inclusive agricultural development and agrarian change. Market-oriented sustainable development has embraced, among other things, a value chain approach that seeks to provide place-appropriate access to improved inputs and markets in order to support food security (Toenniessen et al., 2008). Vorley et al. (2006) describe the incorporation of smallholders into agricultural value chains as ‘regoverning markets,’ and draw direct distinctions between neoliberal policies that favored economic efficiency at any social price, and the current approach to sustainable value chain development that incorporate specificities of social and natural settings into linkages within the value chain (Kaplinsky, 2000).

Modern approaches to international agricultural development have consistently been based on some form of capitalist-market economics, and have made market transactions and
motivations of economic efficiency central to economic systems. And much like classical economic theory past and present, current approaches to market-oriented agricultural development recognize that there are social concerns not captured by market efficiency or profit-maximization. Beginning with Smith’s *The Theory of Moral Sentiments* (2000) and continuing through Keynesian (1937) articulations of government’s role in ensuring equitable economic development, classical market economic theory has offered a standardized theoretical model of the distribution of scarce resources that is both efficient and impersonal, and so requiring tempering by some type of social institution. Abstract morals, social strictures against excess gain, government programs to care for certain populations – all of these social institutions reflect social values that counter and are at times at odds with individual utility-maximization or economically efficient use of resources. Classical economic theorists have long recognized that if market societies hold social values that contrast with pure capitalist-market theory, then institutions that reflect social values can and should interact with economic institutions in order to strike a balance of values (see, for example, Smith, 2000; Schumpeter, 1909; Keynes, 1937). The global push for neoliberalism, in the 1980s and 1990s, stands in contrast to the long history of market economics accepting interaction with and limitation by the social institutions necessary to meet non-economic social concerns (Harvey, 2006b). I see the current approach to international development that stresses value chains and sustainable value chain as in part a reaction to the extensive elimination of social controls that occurred throughout the neoliberal period. Vorley et al.’s (2006) assessment of value chains as potentially regoverning markets implies that value chains can incorporate social as well as economic value into economic activities and systems.

Busch’s (2010) analysis of agrarian change throughout the neoliberal period explains the emergence of the sustainable value chain approach: by cutting any social concerns out of economic systems and market activity, neoliberalism’s association of economic freedom with social or political freedom created space for experimentation and innovation with the neoliberal
paradigm. One result of the differentiated social effects of full neoliberal economic systems, as well as the innovation process in response to those negative impacts, is evident in contemporary articulations of market-oriented sustainable development and value chains that incorporate smallholder farmers (see for example Marsden et al., 2000). Value chains can respond and reform in relation to specific social and natural contexts, while still reflecting organizational principles of economic efficiency. In other words, social systems (and the values they reflect) can be embedded in economic systems. The value chain approach in contemporary market-oriented agricultural development, then, continues to be defined by economic theory, and questions about the social priorities and groups that effect and are affected by agrarian change are present insofar as they can be incorporated into economic processes.

In contrast to classical economic theory, economic sociology reverses the embeddedness equation and considers economic systems as embedded within social systems, so that the organization of economic activity and institutions is not standardized but instead reflects particularities of the social and natural setting (Granovetter, 1985). From this perspective, value chains could be based on a range of social and economic values, rather than only oriented toward market economic value and profit maximization. Key to critical theories of the relationship between social and economic systems is Polanyi’s (1944; 1957b) notion of substantive economies, of which formal market economics is only one possibility. Substantive economies are systems of exchange to meet material needs that can be organized by a range of economic goals conditioned by social values, like reciprocity or redistribution, whereas a formal economy subsumes social values to the economic goal of efficiency. In addition, provisioning systems to meet material needs are organized entirely based on social values (van der Ploeg, 2010). Questions of for what, for whom, and how, become more complicated in substantive economic analysis than in the frame of formal, market-based economics, since the value associated with the economic exchange is no longer necessarily oriented toward individual utility maximization.
Instead, substantive economies are instituted by patterns over time of individual actions that are organized around a consistent, context-specific social or economic goal.

To better understand the relationship between individual actions and motivations, and social and economic systems, I draw upon Bourdieu’s (1979; 1984; 2005) notion of habitus. Habitus reflects social history and natural setting, is manifest in empirically observable patterns of individual actions that create institutions, and shifts through individual and social learning or skilling (Stone, 2004; 2007). Substantive economies and provisioning systems, as instituted by specific habitus, provide a precise and complex framework within which to analyze and explain the persistent agrarian questions originally posed by Kautsky (1988) and Chayanov (1986).

Kautsky (1988) first noted the continued presence, or lack of complete conversion, of pre-capitalist peasant agriculture in the late 19th century, and considered the incomplete shift a phenomenon of the historical moment. Self-sufficient farmers did not immediately see the shift to wage-labor and capitalist production as preferable to the stability associated with peasant agriculture. As peasants persisted in both capitalist and communist countries throughout the early 20th century, Chayanov (1986) articulated an initial theory of peasant economy that distinguished between the modern entrepreneurial peasant farmer, as a manifestation of early response to and integration into capitalist economic systems, and the peasant farm as an organizational type. Chayanov’s distinction laid the foundation for the tradition of peasant studies, which incorporates critical political economy and development theories into an understanding of the social and economic arrangements that defines specific agricultural systems as conditioned by place and time. In other words, peasant agriculture as an organizational type is organized by non-capitalist social and economic principles that are dynamic and changing in response to the higher-order economic systems with which peasant agriculture interacts.

Heterogeneity defines agricultural systems and settings, and so to the social and economic systems that support agricultural production and food security in many parts of the
rural developing world. These social and economic systems are organized by principles that reflect the social and natural setting, and are therefore reasonable in that they are internally consistent and create durable institutions or structure, but not necessarily rational (van der Ploeg, 2013; Richards, 1985; Bourdieu, 2005). Using critical sociological theories to understand the organizing principles of distinct social and economic systems instituted to meet material need begins to answer the questions posed throughout this section, about the underlying goals of specific approaches to agricultural development, for whom those approaches do or do not work, and the types of social systems instituted by specific approaches. In this dissertation, I use the example of seed system development in Sahelian West Africa to explore the economic and social values reflected in farmers’ engagement with newly established seed value chains, and to describe the connections between formal seed value chains and other distinct seed systems in the region. I analyze the social and economic habitus expressed by individuals’ actions and experiences, and then build upon the abstract notion of substantive economies, as well as articulations of peasant agriculture, to categorize several Sahelian seed systems. I see the combination of these theories as contributing to agrarian political economy by strengthening theoretical understandings of how connections among distinct social and economic systems that can expand or exclude access to material goods and information. Exploring and making explicit the multi-level interactions that institute and amend economic systems in particular provides greater understanding of potential exclusionary effects of specific economic systems for specific groups of people. A substantive understanding of the systems used by people left out of formal market approaches to economic development supports as well the argument that alternative economic systems and social institutions will be necessary to meet social goals like food security or general well-being.
The case of seed systems in Sahelian West Africa and conceptualization of research project

The current emphasis on seed value chains and market-oriented seed system development provides a particularly interesting case to analyze through the lens of agrarian political economy. Kloppenburg (2004: xiv) writes in the preface to the second edition of First the Seed that “as both food and means of production, seed sits at a critical nexus where contemporary struggles over the technical, social, and environmental conditions of production and consumption converge and are made manifest.” Seeds can be understood as a technology (Nolan and Santos, 2012), as currency (Polanyi, 1966), as a reproducible agricultural input (Sperling and McGuire, 2010), as private goods and yet public repositories of genetic diversity (Romer, 1990), and as the material embodiment of social and natural history (Zimmerer, 1996). Seed systems can be similarly defined as social, institutional and economic systems that provide seed access and that are organized by specific principles that reflect the combined influence of social, economic and natural settings.

Distinctions are often made between modern/formal and traditional/informal seed systems, with differences are characterized by the seed production process and the actions taken to access seeds (Almekinders et al., 1994; Sperling and McGuire, 2010; Lipper et al., 2010). Often missing, however, is a conceptualization of the value attributed by individuals to the output of the seeds they use, as well as the organizing principles of systems not predicated on market exchange or the private commodity-value of the output. From the point of view of an individual farmer, seed as a production input is a private good that is excludable, and so the value associated with the output of seeds is similarly assessed by the individual (see Morris et al., 1998, for further discussion of the economic characteristics of seeds). As seed system development via value chains is currently being incorporated into international agricultural research for development approaches to food security, there is deep awareness of farmers’ non-market-based seed systems.
and a push to integrate formal and informal seed systems into an integrated seed system (Louwaars and de Boef, 2012; ISPC, 2012). Louwaars and de Boef (2012) raise a tentative critical question about the orientation of seed system development projects, arguing that they can be profit-driven or development-driven. However, the literature continues to lack constructive engagement with the range of seed systems present in particular agricultural and social systems, as well as the organizing principles of those systems and values associated with the output of those seeds.

I expand and develop a multidimensional characterization of distinct seed systems in Sahelian West Africa in order to contribute to the literature on seed systems, value chain development, and differential impacts of specific approaches to agricultural and economic development. Using the empirical case of Sahelian seed systems, I also apply and contribute to theories of substantive economies and peasant studies by exploring the social and economic habitus expressed in farmers’ actions to institute specific seed systems. The case of Sahelian West Africa is interesting for several reasons. The development and scaling up of cereal seed value chains has become a central activity of AGRA and related research for development organizations (Scoones and Thompson, 2011; ISPC, 2012; PASS, 2013). In Mali, Burkina Faso and Niger, seed system projects are building on a decade of participatory plant breeding (PPB) by the public International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) (Weltzien et al., 2008; vom Brocke et al., 2010). PPB projects start from the principle that farmers have their own complex set of priorities and values for seed selection and use, and so provide an alternative to the standard approach to technology development that assumes production efficiency is the singular goal of crop improvement (Ceccarelli et al., 2009). As PPB projects move into the varietal release and seed production stages, there has been a call to connect the results to seed system development projects that continue to take a contextualized approach to agricultural research for development (Bishaw and Turner, 2008; Badstue et al., 2012).
Currently, most projects seeking wider diffusion of PPB varieties are using a value chain approach to seed system development by supporting training for seed producers and seed commercializing farmer organizations, the establishment of national seed certification laws and facilities, and the creation of market-oriented social infrastructure to institute formal markets in rural settings (ISPC, 2012).

While writing my Master’s thesis on the social impacts of ICRISAT’s PPB projects in Sahelian West Africa, I became increasingly interested in the potential narrowing of goals and impacts that could be associated with value chain seed system development. As has been widely documented by others, and mentioned to me as well, farmers in the Sahel consistently emphasize that sorghum and pearl millet seeds, both local grains, are not something that historically has been sold in formal markets, though informal and non-formal seed transactions are common (Smale et al., 2008; Siart, 2008; Ndjeunga, 2002; Smale et al., 2010). Establishing formal markets and cash-based sales as part of the value chain approach seemed potentially unaligned with habits and history in Sahelian seed systems. In addition, because the varieties that have been developed in these PPB projects are conventionally bred (there are no GM varieties), and are mostly open-pollinated rather than hybridized, seed saving and reproducing, which forms the basis of local or traditional seed systems, continues to be a possibility with the newly released improved varieties. ICRISAT had similar questions about how farmers would relate to the creation of the social infrastructure and economic systems necessary to institute a market-oriented seed system, and I developed this dissertation project in direct collaboration with the plant breeders, technicians and farmer organization representatives working on a McKnight Foundation-funded seed systems project that focused on seed commercialization and value chain development. The impact-oriented research questions of the seed systems project focus on changes to local seed systems as individuals and communities interact with market-oriented seed systems, as well as gender differences in access to improved variety seeds in local and formal seed systems.
Based on previous research and collaboration with ICRISAT researchers, I developed this dissertation project to address empirical questions of immediate and differentiated impacts of the development of market-oriented seed systems and seed value chains in Sahelian West Africa, as well as to make theoretical contributions to literatures on alternative economies and peasant studies. I used mixed methods approaches throughout the project design, data gathering and analysis phases to triangulate, test and challenge findings using qualitative, quantitative and visual data (see Small, 2011, for an overview of mixed methods). There have recently been calls for the incorporation of mixed methods into impact assessment in international agricultural development, to make more robust claims of impact (Mackay and Horton, 2003; de Janvry et al., 2010). I also see mixed methods as strengthening the multi-level, critical theory upon which I build in this dissertation project to articulate the relationships between social and natural setting, individual actions and motivations, and the institution of social and economic systems. An additional component to the research project is a specific interest in gender differences in experiences with seed systems – gender is a key component of the seed systems project with which I work, and has been documented in the literature as a potentially important point of differentiation in terms of engagement with market-oriented seed systems (Sachs et al., 1997; Zimmerer, 2003; Smale et al., 2008). I therefore disaggregate quantitative data and incorporate gender as a thematic category running through qualitative analysis (Doss, 2013).

Based on reviews of literature and theory, as well as collaboration with ICRISAT and project partners, I developed the following research questions to test and analyze impacts on seed systems of market-oriented seed system development.

**Research questions**

1) How do the natural setting and social context influence seed systems in Sahelian West Africa?
2) How and why are farmers incorporating improved variety seeds and seed sales into existing seed systems?

3) Do seed access decisions differ by gender?

4) Do seed access decisions differ by crop?

**Overview of dissertation organization**

The following eight chapters present the entire arc of this dissertation process, set within the context described in the introduction. Chapter 2 reviews literature on dominant and alternative discourses in international agricultural development, and situates approaches to seed system development within broader historical trends. A conceptual framework for identifying specific dimensions of seed systems, changes in which can then be measured empirically, is developed out of the literature on economic development and agricultural change. Chapter 3 provides an in-depth synthesis of Polanyi’s notion of substantive economies and Bourdieu’s theories of social and economic habitus, and makes theoretical connections using Marxian articulations of economic value and agrarian political economy analysis of peasant agriculture. Chapters 3 and 4 provide, respectively, an overview and background of the research setting and my role within it, and a detailed description of the methodological considerations and approaches used to conceptualize the dissertation research project, and gather and analyze data. In Chapters 5 through 8, I then present mixed-methods data analysis in a variety of combinations. Chapter 6 uses qualitative, quantitative and visual data to characterize the social and natural settings within which Sahelian seed systems are set, and tests the relationships between key contextual variables and individual seed access decisions in different dimensions of the seed system. Building from this initial analysis, Chapter 7 provides in-depth thematic analysis of qualitative and visual data to categorize the organizing principles of provisioning seed systems and substantive seed economies.
in Sahelian West Africa. In Chapter 8, I develop a comprehensive theoretical model of relationships among dimensions of the seed system and changes in those dimensions over time, and then test a limited model using a panel data set generated during mixed-data gathering. I use a structural equation modeling (SEM) approach to latent growth curve analysis to test for differences in individuals’ trajectories toward engagement with market-oriented seed systems over time, and find significant differences between men and women, and between union and non-union members, in their orientation toward the value of seeds. I synthesize the findings of Chapters 5, 6, and 7 in Chapter 9, by analyzing findings through the questions explored in this introduction about the goals or motivations inherent in specific seed systems, the potential for inclusion or exclusion of specific groups of people, and the institutions and systems necessary to support distinct seed systems. In the conclusion, I make applied recommendations for incorporating these research findings into future research and seed system development projects.
Chapter 2 Literature review

This chapter provides an overview of dominant discourses in agricultural development since World War II and highlights key assumptions about the type of agricultural change that is desirable, for whom development is working, the ‘best’ approach to achieving this change, and appropriate measures of impact or success. Much of the literature on agricultural development focuses on the first Green Revolution, which is relevant both because of its lasting influence on the international agricultural research and development field, and also because the language of the first Green Revolution is currently being repurposed to support a renewed focus on agricultural change via technology development and markets (Das, 2002; Toenniessen et al., 2008). Within the context of historical and contemporary approaches to agricultural development in general, I explore the way that seed systems have been defined, discussed, and impacted by Green Revolution and alternative approaches to agricultural development. Seeds play a unique role in agricultural systems, as both an input and output, as well as being imbued with cultural and historical context and meaning (Heisey and Brennan, 1991; Zimmerer, 1996; Richards et al., 2009). Seed system development, therefore, engages with the intersections of social, economic and natural systems, and depending on the development approach, pushes for change in one or several dimensions of the seed system. In the final section of this chapter, I identity three dimensions of seed systems that are emphasized in the three distinct stages of international agricultural development, and connect them to broader theoretical conversations about agricultural technology and economic systems.

The current dominant discourse and practice in international agricultural research and development calls for a second Green Revolution, one that takes the lessons learned from the first and applies them to the smallholder agriculturalists who were ‘left behind’ the first time around
(Evenson and Gollin, 2003; Toenniessen et al., 2008). The rhetorical framing of the second Green Revolution goals, particularly in Africa, suggests a new approach to agricultural research and development, one that incorporates the variations in farmers’ needs and priorities into research and project design. However, the theoretical assumptions that drive the current push for market-oriented development share much in common with past approaches to international development, from transfer-of-technology models of the 1950s through 1970s to the push for neoliberal infrastructure and governance in the 1980s and 1990s. Contemporary market-oriented development approaches contextualize both technology and economic efficiency, in an effort to be more inclusive than past iterations of international research and development. The fundamental principles and goals of increases in efficiency, yield, and well-being through cash economies and purchasing power have, however, remained consistent. To further characterize the dominant discourses in international agricultural development, throughout this chapter I overview as well alternative, participatory approaches to supporting agricultural livelihoods and change, highlighting the clear contrast to the transfer-of-technology paradigm present in early participatory theory, and the more ambiguous relationship between current market-oriented development strategies and participatory projects (Cohen and Uphoff, 1980; Chambers and Jiggins, 1987; Ashby and Sperling, 1995; Fortmann, 2008).

Within the broader literature on international agricultural development, seed systems and the crop varieties spread through them have played a central, if changing, role in the dominant articulation of the goals and processes of agrarian change. Because farmers can reproduce seeds themselves, the lines between modern and traditional seed systems are often drawn based on genetic purity and seed source, with modern seed systems treating seeds as inputs to be certified, standardized and sold (Tripp, 2001; Lipper et al., 2010). Informal seed systems are then a catch-all ‘everything else’ category that often remains undifferentiated (Sperling and McGuire, 2010). Set within a market-oriented approach to agricultural development, the assumption is that farmers
who engage in formal seed systems choose to purchase seeds in order to maximize yield and gain economic advantage by selling their surplus production. Local and traditional seed systems are viewed as less efficient and less theoretically desirable than new, formal systems, despite much evidence that suggests a range of social contributions made by traditional or informal seed systems (Almekinders et al., 1994; Sperling and McGuire, 2010). One alternative approach to seed system development is participatory plant breeding (PPB), which connects farmers’ knowledge and traditional seed systems with conventional plant science and goals of formal seed systems in order to better meet the needs of specific farmers in specific places (Ceccarelli and Grando, 2007; Almekinders et al., 2007). This dissertation project builds on PPB work by ICRISAT in Sahelian West Africa, and I provide a brief overview of the current state of Sahelian seed systems in this chapter.

Reviewing the literature on seed systems within the agricultural development literature, and particularly the distinctions made between formal and informal/traditional seed systems, I was struck by the consolidation of different dimensions of seed systems into a single measure of formality. In the final section of this chapter, I develop a conceptual framework that draws on existing social science theories to characterize three aspects of seed access about which farmers can and do make a range of decisions: type of activity used to access seeds, type of seed used, and the value of the output. Each axis of decision-making derives from the seed systems and agricultural development literature, but is defined and broadened in the last section of this chapter using literature from economic geography and sociology, and critical studies of science and technology. The conceptual framework developed here provides an analytical heuristic that I then use in the analysis chapters to explore the range of decisions that farmers in Sahelian West Africa describe making in terms of their engagement with new varieties of sorghum and pearl millet, and new input markets for seeds. This research project seeks to provide both a project-specific impact assessment of PPB and seed dissemination activities on formal and informal seed systems.
systems in West Africa, and also to analyze and test a range of theoretical concepts and empirical hypotheses related to agricultural systems and alternative economies. By combining an overview of the literature and discourse on international agricultural development with categorization of observable actions and institutions in seed systems, the framework developed in this chapter also provides an important link between empirical observations of seed systems in West Africa and engagement with social and economic theories (to be elaborated in Chapter 3) of substantive economies and peasant agriculture, and the social and natural embeddedness of economic systems and individual economic orientations.

**Historical approaches to international agricultural development**

Dominant international development theory and practice in the modern, post-World War II era has largely followed economic and social theory emanating from the First World – that is, from the United States and Western Europe, and the international institutions based there. Theories about how best to achieve economic growth, and the relationship between economic systems and social well-being, have defined both development approaches and their intended outcomes. Integral to international agricultural development as well is the role of technology, in terms of how it is generated, how it is incorporated into specific social and natural contexts, and the impacts of its use. In the following section, I overview literature that situates international agricultural development within shifting development theory and practice (Peet and Hartwick, 2009), critical assessments of unintended and negative impacts of development (Chambers, 1974; Edwards, 1989; Escobar, 1995), and macro-level empirical analyses of change in global agri-food systems (Friedmann and McMichael, 1989; Friedmann, 2005). I highlight three distinct stages of international agricultural research and development: paternalistic, transfer-of-technology approaches dominant from the 1950s to the 1970s, including the Green Revolution; neoliberal
shifts toward free trade and privatization in the 1980s and 1990s, which expanded the benefits and risks associated with Green Revolution technologies; and current inclusive, market-oriented sustainable agricultural development, which I argue adapts but does not fundamentally challenge the original Green Revolution approach to technology development and the tenets of neoliberal agricultural production systems.

Transfer-of-technology in international agricultural development

Rist (2002) traces the modern origins of international development to the post-World War II context in which the Marshall Plan, to support Western European rebuilding, and diplomatic efforts to hedge against Soviet expansion were foundational to United States foreign policy. The idea of extending technical knowledge and assistance to Third World or non-aligned nations was initially framed by President Truman as a way to share “the benefits of our scientific advances and industrial progress” with the majority of the world’s citizens, who at the time were “living in conditions approaching misery. Their food is inadequate. They are victims of disease. Their economic life is primitive and stagnant.” Supporting economic development was necessary because “their poverty is a handicap and a threat both to them and to more prosperous areas.” At the outset, international development aid was clearly, if implicitly, linked to the escalating Cold War and the growing assumption that countries with alternative political or economic arrangements would undermine United States expansion and prosperity by opting out of the capitalist global economy. The vision for these underdeveloped areas was, much like the Marshall Plan, to remake them in the image of the industrialized First World. The United States was, as Truman explained, “pre-eminent among nations in the development of industrial and scientific techniques. The material resources which we can afford to use for assistance of other peoples is limited. But our imponderable resources in technical knowledge are constantly
growing and are inexhaustible” (quoted in Rist (2002): 71). Both technological and economic techniques upon which United States agricultural production systems, among others, are based have been enshrined in and exported through international development ever since.

It might seem overly tedious to focus on a few remarks made as an addendum to a much more immediate proposal for European reconstruction by President Truman. However, I think that his comments clearly reflect the goals of economic and social modernization that characterize the transfer-of-technology (and techniques) stage of international development that followed them (Peet and Hartwick, 2009). Generally agreed-upon goals of increasing standards of living, sharing knowledge, and supporting human well-being were seen to be achievable everywhere as they had been in the United States – through the use of science, technology and capitalist market economics. Furthermore, President Truman’s words are particularly prescient for agricultural development in particular, and are strikingly similar to those used by Norman Borlaug in his Nobel Prize acceptance speech 22 years later. Borlaug calls on the world to increase food production “with the help of our Gods and our science,” to help those in the “forgotten world” who “live in poverty, with hunger as a constant companion and fear of famine a continual menace.” Borlaug warns that there is no “elixir to cure all ills of a stagnant, traditional agriculture.” He then goes on to describe the development and transfer of hybrid wheat and rice from Mexico to southeast Asia, marveling that “never before in the history of agriculture has a transplantation of high-yielding improved varieties coupled with an entirely new technology and strategy been achieved on such a massive scale, in so short a period of time, and with such great success. The success of this transplantation is an event of both great scientific and social significance. Its success depended upon good organization of the production program combined with skillful execution by courageous and experienced scientific leaders” (Borlaug, 1970).

My purpose here is not to critique the implications of Green Revolution rhetoric (that critique is to follow), but rather to demonstrate the prosaic power that modernization theory
(Rostow, 1959) and transfer-of-technology stories had in the discourse of international development throughout the 1950s, 1960s and 1970s. The goals, practices, and causal mechanisms are direct, causal and linear. Technological advancement leads to greater efficiency by creating packages of techniques and inputs that can be transplanted to any agricultural setting to improve yields. With the specter of famine haunting much of the world, yield increase was the primary goal, and means were secondary to the end of increased production. The changes wrought by the Green Revolution were the result of technological and scientific advancement, hard work by experts, and financially subsidized transfers of technology from research stations to developing countries and regions (Pray, 1981). From the modernization perspective, the subsidized transfers were necessary to jump-start developing countries toward economic “take-off” and industrialization, setting them on a path that would lead to the same types of economic and social conditions enjoyed by the United States and Western Europe (Rostow, 1959). The economic aspects of the transfer-of-technology approach to international agricultural development were in keeping with the neoclassical economic theory prominent in the United States and, to a lesser extent, Western Europe, at the time. Keynesian theories of the public support necessary to build free market economies dovetailed nicely with development language that suggested a paternal role for industrialized countries in extending both technological and economic know-how to developing countries seeking to launch (Escobar, 1995; Harvey, 2006a; Peet and Hartwick, 2009).

Setting international agricultural development within a broader context of macro-economic trends, Friedmann (2005) argues that the mercantile-industrial food regime of the mid-20th century instituted industrial agriculture in much of the developing world through the Green Revolution’s emphasis on modern agricultural technologies and capitalist economic arrangements. The transfer of hybrid seeds, synthetic fertilizers and pesticides, and mechanization also meant the creation of new markets for the multinational corporations selling
these inputs, corporations headquartered in the developed world. Critics of development policy at the time took issue with the unequal economic and political arrangements inherent in global industrialization, arguing that support by developed countries for developing countries to modernize their agricultural and manufacturing sectors was in fact an extractive exercise. Less developed countries were by definition on the periphery of the global economic system, the terms of which were set by the core countries with more developed institutions and economic capabilities (Cardoso and Faletto, 1979). This world system could only lead to dependency of the periphery on the core, for continued transfers of technology and conditional economic growth (Wallerstein, 1974, 1988; de Janvry, 1981). In part reacting to these macro-level analyses of the dominant development discourse, development practitioners began to articulate an alternative vision for communities and countries, one that re-centered the needs and priorities of individuals and places (Chambers, 1974; Cohen and Uphoff, 1980; Cernea, 1991). Though participatory practices were not well-defined and discussed until the 1980s, it is important to note the similarities in development critiques of the 1960s and 1970s, and the subsequent articulation of alternative understandings of economic and social change that emerged from on-the-ground experiences during the same time period.

The transfer-of-technology approach to agricultural development culminated in the Green Revolution, which was led by agricultural scientists and international bureaucrats, and was conceived of at the global scale to address systemic problems (Pray, 1981; Chambers and Jiggins, 1987; Reijntjes et al., 1992). Integral to the Green Revolution, and at the same time emergent from it, was the system of publically funded international agricultural research centers known as the Consultative Group for International Agricultural Research, now known as the CGIAR Consortium (Herdt, 2010; CGIAR, 2011). Interestingly, the CGIAR centers are organized around geography and cropping systems, so that even research on a global scale is still only applicable in certain contexts. This dissertation project is being carried out in conjunction with the
International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), which, as the name suggests, focuses its research on cropping systems that are foundational to semi-arid regions, conducting research on pearl millets, sorghum, groundnuts and chickpeas, as well as more minor, regionalized crops. Place, then, was from the beginning at least partially incorporated into the Green Revolution approach to transferring agricultural technologies. Missing almost entirely, however, were the supposed beneficiaries of the technologies being transferred.

The roots of participatory development can be traced back in direct contrast to transfer-of-technology approaches that were uni-directional and privileged only scientific expertise and economic efficiency, both acontextual types of knowledge that trumped the particularities of place. By the mid-1970s, there was an increasing awareness among many agricultural development practitioners that the transfer of Green Revolution technology had not alleviated poverty uniformly across the developing world. Many began asking critical questions about who was benefitting and who was not, why these patterns were emerging, and what role the process of technology development and diffusion had on social and economic impacts (Das, 2002). Robert Chambers, an early and influential proponent of alternative agricultural technology development and diffusion approaches, essentially posed questions about the political economy and the political ecology of the transfer-of-technology approach. Chambers (1974) highlighted the need to understand who participates in setting objectives and diffusing technologies, what kind of knowledge ‘experts’ have of specific social and natural settings, and who benefits from the transfer process and use of the technology. Not only were individual farmers not consulted in the development of new technologies, techniques, and delivery systems, but metrics of change appropriate to specific social contexts were not incorporated into measures of success of the Green Revolution (Kloppenburg, 1991; Uphoff, 1991; Thompson and Scoones, 2009). For social scientists seeking to measure the social impacts of agricultural research and development, the participatory, farmer-first approach outlined by Chambers and others offered an application of the
critical development theories that saw technology transfer as not uniformly beneficial for all people or all nations (Chambers et al., 1989; Edwards, 1989).

If the geopolitical economic arrangements and technologies being transferred all emphasized the industrialization of even smallholder agriculture, what were appropriate measures of impact and success? Yield increase, technology adoption, and economic growth at the national scale were the main goals of the transfer-of-technology approach to agricultural development, and so outcomes were measured accordingly. Yield increases were measured at the national and global levels, based on the assumption that more production would lead to less hunger (Pray, 1981). Sociological investigations into the political, economic and social causes of hunger were lacking, though even Norman Borlaug conceded that the Green Revolution and attendant development programs did not evenly distribute the benefits of higher yields (Borlaug, 1970; Sen, 1981). For social scientists, Rogers’ (2003) theory of the diffusion of innovations provided a framework for social scientists to measure both diffusion, the spread of new technologies, and adoption, “the decision to make full use of an innovation” (21). The innovation/diffusion approach to understanding social change aligns with the transfer-of-technology assumption that an innovation or technology will be created and perfected by experts, and then diffused and adopted in a static manner, without the need for further adaptation to specific social or natural conditions (Roling, 2009; Thompson and Scoones, 2009). Within the international agricultural research and development system, and the CGIAR in particular, social science research generally focused on farm-level measures of adoption of new varieties or new techniques, using economic analysis to model theoretical income increases and decreases in hunger, based on increased production and generation of surplus (Kassam, 2006). Connecting surplus production to profit-generating markets was an implicit but under-emphasized aspect of the transfer-of-technology era, and was expanded with global shifts toward neoliberal economic theory and policy.
Neoliberalism and international agricultural development

Neoliberalism, as defined by Harvey (2006a; 2006b), combines the neoclassical understandings of surplus value and profit as arising from marginal rates of return in the production function with an understanding of liberalism that connects political freedom to freedom in market transactions. Public institutions and governments should, by this logic, limit their range of influence to simply providing systems and structures that allow the market, and individuals within it, to operate freely and rationally, thereby ensuring both efficiency and individual liberty. Neoliberalism as an economic theory began to be explored and articulated by Hayek as early as the 1950s, but it was not until the late 1970s that policy-makers and social institutions began to shift toward the promote and adopt neoliberal policies (Migone, 2011). Peet and Hartwick (2009) trace the slow shift from technology-driven, state-supported economic development that occurred in the 1950s and 1960s to the oil crisis of 1974 and subsequent global financial shocks that allowed neoliberal theory to be instituted in the industrialized First World.

In the two decades following World War II, production and economic growth was strong throughout much of the industrialized world, and those marginalized by the capitalist system were taken care of through taxation and the provision of public services. For agricultural producers, modernization theory meant a push toward vertical integration and modernization of farms, pushing out small farmers. Based on (perhaps overly romantic) social desires to maintain the family farming tradition, there were also strong subsidy support programs for farmers to buffer against swings in the global markets (Lobao and Meyer, 2002). In developing countries, the 1960s and 1970s saw a push for import-substitution based on calls to increase productive capacity and wealth while also increasing standards of living at home (Peet and Hartwick, 2009). Agricultural marketing boards provided many smallholder farmers with a guaranteed and stable
market for their cash crops while also prioritizing self-sufficiency in staple crops through subsidies for agricultural inputs (see Roth and Abbot, 1990, for an example from Burkina Faso).

As a result of Keynesian and related modernization policies, the financial crisis of the mid-1970s saw many countries, developed and developing, vulnerable in their financial obligations to local populations as well as, for many developing countries, indebted to international lending institutions (Peet and Hartwick, 2009). With national economies overstretched and international institutions unable to cope with increasing social and material needs around the world, neoliberalism was institutionalized in the early 1980s by the contemporaneous Reagan and Thatcher administrations (Harvey, 2006b). By providing a strong argument for private wealth creation and its “trickle down” effects on general economic well-being, neoliberal rhetoric freed governments from the obligation to provide social safety nets in the event that markets failed to provide for some individuals in society. Instead, governments and international institutions sought to establish and enshrine policy and economic structures that promoted free markets, free trade, and complete ability of capital to maximize profits through unfettered exploitation of the places and people with the largest potential marginal gains (Harvey, 2006b). With the global economic system firmly in place, this meant the creation and strengthening of international institutions to regulate trade (the World Trade Organization), credit (the International Monetary Fund) and capital investments (the World Bank) (Peet, 2009).

Friedmann and McMichael’s (1989) food regimes perspective sees the neoliberal period as a time of restructuring in global agriculture, and the trends and tendencies that emerged as a result and in reaction to neoliberal policies play an integral role in the agri-food system of today (Friedmann, 2005). Throughout the 1980s and 1990s, transnational corporations increasingly played a role in the agricultural input industry, as public research institutions and input subsidy programs were eliminated by structural adjustment programs (Roth and Abbot, 1990; Lobao and Meyer, 2002; Kloppenburg, 2004). For international agricultural research and development,
neoliberal policies led to a shift in investment away from paternalistic technology transfers, and toward a leaner research system that relied on market mechanisms and personal responsibility for diffusion and adoption (Moore et al., 2011; Herdt, 2010). At the national level, many developing countries were encouraged and expected to dismantle their state-supported agricultural marketing boards and input subsidies, based on the neoliberal assumption that free markets for inputs and outputs would increase efficiency and allow more profit to remain with the enterprising farmer (Wunsch, 1990).

Though most critiques of neoliberalism emphasize the philosophical and practical underpinnings that have led to the underdevelopment of many people around the world (for example, Shiva and Bedi (2002)), empirical and experiential accounts are ambiguous as to the long-term effects of neoliberal policies on social well-being and agricultural livelihoods in particular. Busch (2010) argues that the deregulation ensured by economic policies created spaces for new types of governance that embody social and cultural values (examples include certification standards and origin labeling). This governance requires strong political or social institutions as that can function on a similar scale to the economic system, and as neoliberalism became increasingly globalized in the 1990s, government and public governance systems did not keep pace, especially in rural, agricultural regions and nations (Woods, 2007; Moore et al., 2011). Many developing nations were not able to create or maintain the types of institutions necessary to mitigate the effects of the global neoliberal system for the most vulnerable people, due largely to the conditions mandated for participation in global financial institutions and global trade (Peet, 2009). For public agricultural research and development, the 1980s and 1990s are often described as essentially “lost decades,” with little new investment in a sector assumed by many in development institutions to be increasingly irrelevant to national and international economic growth (McMichael, 1997; Djurfeldt, 2013). In response to both macro-level policies and individual experiences on the ground, however, peasant organizations and rural development
practitioners responded to the marginalization of agriculture in the neoliberal era by analyzing their own situation and creating alternative organizations to support their own agricultural needs (Desmarais, 2002; McMichael, 2006; Borras et al., 2008).

Evaluations of changes in African agriculture and rural communities, both in terms of investment and outcomes, suggest that there was an absolute decrease in well-being and standards of living during the neoliberal period in much of sub-Saharan Africa (Smith, 1989; Bryceson, 2009). Standards of living in sub-Saharan Africa in the post-colonial era had been bolstered by state-run agricultural marketing boards that supplemented wages while providing competitive exports on the world markets. Countries like Ghana, which maintained a modified cocoa marketing board throughout the neoliberal era, have stabilized poverty growth in comparison fully liberalized countries like the Ivory Coast (Daviron and Gibbon, 2002). The political economy of globalized neoliberalism in the agricultural sector, with its emphasis on commodity exports and price-setting markets, also meant that food crops and the communities that relied upon them were negatively impacted by self-regulated markets (Birner and Resnick, 2010). Mosley and Chiripanhura (2009) argue that countries like Ghana and Uganda saw decreases in overall poverty with liberalization because they did not fully embrace the liberal aspects of neoliberalism, instead supporting smallholder farmers in entering the commodity markets and reinvesting state revenue in public services. More recently, Moseley et al. (2010) demonstrate that the effects of global food price spikes in 2007 and 2008 were buffered in those countries, like Mali, that had moved away from an emphasis on their comparative advantage (via low labor costs) in certain commodity crops and refocused on food self-sufficiency.

Awareness of the differential and exclusionary effects of neoliberal policies led to the articulation of robust alternative approaches to agricultural development in the 1980s and 1990s. For many natural and social scientists working in international agricultural research and development, experiences with farmers’ own understanding of their agricultural and economic
systems led to the development of participatory methodologies that build upon local knowledge rather than seeking to replace it. From a social development point of view, participatory practice seeks to validate local knowledge and starts from an epistemology of partiality and situatedness. In agriculture in particular, local knowledge is seen by many practitioners as foundational to, rather than impeding, agricultural development. Paul Richards’ (1985) articulation of the relationship between objectivist science and place-specific social and natural elements of agricultural systems directly challenged both the transfer-of-technology and neoliberal paradigms, which offered universal solutions for heterogeneous ‘problems.’ Participatory plant breeding (PPB) is one example of participatory plant science (Sperling et al., 1993) that broadens understandings of whose knowledge is valid in the scientific process. In terms of alternative approaches to economic development, articulations of peasant economics and household dynamics offer conceptualizations of economic decision-making that is embedded in and secondary to the social setting (Halperin and Dow, 1977; Ellis, 1988; de Janvry et al., 1991). I will elaborate upon these theoretical contributions and their implications in the next chapter, but for now it is important to note that the totalizing forces of neoliberalism not only created the possibility for alternative spaces of resistance, as Busch (2010) suggests, but also for alternative interpretations of experience that emerged to challenge the neoliberal narrative of free markets increasing well-being.

The paradox of neoliberal development theory (as a subset of the global neoliberal economy) is the fact that poverty is understood as both a failure of market forces and an ill to be rectified through perfect free market access and participation. For non-economist social scientists, the neoliberal approach to international development did not promote nor was it receptive to research that offered a critical understanding of differentiated impacts of universal economic policies. For international agricultural research centers like ICRISAT, social science research became largely focused on economic modeling and quantitative adoption studies. From
1974 to 2000, there were never more than two sociologists employed across all of the ICRISAT (in West and East Africa, and India), and for all of the 1990s there were no sociologists or other non-economist social science research staff (Kassam, 2006). However, social and natural scientists working from universities and other development organizations were very active in developing participatory rural appraisal and assessment techniques that supported a range of alternative agricultural and rural development projects and processes (Chambers, 1991; Bunch, 1982; Ashby and Sperling, 1995). Integral to the participatory approach is a recognition that experiences of change will be situated and conditional for individuals based on their social and natural settings (Chambers et al., 1989). For many development practitioners working on the edges of the neoliberal economic institutions (in agricultural United Nations organizations, for example), gender became the most potent example of a social characteristic that affects an individual’s experience of economics, agriculture and environmental change. Gendered analyses of agricultural development often connected women to the environment, using metaphors and making arguments that essentialized both nature and gender in an effort to create a narrative of the destruction caused by neoliberalism (Leach, 2007).

Another response to the monolithic understanding of means and ends asserted by neoliberal development theory, put forth by economists like Amartya Sen and later Jeffery Sachs, was less radical than participatory assessments of agricultural and economic systems (Brooks et al., 2009). Sen (1999) combines the imperative to deregulated economic activity integral to neoliberalism with recognition that free action requires more than simply free markets. Sen’s (1999) capabilities approach (see also Nussbaum (2011)) to defining and measuring international development goals offered a palatable amendment to neoliberal theory by maintaining the liberal goal of personal freedom but removing the neoclassical assumptions that markets would necessarily create those freedoms. The Millennium Development Goals were generated out of Sen’s and others’ work on substantive freedoms as buffers for unequal market forces, with the
basic idea being that education, health care, environmental conditions and more provide a necessary foundation for full participation in markets, and so development should approach the ideal of free market economics from a rather Keynesian position of creating the conditions that make market participation possible. For many social scientists, Sen’s (1999) articulations of the freedoms to be supported and in which to invest seem inherently reductionist, based as they are on liberal capitalist ideals (McMichael, 2008). However, a more sympathetic reading of Sen’s (1999) argument demonstrates at least a theoretical awareness that social context and history define the freedoms people seek and the opportunities they value. The development as freedom approach (Sen, 1999) makes explicit the assumption that market-based economics and the freedom for individual economic action will in the end be privileged by all people. However, “if a traditional way of life has to be sacrificed to escape grinding poverty or minuscule longevity...then it is the people directly involved who must have the opportunity to participate in deciding what should be chosen” (Sen, 1999: 31).

Market-oriented sustainable international agricultural development

The adoption of the Millennium Development Goals (MDGs) in 2000 seemed to mark a turning point away from the neoliberal ideal of economic development through free markets and toward an approach to international development that focuses on human development and expanding individual capabilities for livelihood action (UNMDG, 2010; Nussbaum, 2011). Sen’s (1999) framework is, however, explicitly situated within a classical understanding of economic efficiency as synonymous with human well-being. Tripp (2001) and others (Brooks et al., 2009) argue that even the less austere, more inclusive human development approach taken by the MDGs and current emphases on developing human and social capital define the end goal of development only as market-oriented economic growth. In the literature on contemporary agricultural
development in this dominant paradigm, there is an explicit understanding that a “relative decline of agriculture during [economic] transformation is paradoxical but inevitable,” and that investment should be focused on increasing agricultural efficiency through technology (Webb and Block, 2012: 12309). Escobar (1995: 17) suggests that there is a continuity to the current macro-analyses that drive agricultural development, since “to speak development, one must adhere to certain rules of statement that go back to the basic system of categories and relations,” which derive from modernization theory and market economics. In this section, I combine critical assessments of the roles of technology and economic theory in the contemporary discourse of sustainable agricultural development analysis to highlight the continuities and subversions of contemporary agricultural development practice.

The current players in market-oriented agricultural development scene are both the usual suspects – USAID, the CGIAR system and agri-business input suppliers – and a few new players. Most notable of the latter are the Bill and Melinda Gates Foundation, which began supporting international agricultural research and development in 2005, and AGRA, a financially and ideologically related organization focused solely on agricultural development in sub-Saharan Africa. Herdt (2010) chronicles the role that private foundations have played over time in supporting the CGIAR system and international agricultural research more generally, and highlights the significant role (in terms of percentage of funding) that the Gates Foundation is currently contributing to international agricultural research. Busch (2010) has argued recently that in the context of international agricultural research, the CGIAR system and attendant organizations play a small role in terms of resources when compared to private enterprise. In sub-Saharan Africa, however, public international agricultural research has long been a major component of overall agricultural research, in part because of the lack of markets that justifies aid money makes private business unattractive (Renkow and Byerlee, 2010). The influx of
philanthro-capital into the public international agricultural research system has already had a huge influence on priority setting and research agendas in the CGIAR system (Brooks et al., 2009).

Brooks et al. (2009) suggest that the commitment to technology that created the endowment now funding the Gates Foundation plays out in the silver bullet approach to agricultural technology development and diffusion being instituted in current agricultural research agendas. These silver bullets include high-yielding hybrid seed varieties (Alene et al., 2011), the efficient use of synthetic fertilizer called microdosing (Aune and Bationo, 2008), and value-chain creation through the support of local input agrodealers (Scoones and Thompson, 2011). Both the problem identification and proposed solutions put forth by the Gates Foundation, USAID and other leaders of market-oriented agricultural development derive from what Friedmann (2005) describes as the current corporate-environmental or green capitalist food regime. The emphasis is on growing local value chains, supporting local entrepreneurs, and creating regional supply chain linkages (Van Mele et al., 2011; Byiers and Liu, 2013). In essence, the current food regime reflects the more general approach to sustainable development that incorporates economic, social and environmental concerns into the global economic governance system (Lawrence, 2005).

Dubé et al. (2012) describe the inclusion of non-economic variables and priorities in market-oriented sustainable development as spaces of convergence, where multiple human development goals can mutually reinforce one another. The creation of local agro-input shops, for example, supports rural development and local agency while also creating efficiencies on the input side of the agricultural value chain (Scoones and Thompson, 2011). Long and Roberts (2005) argue, however, that sustainable development is effectively still based on neoliberal economic theory, and that value chains will inherently create differentiated outcomes that cannot increase economic, social and environmental well-being while still uniformly prioritizing economic efficiency. The foundational assumptions of modernization theory and capitalist market economics are consistently present in these convergent spaces, a rhetorical reality that
becomes apparent as one explores more specific goals and processes associated with market-oriented agricultural development. For example, food price spikes in 2008, though caused by political and economic policies more than by production failures, reinvigorated calls for production-oriented agricultural development in sub-Saharan Africa, and at the same time maintained the market orientation that has been critiqued for both inhibiting food security and creating uncertainty in global food prices and access (Bryceson, 2009; Evenson and Gollin, 2003; McMichael, 2009; Sen, 1981).

In reviewing the literature on market-oriented sustainable agricultural development and the value chain approach, I see the questions of what, for whom, and how answered implicitly through emphasis on innovation and diversification processes in agricultural and economic systems. Innovation builds social infrastructure that facilitates market interactions, and diversification supports livelihood portfolios and agrobiodiversity. Innovation, in the framing of market-oriented development, relates to the efficient use of technology in order to take advantage of market opportunities (Deghan et al., 2010). At their best, innovation approaches to market-oriented agricultural development recognize the social nature of agricultural systems, research and technology, and seek to incorporate contextual understandings into the standardized technologies and markets being developed (Hall et al., 2003). At its worst, innovation is reduced to efficiency in diffusion (Roling, 2009). In terms of final goals and measurable ends, then, quixotic sociological variables “tend to cancel themselves out, leaving the economic variables as the major determinants of the pattern of technological change” (Griliches, 1957). Because of the inclusive rhetoric related to sustainable and human development, the outcomes of innovations processes are often discussed using social language, with building human and social capital being the main goal of many innovation-oriented processes (Fine, 2003; Johnson et al., 2003). Long (2008) in particular argues that an emphasis on social capital is in fact contemporaneous with ongoing neoliberal economic theory, which suggests that people without access to markets in
which to generate capital will use interpersonal networks to create new economic leverage points. Institutionalizing those leverage points creates social infrastructure, defined here as the social-level connections created through and used to enhance locally oriented economic development (Sharp et al., 2002; Flora and Flora, 1993). Social infrastructure can be measured through capacity to act through local channels to enhance economic well-being (Swanson, 1996).

Innovation, within the market-oriented framework, facilitates and is facilitated by market-oriented social infrastructure.

A second theme in the market-oriented agricultural development literature is the diversification of economic activities and production systems to create a buffering system for agricultural households in high-risk settings and to capitalize on market opportunities (Baumann, 2002; Thompson and Scoones, 2009; Zimmerer, 2007). Batterbury (2001) describes these two options as diversification for survival versus accumulation. In much of the agricultural development literature, specifically that which focuses on livelihood portfolios, diversification for survival seems to be celebrated as creating the potential for accumulation, rather than as a response to the pressures of market-oriented agricultural economic and production systems being imposed from the outside (see Bebbington and Batterbury, 2001, for an extensive critique of globalization and diversification). The opportunities created for smallholder farmers by global agricultural value chains require flexibility and adaptability, which can be celebrated as niche-finding or critically analyzed as destabilizing more stable, locally integrated economic systems in favor of higher possible returns on agricultural production and other livelihood pursuits (Lee et al., 2012). In addition to diversification of agricultural livelihoods, agrobiodiversity as a characteristic of production systems is being championed in the current market-oriented sustainable agricultural development literature, particularly in relation to new emphases on underutilized crops. Mushita and Thompson (2008) describe the shift from early calls for locally diversified agricultural production systems in the new Green Revolution for Africa, to current
silver bullet approaches that focus on a more diverse field of crops than the first Green
Revolution but still do not prioritize agrobiodiversity over production efficiency. This analysis
echoes Zimmerer’s (2003) analysis of the place-specificity of agrobiodiversity conservation,
which by definition cannot be scaled up through standardized management or development
approaches.

Critical analyses of contemporary agricultural development discourses suggest that it is
not the convergent, complementary spaces but the mutually exclusive spaces of market-oriented
sustainable development that could allow for innovative, alternative types of social and
environmental change to emerge in relation to agricultural systems (Busch and Bain, 2004;
Busch, 2010). Pretty et al. (2011) argue for sustainable agricultural intensification that does not
start from a market orientation and then seek the possible inclusion of social and environmental
concerns. Instead, agroecological and low-external input approaches to agricultural production
are identified as more appropriate to many rural developing country contexts than an orientation
toward global value chains (Snapp and Pound, 2008; de Schutter, 2010; Smale and Mahoney,
2010). The low-external input approach to sustainable agriculture has a long history connected to
participatory processes and a commitment to validating and starting from local ecological and
agricultural knowledge (Chambers et al., 1989; Reijntjes et al., 1992). A similar set of alternative
understandings of peasant economics and the embeddedness of markets within social settings is
also connected to critiques of conventional agricultural development approaches over time (Ellis,
1988; de Janvry et al., 1991; McMichael, 2006). The theoretical implications of various
understandings of peasants and agricultural households will be discussed further in Chapter 3.
Bryceson (2009: n.p.) offers an explicit explanation of how the neoliberal and market-oriented
approaches to agricultural development have undermined agroecological and localized
production, social and economic systems, and argues that “for the sake of human welfare,
agricultural productivity, and national stability, smallholder agriculture is preferable to large-scale, highly capitalized agriculture.”

How do innovation and diversification play out in the alternative spaces excluded from the current push for market-oriented agricultural development? For some farmers, communities and agricultural development practitioners, the goal should be reagrarianization, the creation of new systems that put land, food and farmers at the center, to counter the differentiating effects of the global capitalist system (Djurfeldt, 2013). Richards (2010) calls for a Green Revolution from below that prioritizes experimentation with and adaptation of agricultural technology to meet individual and community needs. Stone (2004; 2007) defines the experiential learning and adapting of technology as skilling, and provides an important critique of the necessity for in situ experiential and social skilling with new agricultural technologies for resource-poor farmers. From this viewpoint, heterogeneous agricultural, ecological and social settings will condition the applicability of a new technology, effectively removing the possibility of a silver bullet. The epistemological conclusion of these understandings of innovation and experimentation, as agricultural development theorists from Boserup (1965) to Richards (1985) have long argued, advocates for an approach to agricultural development that validates local experimentation and adaptation.

Adaptive innovation with agricultural technologies is not enough, however. I argue as well that innovative economic and social arrangements should be encouraged and supported by agricultural development approaches that recognize the limitations of past transfer-of-technology and neoliberal approaches. The participatory nature of technology development that has supported skilling processes with agricultural technologies is much harder to extend to economic arrangements, given the monolithic theory of capitalist market economics. As Zein-Elabdin (2010) suggests, postcolonial or subaltern convictions have not yet found a role in mainstream economics. However, as I will explore further in Chapter 3 and throughout the analysis presented
in this dissertation, the same epistemological understandings that inform participatory research and technology development can be used to support systems of sharing and access to agricultural inputs and outputs that do not assume a modern, utility-maximizing economic orientation. Social certification of seeds, where quality is guaranteed by social trust rather than in a laboratory, is one particularly relevant example of an economic arrangement that can emerge from a skilling process as more appropriate for many farmers than formal seed certification (Thiele, 1999; Sperling and McGuire, 2010). Local value chains based solely in traditional markets are another adaptive approach that embeds extra-local economic imperatives in a local, social context (Lee et al., 2012; van der Ploeg, 2010).

Just as innovation can be seen not as a means for technology diffusion but as a way to re-center agency with individuals and communities, diversification is also conceptualized not only as a means to capitalize on niche markets, but as a tool for resistance and self-sufficiency. The food sovereignty movement has built upon critical theory’s analysis of food regimes and global capitalism to articulate an alternative vision of the food system that reflects many smallholder farmers’ experiences with the differentiated effects of modern agricultural development (Vía Campesina, 2007; Desmarais, 2008). Diversification of livelihoods is seen by many agriculturalists not as an opportunity but as out of sync with their natural and social settings, where stability and buffering again risk is prioritized over possible wealth accumulation (de Janvry and LeVeen, 1986). Carr (2013) builds upon this experiential knowledge and analysis, and offers an alternative understanding of livelihoods as a dynamic process of aligning the “often-contradictory arenas” of “social goals and material needs” (77). In terms of agrobiodiversity, the incorporation of sustainability into current market-oriented agricultural development approaches do to a certain extent validate in situ conservation of genetic resources and integrated systems. One important challenge to maintaining agrobiodiversity that arises from market-oriented agricultural development approaches, however, is the inability or illegality of seed saving as
formal certification and markets are legislated and hybridized seeds prioritized (Mushita and Thompson, 2008). Responses to the potential decrease in agrobiodiversity associated with market forces include the creation of seed banks and alternative breeding networks, as well as organized movement against biotechnology that precludes seed saving (Shiva and Jafri, 2002; Kloppenburg, 2004; Kinchy et al., 2008). Participatory approaches to agricultural technology development also often make support for biodiversity an explicit goal and measurable outcome of their work (Lilja et al., 2001).

The persistent heterogeneity of agricultural models and farmers that exists in the contemporary peasant world is reflected in critiques and calls for disaggregated data analysis across analytical categories and levels (van der Ploeg, 2008; Doss, 2013). At the abstract systems level, the market-oriented agricultural development framework tends to lump all non-entrepreneurial farmers into a category of inefficient or non-modern; this is not done out of malice, but rather with exactly the opposite intention. The goal is to increase well-being through market integration, so it is necessary to create clear categories of farmers operating within or outside of the market system, so as to better design technologies and development projects that expand the virtues of agricultural value chains and markets. In heterogeneous environments, however, process and outcomes will vary as well, and many critiques of both dominant and alternative, participatory approaches argue that recognizing complexity is not enough. Without asking questions about status, exclusion and differentiation, even alternative approaches to development can disingenuously perpetuate the type of power dynamics that participatory theory critiqued in technological modernization approaches to agricultural development (Agarwal, 2001; Cornwall, 2003; Guijt and Shah, 2008).

Critiques of aggregated data and standardized process as flattening difference are most developed by feminist scholar-practitioners observing the way that gender is being increasingly mainstreamed in international agricultural development as simply an observed social
characteristic rather than as a potential signifier of alternative needs and priorities (Leach, 2007). Disaggregating data by gender can validate women’s knowledge and create gender-specific approaches to agricultural development (Sachs, 1996; Jagger et al., 2012; Doss, 2013). The end goal of these critiques, however, is to characterize complexity and diversity in order to understand differentiated impacts of specific development processes or goals. For those researchers and practitioners with a commitment to validating alternative systems and identities, it has long been important to use research methods that combine place-based knowledge of both agricultural production, and social and economic systems (Chambers, 1974; Richards, 1985; Chambers, 1991). For example, Momsen (2007) and others make the case for considering gender in conjunction with the conservation of agrobiodiversity, arguing that women have both unique knowledge of certain local plants and specific systems of maintaining that knowledge that differ from men’s knowledge and from women’s knowledge about non-local species (Sachs et al., 1997; Shiva, 2001). The interactions among gender, seed type, conservation and use demonstrate how seeds and seed systems provide a particularly salient example of the confluence of individual characteristics, and traits of the social and natural context. Recognition of the complexity inherent in seed systems suggests that research methods and expected impacts should anticipate differentiated effects of the move toward seed value chains and market-oriented seed system development.

Seed systems in international agricultural development

Seeds and seed systems have been central to both the technologies and the institutional arrangements that have been generated by the international agricultural development system throughout its modern history. At a general level, seed systems are can be defined as “a set of market and non-market institutions that govern farmers’ access to and use of seeds, and of the
genetic resources held therein” (Lipper et al., 2010: 5). Seed systems are further differentiated between formal and informal, categories that become increasingly complex with the inclusion of new actors in the agricultural development field. Definitions of the formal seed system have shifted over time to reflect the contemporaneous approach to agricultural change, from the transfer-of-technology emphasis through neoliberalization to contemporary market-oriented sustainable development projects. Informal seed systems have consistently been the catch-all, ‘everything else’ category, defined in relation to formal seed systems (and so reflecting the development discourse of the moment), and also as traditional or pre-modern and therefore static (Sperling and McGuire, 2010). The goals and assumptions of seed system development have followed the trends in international agricultural development, from a focus on public support for research and dissemination, to a push toward privatization and commercialization. More recently, there have been calls to integrate the most effective elements of public and private, and formal and informal seed systems to create an integrated seed system development approach, especially in sub-Saharan Africa (Louwaars and de Boef, 2012). In the following section, I provide an overview of seed systems in the context of international agricultural development over time, and identify key distinctions in the literature to provide a framework for characterizing contemporary seed systems. I then apply that framework to seed systems in Sahelian West Africa in order to highlight the history and current state of seeds and seed systems as they relate to this research project.

Formal seed system definition and elements

Formal seed systems have been categorized over time based on characteristics of specific steps in the chain that creates access to seeds for farmers. Seeds were integral to the transfer-of-technology approach to agricultural development that characterized the first Green Revolution,
and since the emphasis during that time period was largely on characteristics of the technologies being diffused, formal seed systems were defined as those institutions and actors that supported the creation and certification of distinct, uniform and stable crop varieties through scientific breeding (Bishaw and Turner, 2008; Berg, 2009; Lipper et al., 2010). In the era of state-supported agriculture in both developed and developing countries, formal seed systems were largely organized and managed by public entities like land-grant universities in the United States, and the CGIAR system and national agricultural research systems (NARS) in the international context (Pingali and Kelley, 2007; Kloppenburg, 2010). In the run up to and first decade of the Green Revolution, the formal seed systems in many developing countries reflected a division of labor across the different elements of the seed system (Tripp, 2001). CGIAR centers would provide the basic research and plant breeding expertise, which resulted in the creation of improved crop varieties that could then be multiplied by NARS and other national government agencies (van Gastel et al., 1997). Seeds were disseminated directly through government and NGO aid programs that provided seeds for free, as well as through sales by parastatal organizations (akin to grain marketing boards) that were subsidized by national governments and international donors (Tripp, 2001). In short, formal seed systems in the first few decades of modern international agricultural development were largely defined by the technology of improved variety seeds and their genetic make-up, which were then diffused through institutional mechanisms premised on farmers’ need for and inability to purchase improved variety seeds.

The genotype by environment heuristic often used in modern plant breeding, which refers to the interaction between genetic make-up and variation in the natural environment, provides a useful means of understanding the shifts in the formal seed system over time (Desclaux et al., 2008). Transfer-of-technology era formal seed systems were defined almost entirely by the genotype of the seed being transferred, and because the institutions involved were national and regional (defined by cropping ecosystems), the natural environment was taken into account at
certain scales (Richards, 1985). The standardization of genetic traits was occurring within a
given setting (even if still largely on research stations rather than in farmers’ fields), and seed
diffusion was place-specific because organized by public entities. By the early 1970s, however,
as Green Revolution seeds and associated production systems were shown to be profitable for
certain farmers in certain conditions, there was a shift from describing formal seed systems as any
mechanisms to diffuse improved variety seeds toward the goal of establishing market-based seed
institutions (McCann, 2011). Initially, this push came less from the global capitalist forces that
were consolidating formal seed systems in the United States and other parts of the developed
world (Kloppenburg, 2004), and more from a recognition that modern plant breeding and seed
production came with a high price tag, and might be more sustainable if farmers could pay some
of the costs associated with acquiring seed from the formal seed system (Tripp, 2001). The goal
of cost-recovery associated with public breeding and seed subsidization programs in the 1970s,
however, coincided with the rise of global neoliberalism, and shifting understandings of formal
seed systems coincided with changes in the broader frame of international agricultural
development.

Because the neoliberal mandate demanded a decrease in public funding for goods that
could be privatized, many developing countries decreased or stopped their support for formal
seed systems throughout the 1980s and 1990s (Tripp and Louwaars, 1997). In addition,
international donor support for agricultural development also peaked in the early 1980s and has
been declining ever since (at least up until the recent food price crisis) (Herdt, 2010; Lynam,
2011). For the development of the formal seed system, however, the neoliberal era of agricultural
development was less a time of neglect than a time of restructuring and redefinition. Seed
systems were incorporated into the general trend toward market liberalization and privatization,
so that formality became defined not only based on the technology, the seed, but also on the type
of institutional arrangements used to diffuse the seed (Lynam, 2011; Tripp, 2001). Formality in
the seed system now included privatization and commercialization of seed production, multiplication and diffusion (Bishaw and Turner, 2008).

In the developed country context, as Kloppenburg (2004; 2010) has detailed, neoliberalism accelerated the dispossession and genetic enclosure of both seeds and seed system configurations through the rise of private investment in agricultural research, complete commercialization of seeds, and the application of intellectual property rights to plant breeding activities. Formal seed systems in the developing world did not experience the same consolidation and expansion as that described by Kloppenburg (2010) for two key reasons. First off, the mandates of structural adjustment sought to shift investment in the seed sector from public funds to private entities, but did not account for the fact that staple cereals and tubers in much of the developing world had little commercial value to private agricultural corporations (Ndjeunga, 1997; Tripp, 2001; Bishaw and Turner, 2008). By definition, the resource-poor farmers engaged with the publically funded formal seed sector of the 1960s and 1970s did not have the cash to create sufficient demand for profit-oriented economic actors to take over seed production and commercialization (Tripp, 1997; McCann, 2011). In addition, the highly variable natural environments in sub-Saharan Africa mean that genotype by environment interactions limit the standardization and scalability of improved varieties, which runs counter to the economic efficiencies necessary for private entities (Scoones and Thompson, 2011). Diversity is a necessary and key component of both socially and agronomically viable seed systems of any type in highly variable natural environments (Richards, 1985; Zimmerer, 2003). Economic efficiency, however, tends to prioritize standardization over heterogeneity, in order to capitalize on economies of scale. In order to counter this challenge, neoliberal formal seed systems sought to standardize the natural environment, through the use of fertilizer and pesticides, in order to standardize the range of genotypes that needed to be offered (Desclaux et al., 2008).
A second challenge to neoliberal formal seed systems in the international context was the foundational commitment to public research and public outputs held by the CGIAR system. NARS research could be pushed out or shifted toward a private enterprise orientation by Washington Consensus demands for austerity, but the international public agricultural research system could not be similarly restructured. Instead, the CGIAR system and related publically funded international agricultural research was simply defunded, as private multinationals were encouraged to enter the international agricultural development arena (see Smale et al. 2011 for a description of this approach with maize). Kloppenburg (2010) describes the neoliberal era as “emasculating” the public agricultural research sector, because of both lack of funding and the threat of privatization of publically identified and maintained genetic resources. As the public sector dwindled throughout the 1980s and 1990s, informal seed systems (farmer activities outside of the formal institutions) did not dwindle or become incorporated into the privatized formal seed system. Instead, informal seed systems have remained the bulwark of most farmers’ seed access options (Almekinders et al., 1994; Louwaars and de Boef, 2012).

The contemporary restructuring of the global food regime described by Friedmann (2005) has been reflected in agricultural development approaches in general and more specifically, in seed system definitions and goals. Recognition of the low commercial value of many staple grains (Ocran, 1997), the versatility of the public agricultural research sector (van Gastel et al., 1997; Lynam, 2011) and the reincorporation of environmental and social externalities into the capitalist framework has led to new definitions of formal seed systems and approaches to developing them. Contemporary definitions of formal seed systems generally relate formality to the value chain approach, where “formal systems are purposively composed of separate activities to provide new varieties, maintain their purity, certify the seeds and distribute them to farmers, usually through officially recognized seed outlets” (Bentley et al., 2011: 8). Some descriptions are more explicit about the centrality of standardized technology and markets to formal seed
systems: “the formal seed sector is comprised of certified seeds of improved varieties produced by scientific breeding and distributed through commercial seed channels” (Lipper et al., 2010: 5). Others emphasize that formal seed systems operate at the national or international level (rather than at the community or regional level) and can be public or private (Bishaw and Turner, 2008). When taken together, we can see that the assumptions and frameworks of both the transfer-of-technology and neoliberal eras of agricultural development have been incorporated into contemporary definitions of formal seed systems as situated in the current corporate-environmental food regime (Friedmann, 2005).

One wrinkle in the contemporary market-oriented approach to formal seed system development can be analyzed through the lens of current trends toward public-private partnerships (Scoones and Thompson, 2011). Public-private partnerships build on the value chain approach to identify comparative advantage at different links in the value chain, theoretically creating new efficiencies and integrating profit into development. Formal seed systems could be made more dynamic by the integration of both public and private institutional actors, which would broaden the social and institutional environment that interacts with specific genetic characteristics of improved varieties (Desclaux et al., 2008). Louwaars and de Boef (2012) describe the inherent contradictions for public international agricultural research institutions like the CGIAR system, with its commitment to creating public goods, and the economic efficiency goals of potential private partners. Public formal seed value chains are largely development oriented, which means a primary emphasis on plant breeding, heterogeneous environments and underinvested crops. Private seed value chains are profit-oriented, and throughout the neoliberal era private seed enterprises focused mostly on high value-added crops and varieties like hybrid maize (Smale et al., 2011; Louwaars and de Boef, 2012). Contemporary critiques of public-private partnerships in seed systems highlight the political economy of commercialization and exclusion in developing country agriculture, and argue that formal seed systems with a privatized
component are inherently limited in their ability to provide for farmers with few resources (Shiva, 2001; Stone, 2002; Kloppenburg, 2010). Other agricultural development scholars argue that public institutions’ roles in public-private partnerships can shift the power dynamics away from exploitation and incorporate some of the externalities associated with profit-oriented development into a more sustainable market-oriented approach to seed system development (Wield et al., 2008).

Building on these critiques and ambiguities, Louwaars and de Boef (2012) offer an integrated seed system development framework for sub-Saharan Africa that institutionalizes both profit and development orientations in formal seed systems, and links the formal system to the informal seed systems through connections at a range of levels. This integrated approach reflects the market-oriented sustainable international agricultural development framework described above, by expanding the seed value chain to include public and informal institutional actors and systems. A corollary to integrated seed system development has been efforts to connect participatory plant breeding activities to the formal and informal sectors. PPB activities have been an important component of the public development-oriented formal seed system for the past two decades, and have done much to integrate a range of natural and social environmental variables into scientific plant breeding (Ceccarelli et al., 2009). As these programs reach their end stages, the desire to connect these participatory but still formal programs to both formal and informal seed diffusion systems has led to some uncertainty of how to proceed. Badstue et al. (2012) describe the participatory crop improvement process as seeking to broaden or shift the epistemological assumptions of modern plant breeding by acknowledging the genotype by environment interactions that vary by social and individual context. The same acknowledgement will be necessary for seed diffusion approaches that seek to integrate formal and informal seed systems, since informal seed systems, as will be explored next, are not necessarily based on market principles. Because the current push for public-private partnerships to support formal and
integrated seed system development gives primacy to the privatization and commercialization of seeds, informal seed systems are more likely to be co-opted rather than validated by integrated seed system development (Kloppenburg, 2010).

**Informal seed system definitions and elements**

Informal seed systems have in the modern era consistently been defined as “everything else” that is not formal. Depending on the development discourse that sets the parameters for what qualifies as the formal seed system, the alternative has been called traditional, informal, local. These modifiers derive from the scientific and economic analysis of seed systems, and do not necessarily fit with farmers’ experiences of different seed access options and possibilities. In particular, the distinction between seed access through economic exchange versus access through social provisioning channels has been underdeveloped in the seed system literature (Zimmerer, 2003; van der Ploeg, 2010). I provide here a description of informal seed systems as they have been widely described in the literature on agricultural development approaches, and offer a brief overview of alternative distinctions in seed access systems, which derive from theories of peasant organization and which will be explored in depth in Chapter 3.

The rhetoric of the modernization era and the first Green Revolution focused mostly on the traits of the seed to define both formal and informal seed systems. Recall Norman Borlaug’s (1970) description of traditional agriculture as “stagnant,” and the rhetoric of new, improved varieties to counter static and underperforming traditional agricultural systems. This analysis is not meant to insinuate that Green Revolution scientists and proponents were malicious in their characterization of traditional agriculture and traditional crop varieties in particular. Instead, the emphasis on new and improved varieties suggests that the main axis of differentiation for seed systems in the modernization era was based on the type of seed being extended (Berg, 2009).
Tripp (2001) describes farmer management of seed production and reproduction as being characterized by a high degree of genetic diversity, which, as previously been discussed, creates a buffer against uncertain natural conditions in high-pressure environments (Richards, 1985; Nuijten, 2005; Zimmerer, 2007). Genetic diversity is here conceptualized at the scale of the seed; that is, formal seed systems are defined as providing seeds that are distinct, uniform and stable at the genomic level (Bishaw and Turner, 2008). Traditional, farmer-managed seed systems create seeds with a high degree of genetic diversity at the genomic level, because seeds of traditional varieties, or landraces, are not managed to be genetically pure (Wood and Lenné, 1997; Berg, 2009). Similarly, formal, improved variety seeds managed by farmers become “creolized” or “rusticated” through intentional or unintentional genetic mixing, thereby entering the non-formal, traditional system (Morris et al., 2003; Meng et al., 1998; Bellon et al., 2010). Creolization can refer either to seed intentionally generated through crosses between improved varieties and landraces (see for example Wood and Lenné, 1997) or to the genetic mixing that occurs naturally through cross-pollination and is then recognized and accounted for by farmers (Bellon et al., 2010; Meng et al., 1998). Some scholars see traditional seed systems as maintaining higher degrees of agrobiodiversity at the agricultural system scale as well (Shiva and Bedi, 2002; Momsen, 2007). Other studies have shown that formal seed systems, especially those deriving from public plant breeding programs, do not necessarily decrease agrobiodiversity (Smale et al., 2011; Lipper et al., 2010).

Traditional seed systems during the transfer-of-technology era, then, were mostly defined based on the type of seed being provided, as characterized at the genetic level. As the Green Revolution became increasingly marketized, formal seed systems began to include explicit description of how the seeds were being produced and distributed. By the time that neoliberal theory and practice began to frame agricultural development more generally, informal seed systems were characterized not only by the type of seed but also by the type of access mechanism
instituted by the system. The neoliberal ideal was not only genetically distinct and standard improved varieties (a standardized, commodified good) but also a standardized, profit-oriented exchange system (de Janvry and LeVeen, 1986). With the combination of seed certification laws and the rise of intellectual property rights, the type of seed was effectively linked to the type of access. Formal improved varieties could only be accessed through sales from institutions that had produced seeds through formal scientific processes, and formal sales could only be of officially certified seeds (Kloppenburg, 2010; Lipper et al., 2010). That meant that informal seed systems came to be seen as truly everything else – all other kinds of seeds, traditional, creolized and uncertified, and all other kinds of transactions, in local markets with cash, through exchanges and gifts (Almekinders et al., 1994).

The informal seed system as described by the neoliberal era continues to be the predominant conceptualization in agricultural development literature and within the public research organizations (see Thiele, 1999, for example). Van Gastel et al. (1997) highlight the need for the CGIAR system to engage with the informal seed sector, since their mandate is to work on undercapitalized agricultural systems. Given that the CGIAR system is both less completely able to participate in the neoliberal framework because of its public mandate and still clearly operates within the modernist paradigm that prioritizes genetic purity and standardization, engagement with the informal seed system means only those parts of it that could be reasonably thought to provide access to improved variety seeds. Because of this ambiguity in public research related to informal seed systems, much of the literature has shifted slightly to draw distinctions among formal seed systems as a singular configuration, informal seed markets based on cash exchanges, and traditional seed exchanges and gifts (Smale et al., 2008; Sperling and McGuire, 2010; Louwaars and de Boef, 2012). Reframing the categories to re-separate type of seed from type of access allows public and alternative varietal development approaches like PPB to engage
with informal seed markets as distinct from the rest of the informal seed system to facilitate diffusion of improved varieties (Weltzien and Christinck, 2009; Badstue et al., 2012).

Yet another conceptualization of seed systems is beginning to emerge as the value chain approach to market-oriented sustainable development is applied to seed systems. Value chains provide an explicitly spatial component to seed systems and the institutions that comprise and govern them. In this framing, local seed systems are patterns of production and reproduction that occur at a local, community or landscape scale (Bellon et al., 2010). Some scholars collapse the formal/informal dichotomy and have begun to instead categorize seed transactions, which include all possible types of seeds and access points (Badstue et al., 2002; Lipper et al., 2010). Others have begun to describe new institutional arrangements that can connect the formal and local scales. Farmer organizations (Tripp, 2001; Coulibaly et al., 2008) and local input sellers or agrodealers (Scoones and Thompson, 2011) are two examples of new institutional arrangements that can support seed system integration, particularly in sub-Saharan Africa (Louwaars and de Boef, 2012). Because the current rhetoric and reality around market-oriented sustainable development is more inclusive than previous neoliberal market dictates, the linkages being created between formal and local seed systems are accessible to a much wider range of farmers than the fully commodified seed sector vision of the 1980s and 1990s. Regional and national-level seed enterprises, for example, are able to reproduce a range of varieties of local staple crops that were unprofitable for multinational companies in the past (Van Mele et al., 2011). The need for more context-appropriate sales, in small amount and for low cost, has led to the development of the mini-packet approach that is the foundation of this and other research projects (see also Thiele, 1999; Sperling and McGuire, 2010).

Local, informal, traditional seed systems, when defined in direct contrast to formal seed systems, become a static category of activities and institutions. An alternative conceptualization, which I will explore in more detail below but which bears noting here, is of seed provisioning
systems as distinct from economic or exchange-based seeds systems. In analyzing the seed system literature, I see a clear distinction between seed systems based on social and ecological priorities, and seed systems which incorporate some or all elements of the economic value of seeds and agricultural production inherent in formal seed systems. Seed provisioning systems are place-specific and relate to cultural and social histories and habitus (Bourdieu, 1984). Seed transaction systems (modifying Badstue et al., 2002), are those based on some type of economic valuation and exchange. Both provisioning and economic seed systems are dynamic and contemporary, rather than the old/new, traditional/modern dichotomies that tend to define informal and formal seed systems. Richards et al. (2009) begin to elaborate upon the spatial, temporal and procedural differences between seed provisioning, which starts from place-specific social history and priorities for seeds, and conventional seed systems. They suggest that “full description of the functioning of, and knowledge states within, West African farmer seed systems would require account to be taken, therefore, of a range of seed acquisition strategies and distribution processes, including on-farm crossing and selection, retention and distribution strategies, seed loans, market acquisition and local and scientific experimentation” (Richards et al., 2009: 200). In the conceptual framework presented in the final section of this chapter as well as in Chapter 3, I will build on this framing of seed systems to characterize the current state of sorghum and pearl millet seed systems in Sahelian West Africa not as formal or informal, but as those based on provisioning or economic exchange, within which are a range of seed access configurations.

**Social infrastructure in seed system development**

The value chain approach to seed system development that derives from the current market-oriented, sustainable agricultural development discourse seeks to integrate seed systems at
various scales by building social infrastructure (Badstue et al., 2002; Louwaars and de Boef, 2012). Seed systems based on market exchanges of some type require a range of market-oriented social infrastructure at every step of the seed value chain. Field trials, demonstrations and field days from PPB projects provide means to spread information about new varieties and how to access the seeds (Weltzien et al., 2003; Bishaw and Turner, 2008). The establishment of seed producer organizations had facilitated connections between formal plant breeding programs and local seed systems by connecting farmer seed producers to information and training about producing new varieties (Trædal, 2005; Coulibaly et al., 2008; Dalohoun et al., 2011). Linkages between the public and private sectors in terms of seed marketing and commercialization are difficult at the international level, given the CGIAR system’s mandate of creating public goods in the name of development (van Gastel et al., 1997). Relationships between national and sub-national ‘local’ seed enterprises, however, are being championed as an important new type of development-oriented public-private partnership that keeps value chains and their profits local (Gisselquist, 1997; Dalohoun et al., 2011).

Scoones and Thompson (2011) argue that the general consensus on sustainable agricultural intensification emanating from the major private, public and philanthropic players in international agricultural development frames market-oriented social infrastructure as a win-win situation for all actors in all types of seed systems. Public entities focus on providing both upstream research and downstream regulatory structures. Private enterprise at a variety of scales provides much-needed expansion and dissemination of the scientifically generated and certified technologies. And farmers increase production and so food security by accessing seeds through a variety of channels designed to meet their needs (Scoones and Thompson, 2011). However, underlying the supposed dynamism and flexibility of the value chains approach to seed system development are assumptions about the superiority of markets and of improved variety seeds that limit the possible types of social infrastructure being instituted to facilitate seed access. Rather
than allowing seed systems and the appropriate infrastructure to support them be emergent through a learning process for farmers and institutions at every scale, market-oriented development is still prescriptive, even if more inclusive (Richards et al., 2009). This means that innovation and the diversity of possibilities for types of seeds and seed access systems that innovation-as-learning can generate are sidelined by innovation-as-adoption (Roling, 2009; Tansey, 2011).

Stone’s (2004; 2007) analysis of skilling and deskilling by farmers in changing seed systems provides an important example of how the social infrastructure associated with market-oriented seed system development must provide time and space for experimentation and adaptation by farmers, in order to maximize the benefits of any seed system intervention. The market-oriented social infrastructure associated with PPB approaches to seed system development allows for social and experiential learning with improved variety and other types of seeds, and if similar learning were facilitated in relation to seed access, a wider range of social infrastructure could emerge (Bishaw and Turner, 2008; Badstue et al., 2012). Kloppenburg (2010) suggests that because the CGIAR system has a public mandate in relation to genetic resources, the international research system “should be the institutional platform for knowledge generation based on the principle of sharing rather than exclusion” (379). The social infrastructure associated with sharing rather exclusionary principles would be that found in provisioning systems, as well as non-monetary seed exchanges. Examples of these types of social infrastructure include social certification (Sperling and McGuire, 2010) and truthful certification, which embeds quality control in local, social relationships rather than in economic transactions (Tripp, 2001).

Gisselquist (1997) argues that levels of standardization in seed systems can provide access to wider range of farmers than can formal systems alone. Singh et al. (1997) suggest that providing training and information to farmers about seed saving and reproduction techniques can strengthen both market-oriented and social infrastructure by facilitating place-specific links between the two.
**Seed systems in Sahelian West Africa past and present**

Formal seed systems in Sahelian West Africa have been jointly maintained and supported by ICRISAT and the NARS throughout much of the post-colonial modern international agricultural development era. ICRISAT has historically provided a significant portion of the scientific expertise necessary for a modern plant breeding program, as well as the facilities to maintain quantities of breeder seed within the Sahel (Ndjeunga, 1997). During the transfer-of-technology era, NARS produced foundation seed and engaged in seed multiplication, seed that then provided to government-subsidized programs, NGOs and aid organizations (Rohrbach, 1997). Much of the national-level public sector capacity was lost through structural adjustment policies that cut funding for public research and extension throughout the 1980s and 1990s, but Sahelian West African countries generally did not completely acquiesce to neoliberal demands. Moseley (2011) explains how Mali’s emphasis on food self-sufficiency over the past twenty years helped to buffer against the worst price spikes during the 2008 food crisis. Burkina Faso, in contrast, reduced its public expenditures for food security throughout the 1980s and encouraged farmers to enter the cotton commodity market (Roth and Philip, 1990). Across West Africa, there is a current emphasis on market-oriented seed system development, with extensive investments in national seed enterprises in Mali and Niger (Daloahun et al., 2011), agrodealer training in Mali (Scoones and Thompson, 2011), and the strengthening of seed production laws and producers cooperatives in across the region (Coulibaly et al., 2008; Smale et al., 2010).

With ongoing efforts at seed sector liberalization in Sahelian West Africa (see Van Mele et al., 2011) and the current push toward market-oriented value chain development, there have been efforts to harmonize seed laws at the national and regional level. The seed laws that were recently passed, and which reference international standards, effectively tie all sanctioned seed system changes to the dominant value-chain approach to agricultural development (INSAH,
2009). It is now illegal to sell uncertified seeds (Dalton et al., 2010), and certification is cost and land-prohibitive to many small farmers, since certain production and quality standards must be met. In one study site for this project, the farmer organization active in the area had the number of seed producers drop from 64 to 3 from 2009 to 2010, with the implementation of certification standards that include minimum field size. The formalization of seed production laws undermines the PPB approach to crop improvement, which professes the intention and outcome of supporting both the development of material improvements (seeds), and a range of skills and knowledge upon which farmers can build (Okali et al., 1994). The innovation process in Sahelian West Africa continues in relation to varietal selection and information dissemination; seed diffusion, however, is limited by legislation and aid agendas that focus on a market-oriented value chain approach that is more localized than the neoliberal mandate to fully privatize agricultural development in the 1980s and 1990s, but does not validate or support seed systems that are not based economic transactions.

Contemporary influences on local seed systems include the ongoing pressures of low and erratic rainfall and associated risks (Raynaut, 1997; Jalloh et al., 2013), as well as novel approaches to seed system development like PPB. Weltzien et al. (2008) note that farmers report appreciation not only of links to the formal seed system that come from participation in PPB activities, but also the connections among farmers, which provide an opportunity for social skilling with new varieties through conversation and observation (see Stone, 2004, for skilling). Traditional or local seed systems in Sahelian West Africa are best defined not in relation to formal seed systems, but instead as consisting of both provisioning activities and economic exchanges embedded within social relations. A consistent theme of local seed systems is the social injunction against purchasing or selling seeds in many areas of Sahelian West Africa (Smale et al., 2008). Provisioning seed systems and the social infrastructure associated with them are instituted instead by sharing, kinship obligation and a cultural understanding of seeds as a
social good (Siart, 2008; Smale et al., 2010). Interestingly, the social infrastructure that exists within local markets provides a space within which seed exchanges are acceptable, perhaps in part because these exchanges are still mediated by social relationships and in part because of the pragmatic necessity in the most risk-prone areas to sell or exchange seeds in some way (Smale et al., 2010). Local transaction seed systems are connected to contemporary developments at other scales of the formal seed system, and new configurations of informal seed systems are starting to emerge as farmer organizations and seed producer associations are strengthened (Diakité et al., 2008).

**Conceptual framework for characterizing dimensions of seed systems**

Reviewing the literature on approaches to international agricultural development as they relate to seed systems, I see the need to expand definitions of seed systems beyond a single measure of formality or informality. Categorizing seed systems based on combinations of three dimensions – type of seed, type of access activity, and value of output – allows for a dynamic assessment of how farmers’ seed access decisions create patterns that institute distinct seed systems. Distinguishing among dimensions of the seed system also broadens understandings of how distinct seed systems are and can be integrated without being subsumed. The seed system dimensions described in this section and depicted in Figure 2-1 derive from the seed systems and agricultural development literature overviewed in this chapter (see, for example, Dalton et al., 2010, for a two-dimensional description of seed systems). Transfer-of-technology era definitions of seed systems focused on the type of seed being extended, while access activities (economic exchange versus some other action to access seeds) were the main focus of the neoliberal era’s push for privatization of seed diffusion at the global scale. Finally, contemporary approaches to
sustainable seed value chain development incorporate implicit assumptions about the economic or social value of the agricultural output in relation to the social and natural context.

Figure 2-1. Conceptual model of seed system dimensions

Figure 1 presents a conceptual model of the different dimensions of the seed system, configurations of which define specific seed systems. As skilling (Stone, 2004) occurs differently for individual farmers across these dimensions of seed systems, patterns of seed access and use will emerge to define both the limits of the formal seed system as well as the characteristics of a range of alternative systems. In descriptions of these dimensions that follow, I draw on critical theory to categorize the range inherent in each dimension, to broaden the either/or dichotomies often present in the seed system literature. The discursive nature of seed and varietal definition derives from a political economy understanding of technology development (Yapa, 1996), and I apply critiques of the sociology of science and plant breeding to conceptualize alternative definitions of types of seeds. The action taken to access seeds can be oriented toward provisioning or economic exchange, and there are multiple types of exchanges that are relational to one another but also derive from distinct social and economic priorities. Finally, characterizing
the value of the output to the individual using the seed helps to both explain the type of seed and type of access decisions made, and to assess appropriate seed system developments for specific groups of individuals.

The transfer-of-technology era largely defined seed systems based on what type of seed was being extended, and the framework in Figure 2-1 expands the categorization based on contemporary descriptions of types of seeds in integrated seed systems. Seeds can vary from those of various types of improved varieties (including open-pollinated and hybrid) originating as germplasm in formal breeding programs and produced as certified seed, to creolized or rusticated seeds that evolve as improved varieties outcross, intentionally or not, in the fields of farmers and the resulting seeds are saved and reused, to landraces bred and managed through mass selection by farmers and communities (Bellon et al., 2010). The natural properties of the species (as cross or self-pollinated) and the variety (improved open-pollinated or hybridized) influence where seeds fall on the ‘type of seed’ spectrum, since these characteristics affect the extent of outcrossing in the field and how well the variety traits are reproduced from saved seed (Rohrbach, 1997; Bishaw and Turner, 2008; Berg, 2009). However, identifying seeds by assessing the genetic level might not be the most appropriate construct for many situations. Cleveland (2001) presents several epistemological approaches to plant breeding that define improved varieties and other types of seeds in different ways. Objectivist approaches derive from a general positivistic approach to modern agriculture that prioritizes genetic uniformity over other measures of distinctness or uniformity. Discursive, constructivist approaches allow for place specific categories, like creolized or rusticated seeds, as well as for critical reflection on the political and economic influences on plant breeding that push for specific definitions of ‘improved’ (Cleveland, 2001; Harding, 2006). The constructivist approach makes explicit the role the varietal definition has played in seed system development approaches over time, and makes possible the characterization of seed systems using combinations type of seed and the action
taken to access them through saving and sharing. For example, farmers’ actions to save creolized seeds, to purchase new improved variety seeds each year, or to plant only self-selected landrace seeds each comprise distinct seed systems in the constructivist characterizations.

The neoliberal era of international agricultural development incorporated access activity as the defining feature of formal seed systems, contrasting standardized market-based seed sales with all other access activities. Drawing on the literature overviewed above, the type of access activity dimension of seed systems in Figure 2-1 ranges from provisioning activities through all types of economic exchanges. Provisioning, which will be discussed in detail in Chapter 3, include non-exchange-based access actions of seed saving and seed sharing (van der Ploeg, 2010). Economic exchanges range from formal, based on standardized price and currency, to informal and non-formal. I draw here on Hart’s (2006) description of informal markets as directly relational to formal markets, in that prices generally related to formal market prices but are adjusted to reflect the social context in which informal exchanges are set, which is outside of formal economic institutions. Non-formal exchanges are conditioned first by the social context, because the currency used for exchange is non-monetary and place specific. The exchange rates are still related, however, to the formal and informal exchange systems to which non-formal seed exchanges are connected (Hart, 2006; Lipper et al., 2010). The various possible activities for seed access all occur within the same natural and social setting, and so are connected by points of overlap where contextual influences push or pull farmers from one access activity to another. The analytical tool of setting all seed access actions on a single spectrum not only highlights Hart’s (2006) description of exchange types as relational, but also strengthens Lindblom’s (2001) argument that the market system is a unique configuration of variables situated within a much broader context in which people make use of markets and economic exchanges in a range of ways.
The final dimension of seed systems, made explicit by the value chain approach to agricultural and seed system development, is the value of the output or agricultural production to the farmer. The first two dimensions of seed systems – seed type and access activity – vary based on a complex genotype by environment interaction that accounts for social, economic and natural environment (Desclaux et al., 2008). Farmers’ ultimate decisions about seed access and use are then made based on their orientation toward and desire for social value or economic value, including use, exchange and commodity-value, of the output (Schumpeter, 1909; Tool, 1977; Marx, 1978). By emphasizing seed value chain development, market-oriented formal seed systems are predicated on the assumption that farmers will experience and then prioritize the commodity-value associated with improved variety seeds and their output. In Figure 2-1, I again take a constructivist approach to understanding seed access actions, and argue with Badstue et al. (2002: 13) that “seed flow is a social process, a negotiation, in which people’s decisions can be interpreted as responses adapted to conditions characterizing their current situation—economically, socially, and culturally.” The social value of seeds includes but is not limited to economic value, with social value being reflected in social institutions like family obligation as well as in economic institutions like price-setting markets (Schumpeter, 1909). I highlight here Marx’s (1978) description of the genesis and definition of economic value in various exchange systems. In particular, exchange-value is identified an intermediate step between pre-capitalistic economies based on the simple circulation of use-value and fully commodified and utility-maximizing modern capitalistic systems. Exchange-value can be conceptualized as value added in relation to conditions of the local context, in contrast to commodity-value, which (at least theoretically) is defined as standardized and aspatial level. In practice, exchange-value is the price of grain in the local market, which varies with local preferences and seasonal needs, and can be conditioned by social imperatives of communal well-being that limit price spikes for
maximum profit. In contrast, commodity-value is prioritized by selling grain to outside buyers based on standardizes prices, with no social obligations conditioning the price.

**Summary**

Figure 2-1 depicts three dimensions of seed systems that have been emphasized in modern approaches to international agricultural development. Each dimension of the seed system has been used over time to characterize the formal/informal seed system dichotomy, as well as to define the ultimate goals of both seed and agricultural production systems, and the farmers who institute them. Goodman and Depuis (2002) argue that a critical commodity chain analysis is meant to challenge the assumptions inherent in economic valuation of each step of product production and development. Because the value chain approach to seed system development is new and still emergent, I argue as well that recognition of the way that social and natural settings condition valuation of seeds’ output provides an additional dimension to configurations of seed use decisions that institute distinct seed systems. As Badstue et al. (2002) argue about maize in Mexico, “although it can be sold, bartered, lent, or given away, farmers’ behavior and attitude towards seed is different than towards a commodity” (13). Seeds play a unique role in agricultural systems in the developed and developing world, and expanding and supporting seed systems that provide access to a wide range of farmers requires acknowledgement of the reproductive potential inherent in seeds (van der Ploeg, 2010). In this dissertation, I apply agrarian political economy to the development and analysis of seed value chains in Sahelian West Africa, using the conceptual heuristic developed here to analyze farmers’ experiences with, and potential exclusions from, seed systems that are increasingly formalized and commodity oriented.
Chapter 3
Theoretical framework

The review of literature, presented in Chapter 2, that frames and critiques approaches to international agricultural development over time raises several questions about the relationships among social, economic and natural systems, and the ways in which individuals and societies create and perpetuate those relationships. What are the social and economic priorities and needs of rural, agricultural households and communities? What social and economic arrangements have met those goals in the past, and how do these arrangements incorporate technological and economic changes that occur within and outside of the scale at which society and economy is organized? How are social and economic priorities and systems influenced by the natural setting within which agriculture is practiced? Finally, how can social scientists use patterns of individual decision making to understand the priorities that institute and perpetuate social and economic systems within a given natural context?

In the following sections, I first explore Polanyi (1944, 1957b) and other theorists’ (Granovetter, 1973, 2005; Lindblom, 2001) understandings of how economic systems are embedded within and are manifestations of social systems, and focus in particular on Polanyi’s (1957b) articulation of substantive economics as a conceptual approach to understanding how economic arrangements differ across social and natural contexts. Theories of embeddedness and substantive economy challenge the assumption of positivist capitalist economics that economic efficiency and rational decision making is a generalizable feature of all economic arrangements (Friedman, 2008). Once an alternative understanding of economic activity as embedded within specific social and natural settings is presented, I then explore the relationship between individual
actions and social systems (with economic systems now seen as a subset of social systems more
generally). Bourdieu (2005) argues that “the social world is present in its entirety in every
‘economic’ action” taken by an individual, meaning that there can be no objective, generalizable
theory of economic action (à la Friedman) (3). Instead, individuals’ experience of their social and
natural settings informs the decision-making that over time institutes an economic system that is
‘reasonable’ within a given context (Bourdieu, 2005). Economic actions reflect the value of the
outcome or output to an individual, and I draw on Marx (1978) to highlight the ways that
economic value is conditioned by social and natural context. By drawing together Marxian
dialectics, and interpretive and post-structuralist understandings of economic systems as
manifestations of social systems, I seek to reinforce the argument that economic analysis is not
singular and acontextual, but instead is particular to the social and natural contexts within which
economic decisions are made (Polanyi et al., 1957).

Using the framework developed through the synthesis of Polanyi and Bourdieu’s theories
of economic embeddedness and reasonable economic decision-making, I then explore definitions
of peasants and peasant agriculture in order to provide examples of how social and natural
settings condition substantive peasant economies, as well as peasant provisioning systems.
Theories of peasant agriculture and peasant economics have been making similar arguments
about the conditional role of economic systems within the context of smallholder agriculture
since the early 20th century, beginning with Chayanov and continuing through to contemporary
articulations of the persistence and emergence of non-capitalist peasantries (Mann and Dickinson,
1978; van der Ploeg, 2008). Finally, I provide a focused overview of the use of scale in
sociological approaches to economic analysis, since scale is an important and under-incorporated
characteristic and category in the theories being presented here, as well as in value chain
approaches to agricultural development described in Chapter 2 (Peck, 2005). I incorporate
explicit notions of scale into the integrated theory that reasonable decision-making institutes
provisioning systems and substantive economies. The integration of theories across scales in this chapter is a precursor to the analysis presented in Chapter 9, where I synthesize the qualitative, quantitative and visual analyses presented throughout this dissertation in order to offer a characterization of provisioning seed systems and substantive seed economies in Sahelian West Africa, which include but are not limited to the value chain approach to seed system development currently being prioritized implemented by contemporary agricultural development projects.

Agricultural systems in developing countries offer a unique opportunity to explore questions about the relationships between social organization, economic theory and natural setting because of the explicit contingencies that each aspect of the system places on the other two (van der Ploeg, 2013). This contingency is most obvious, perhaps, in the constraints and opportunities created by the natural setting, which shape farmers’ production possibilities and affect economic decision making. In arid environments, for example, the possibility of drought becomes an integral part of farmers’ planning process, so that buffering against risk through diversification becomes more of a priority than achieving economies of scale through standardized practices (Swinton, 1988). Because agriculture is central to rural livelihoods in many parts of the world, economic arrangements related to agriculture at the local scale reflect specificities of both social and natural contexts. De Janvry et al. (1991), for example, articulate the non-separable nature of many smallholder farming households, where production and consumption decisions are integrated due to agricultural households’ ability to produce and reproduce most, if not all, of the necessary inputs to sustain themselves. The dominant trend in agricultural development throughout the modern era has been to ‘scale up’ productive and economic efficiencies, an approach that minimizes the heterogeneity of social and natural settings, and reasonable economic and agricultural systems within them (Da Costa and McMichael, 2007; Brooks et al., 2009).
The questions posed in the opening paragraph of this chapter are implicitly answered in both the dominant and alternative discourses about international agricultural development, through the ways in which technology, markets, participation and scale are incorporated into development approaches, and their stated goals and intended outcomes. However, a comprehensive theory of the relationships among society, economy and nature is rarely made explicit or consistently applied within and throughout the literature on needs, projects and impacts of international agricultural development. In this chapter, I take a step back from the literature on agricultural development in particular to explore the theoretical underpinnings and implications of the questions raised by contemporary approaches to international agricultural development. Using sociological theory to create a framework that connects the contextual, systemic and individual scales, I seek to make explicit the ways in which personal decisions influence and are influenced by social and economic systems, in order to challenge the primacy given to economic efficiency and rational decision-making in contemporary market-oriented development. I then apply the framework provided by sociological theory more generally to discussions about social and economic arrangements in agrarian societies, in order to highlight the unique position of agriculture in relation to both human and natural systems.

Definitions of the economy

Before diving into abstract theories of embeddedness and substantive economies, a few definitions are in order. First off, what is the economy, and how are economic goods defined? Economists and sociologists generally agree with Adam Smith’s (2003) original framing of economic activity as “truck, barter and exchange,” but disagree as to the range of possible goals of economic activity (Granovetter, 1985). For economists trained in the classical tradition, operating within the objectivist framework described by Friedman (2008), economic activity is
driven by an individual desire to maximize utility in a world of scarcity, a desire that is defined as economic rationality. The utility maximizing framework means that economic possibilities and decisions can be described and measured by the degree to which they are fully rational, and ideal-type characterizations of economic systems can be defined \textit{a priori} to a specific social setting. More contemporary strands of economic thought, like new institutional economics and resource economics, broaden and complicate understandings of how individuals identify and evaluate personal and collective utility and the value of goods. New institutional economics, for example, defines human institutions, formal and informal, as dynamic and iterative, so that the structures and arrangements guiding individual evaluations and actions reflect specific histories and places (Ménard and Shirley, 2008). However, new institutional economics continues to see institutions, organizations and the individual actions they engender as responding to the basic assumed conditions of scarcity of and competition for material resources and goods (North, 2008).

Natural resource and environmental economics further explore the nature of scarcity and competition for different types of resources and goods, particularly those that exist in and derive from the natural world. Romer (1990) argues that characteristics of both technologies and institutional settings determine the type of economic arrangements needed to manage competition for different types of goods. Conventional private goods are rivalrous, meaning that intrinsic properties of the good prevent it from being used by more than one actor at a time, and excludable, in that the technological and institutional setting provides mechanisms for one actor to prevent the use of the good by other actors. Public goods are nonrivalrous and nonexcludable (Romer, 1990). Resource economics recognizes as well that goods can fall between and overlap with these two ideal categories, resulting in complex possibilities for market and governance structures to provide access and use. Taking the example of seeds, Morris et al. (1998) defines seeds as both a private, consumable input and as a public source of germplasm. Smale (2006) further elaborates, explaining that “seed is highly rival, with low cost of exclusion, but the genetic
resources embodied in seed are non-rival and the costs of controlling their use can be high” (4).

Both resource economics and new institutional economics provide a more nuanced and complex understanding of individuals’ economic decision making than that offered by neoclassical theories of utility maximization. However, these and other schools of economic theory continue to analyze all relationships and transactions to meet material needs through the lens of competition among individuals for access to scarce resources.

Granovetter (2002) argues that the “methodological individualism” inherent in classical economics does not allow for the recognition of interpersonal relationships or social systems that might influence not only the functioning and organization of the economy (an influence that is accounted for in sub-disciplines like new institutional economics), but also the motivations that underpin economic activity in the first place. The contemporary economic schools overviewed above address the first set of critiques by incorporating characteristics of human institutions and different types of economic goods into understandings of individual decision making. However, as made explicit by North (2008), a foundational underpinning of economic analysis is that decisions about access and use of material goods are made by individuals with basic motivation of maximizing individual well-being in a competitive environment. The goal of economic sociology, in contrast, is to explore both the organization of economic activity and the underlying goals of that activity, recognizing that “other economies need not be miniatures or early specimens of our own, but may be sharply at variance with it, both as to individual motives and organization” (Polanyi et al., 1957: xviii). In sociological analysis, the interests associated with economic activity and institutions are not limited to scarcity avoidance and utility maximization, but can include as well social goals and interests (Nee and Swedberg, 2008). Analyzing the efficacy of specific economic arrangements, then, requires understanding the underlying interests or goals associated with activities undertaken to meet material needs, recognizing that economic efficiency is only one possible goal.
To further explicate the differences between economic and sociological analysis of economic arrangements in society, Polanyi (1957b) offers two definitions of economy:

The substantive meaning of economic derives from man’s dependence for his living upon nature and his fellows. It refers to the interchange with his natural and social environment, in so far as this results in supplying him with the means of material want satisfaction. The formal meaning of economic derives from the logical character of the means-ends relationship, as apparent in such words as “economical” or “economizing.” It refers to a definite situation of choice, namely, that between the different uses of means induced by an insufficiency of those means. If we call the rules governing choice of means the logic of rational action, then we may denote this variant of logic, with an improvised term, as formal economics. (243)

I will explore Polanyi’s understanding of substantive economics below, but first offer my own amended definition of economic activity, based on the range of definitions implicit and explicit in economic sociology and social theory more generally. I define the economy as the set of interactions among individuals and communities that are based on exchange and undertaken to meet material needs. There are four important components to this definition that must be made explicit. First, the economy is defined by human interactions, which make it distinctly social and interpersonal. Self-provisioning and complete autarky, in Polanyi’s terms “the interchange between man and his natural environment,” cannot be considered economic decisions, even if decisions in favor of these systems occur in relation to the social and economic context. The second distinction relates to the first, by characterizing economic activity as human interaction based on exchange. I see an overemphasis in economic sociology on trying to understand all types of social interactions as economic exchanges of some type. I argue that social habitus can set limits on which goods, services and interactions are able to be exchanged, and that in some
settings certain of those will be considered off-limits for economic activity but still shared through gifts.

The third point of emphasis in the definition of economy that I offer above is that defining economic activities as social activities brings influences and interactions at various scales back into analysis of the goals of individual economic decision making. The renewed interest in economic sociology to engage in cross-scale analysis derives from key concepts initially identified in new institutional economics (Sindzingre, 2006; Nee and Swedberg, 2008). In addition to analysis at multiple scales, a final and distinguishing element of the sociological analysis of economic activities presented in this dissertation is the assertion that meeting material need is not the goal of economic activity but the motivation for it. Polanyi (1957b) makes this point implicitly by contrasting formal economic logic, which is predicted on choices made about the use of insufficient means, to substantive economic principles based on “neither choice nor insufficiency of means” (243). Understanding material need as a basic element of the human experience means that systems organized to meet material needs can be based on a range of social principles, including but not limited to rational economic logic. Non-exchange based provisioning systems can be instituted through individual self-sufficiency actions as well as through social interactions not predicated on exchange. Economic systems are another option, and parameters for exchanges to meet material needs will be conditioned by the social and natural context within which the economic activity takes place.

The definition of economy I offer here derives from theories of how economic systems relate to social systems, and how individual decision-making is conditioned by and in turn perpetuates social systems. I start with Polanyi’s overview of various understandings of the economy throughout history. In the edited volume on Trade and Market in the Early Empires (Polanyi et al., 1957), Polanyi and others provide historical analysis of economic arrangements in the ancient Mediterranean societies, highlighting the various configurations of economic
activities that created trade, money, manufacturing and bazaars, but that did not result in profit-maximizing economies. A key analytical tool used by Polanyi and others in analysis of non-capitalist economies is the exploration of the goals of economic activity, as articulated in social and political texts, and the governance structures instituted to facilitate those goals. Polanyi (1957a) makes the argument that the presence of exchange activity and markets is not the defining characteristic of a market economy, since economic activity was noted and fostered long before the profit-maximizing market system was established. He draws in particular on Aristotle’s early writings about economic activity, which emphasize community as the appropriate unit of analysis at which to analyze the economy, since economic activity is social and so inherently reflective of the social context.

Building on Polanyi et al.’s (1957) analysis of markets in ancient economies, Lindblom (2001) clarifies the role of markets in economic activity in modern terms by distinguishing between making use of markets in general and the market system in particular. The physical presence of markets and money to facilitate trade are evidence of coordination of economic activity at a societal scale (Pearson, 1957). The market system, however, is a particular configuration of economic activities, unique in world history, that take market interactions to be the coordinators of society, rather than society coordinating market interactions (Lindblom, 2001). The shift from social coordination of economic activity to economic coordination of social activity has created the tautology that I see in the classical definition of the economy: to be considered economic actors, individuals must economize and maximize utility, but utility maximizing activities are necessary to institute a formal economic system. Any activity that involves exchanges for meeting material needs but is not utility maximizing is not economically rational and so characterized with “negative references or irrelevant ones” (Neale, 1957: 228).

Granovetter (2002) notes that if economic sociology is to make a constructive contribution to understanding the ways in which economies are embedded in social systems,
social theories must move beyond reacting to the narrow definition of economy offered by classical economics. He also emphasizes the pragmatic value in “sharpening” the sociological argument by clarifying where it stands in relation to the economic argument. I see this need for explicit reframing and situating of classical economic theories in calls for alternative approaches to international agricultural development, where classical assumptions about what constitutes economic activity and what the goals of economic activity ‘should’ be are driving the dominant development discourse. Alternative approaches like participatory development and food sovereignty projects are often put on the defensive, and have not yet adequately articulated a theory of development that incorporates their critiques of capitalist market economics and the productivist paradigm (itself a technological manifestation of profit-maximizing economic theory). However, historical economic sociology provides an important foundation from which to develop contemporary ideas about economies as socially instituted processes that can incorporate a range of social and economic goals.

Polanyi and substantive embedded economies

The definition of substantive economics generated by Polanyi (1957b) to describe historical economic systems emphasizes that economic activity is generated within a range of social and natural settings, meaning that scarcity and the trade-offs that insufficient material means demand are not the only logic that leads to exchange systems to meet material needs. The capitalist market system, from which formal economics derives, starts from the almost Hobbesian assumption that in settings of insufficient means to meet material ends, individuals will have to make choices about the most efficient, utility maximizing distribution of scarce resources. And since, in Simmel’s (1982) estimation, scarcity creates value which leads to demand, people are always interacting in a setting of scarcity of the means in which they are interested. Formal
economics posits the end goal of economic activity as the satisfaction of material need through exchange activity, which means that the rules of the exchange are set by the *a priori* assumptions of scarcity and the ideal of economizing action. These assumptions lead to an economic analysis based on the universal laws described by Friedman (2008), and a market system predicated on the laws of supply and demand, as defined by scarcity and choice (Polanyi, 1957b). Seen through the lens of substantive economics, the formal economy is again caught in a tautological trap: systems that are instituted by creating scarcity and choice (through price-setting markets) are instituted on the assumption that insufficiency of means requires the perpetuation of the system.

Polanyi (1957b) argues that formal economic analysis is limited in its ability to understand substantive economic activity that falls out of the scarcity-choice-economizing framework, a framework which is not evident in much empirical description of historical economic systems analyzed by Polanyi and his colleagues (Polanyi et al., 1957). The reframing offered by a substantive definition of economics opens up the missing spaces described by Granovetter (2002), by seeing the economy as an “instituted process of interaction between man and his environment” (Polanyi, 1957b: 248). The economic process includes production, acquisition and distribution of goods, services, and resources, and is conditioned by the limits of the natural setting within which the society is set. Social institutions that are not primarily economic, like government (at least outside of the market economy) and religion, also provide structure to economic processes because of the non-economic social expectations and obligations enshrined in them. However, in the sociological approach to understanding the economy taken by Polanyi, social structures are not static or separate from the patterns of individual motivations and actions that create and perpetuate them, “hence the transcending importance of the institutional aspect of the economy” (Polanyi, 1957b: 249).

Polanyi (1957b) describes the instituting of economic process in terms that border on structural-functionalism, but his emphasis is not on the instrumental outcome of the economic
structures that are instituted. Instead, his view of substantive economic analysis keeps primary attention on the ongoing interaction between individuals, the natural setting, and both economic and non-economic social institutions. At heart, substantive economics is an interpretive rather than instrumental approach to understanding how and why individuals and communities come to certain arrangements to meet their material needs. The notion of the economy as embedded in the social system derives from Polanyian notion of “instituted process;” because the economy is instituted by and among individuals, it reflects their entire experiential reality and will both influence and be influenced by the non-economic social world and the natural environment.

Polanyi’s theory building stems from review and detailed analysis of a range of archaic and non-capitalist economies, and is therefore firmly and explicitly empirically induced. His emphasis on institution as situated action, however, provides a link to more explicitly interpretive and post-structuralist understandings of the relationship between individual action and social systems, which I will explore further below using Bourdieu’s habitus.

Contemporary critiques of Polanyi’s articulations of the relationship between economic activity and non-economic social systems argue that the application of the theory of substantive economy can easily lead to oversocialized hypotheses about the influences of human activity, much like classical economic theory posits an undersocialized version of individual action (Granovetter, 1985). However, the analytical frame enumerated in original descriptions of substantive economics suggests that economic systems must be analyzed on multiple scales and not take for granted the relationships between economic and non-economic social institutions. Hopkins (1957) overviews the three aspects of economic systems that can be characterized in substantive economic analysis: the movement of means to meet material wants (process), the patterns through which actions are integrated (institutionalization), and the degree of embeddedness. Measuring or characterizing economic embeddedness creates a methodological challenge that is too often met with overly simplistic heuristics about how fully free markets are
or the incorporation of social and ecological externalities into market prices. Hopkins (1957) reminds us that centrally planned economies are just as disembedded as fully rational market economic models, which shifts the dichotomous, idealistic view of rational market economics as fully disembedded and all other economic arrangements as fundamentally embedded. However, definitions and explanations of embeddedness remain elusive when operating within the framework of formal economics. Embeddedness comes to be synonymous with non-formal or substantive, which is clearly contrary to Polanyi’s notion of substantive economics providing a unifying analytical approach rather than an either/or articulation for understanding economic activities.

Polanyi’s (1944) early articulation of embeddedness is simple and reflective of substantive economics in general: “man’s economy, as a rule, is submerged in his social relationships. He does not act so as to safeguard his individual interest in the possession of material goods, he acts so as to safeguard his social standing, his social claims, his social assets” (46). In overviewing economies through history, Polanyi builds on Marx’s (1977) observations of a metabolic and social rift that occurred when relationships among people, and between people and nature, were disrupted by economic activity predicated on individual gain rather than social support. Embeddedness, implicitly, can be defined as manifest when land and labor are not economic assets through which to maximize efficiency or profit, and instead where social and natural settings set the limits on how land and labor are used. Halperin (1984) argues that the historical moment in which Polanyi was writing (from the United States, during and after the second World War), led him to obfuscate the influence of political economy and Marxian analysis of economic history on his theories of embeddedness, and to instead focus on institutions as a less ideological aspect of economic systems. I agree with Halperin’s assessment of the Marxian foundations to Polanyi’s theory of substantive economy, and find it useful to highlight
the parallels between descriptions of embeddedness and disembeddedness, and Marx’s ideas of non-objectification and alienation of land and labor (Marx, 1978).

In later works, Polanyi (1966) is more explicit about the relationship between embeddedness and political economy. In the introduction to his analysis of the Dahomey Empire in West Africa, he argues that with the shift from other forms of substantive economies to a capitalist market economic system, “the consequences for man’s idea of himself and his society were fateful: once livelihoods had been organized through an interconnected set of markets, based on the profit motive and determined by competitive attitudes, man's society became an organism that was in all essential regards subservient to materially gainful purposes” (Polanyi, 1966: xvi). Taken apart from Polanyi’s extensive analysis of a range of societies and their economic institutions, this implicit definition of embeddedness could be read as overly reductionist in its description of society and economy. However, when incorporated into analyses that include all three dimensions of substantive economic analysis described by Hopkins (1957) and elaborated below, embeddedness becomes both a relational category and a theoretical abstraction made concrete by assessing the instituted process of economic activity in a specific setting.

Through his own analysis of economies ranging from ancient Greece to West African empires, as well as by drawing from anthropological descriptions of non-Western economies in the 20th century, Polanyi (1957b) identifies specific types of economic process and patterns of instituting economic activities. Economic processes involve movement of some kind, either locational (through production and transport) or appropriative (the circulation and administration of goods). Appropriative processes are further differentiated as either transactions, between actors, or dispositions, one-sided actions based on custom or law that force indirect transactions (taxation and public spending is an example of a disposition). These processes, or actions to meet material wants, are instituted through patterns based on reciprocity, redistribution and/or exchange. Reciprocity and redistribution are defined and situated within social relationships, so
that individual economic decisions occur within social institutions that provide the symmetry necessary for reciprocal relationships, on the one hand, or the social mores necessary to guide redistributive decisions on the other. The specific social institutions that create the possibility for substantive economies instituted through reciprocity or redistribution are varied in terms of their presence and influence in a given society. The generalized point Polanyi (1957b) makes, however, is that economic processes like transactions can be instituted not only through patterns of efficient or profit-maximizing exchange, which require price-setting markets as the primary institution, but also through relationships defined by social institutions like kinship groups.

Halperin (1984) suggests that Polanyi’s understanding and characterization of substantive economies starts from Marx’s analysis of alienation inherent in a shift to market economies, and that in drawing on his own and others’ anthropological data, Polanyi is able to test classical political economy theories across a range of historical and cultural settings in order to further clarify and refine the categories of economic activity and their societal impacts. Elsewhere, Halperin (1994) argues that both Marxian and Polanyian analyses of human economies have taken an overly institutional approach, perhaps in response to the methodological individualism associated with classical economic theory. However, the analytical intent of the substantive economic framework is to create space to uncover economic institutions at a variety of scales within social settings, in order to broaden the understanding of individual economic activity. Hopkins (1957) suggests that the three patterns of institution defined by Polanyi are not necessarily the only three abstract categories of social interactions that condition economies, creating a methodological opening for research and analysis at the individual, institutional and social scales. One contemporary example of such an interpretive dialectic analysis is Hart’s (2010) articulation of informal economy, a subset of activities that generated its own institutions (often referred to as the “black market”) within the broader framework of an economy based on formal market-exchange institutions.
In exploring and applying Polanyian ideas of substantive economics to my own analysis of seed systems in Sahelian West Africa, I found myself echoing Halperin’s (1994) critique of the overly institutionalist methodology that seems to filter out through the category of embeddedness in particular. Returning to the original texts, I see Polanyi taking an interpretive approach to theory building, by consistently referencing the dialectical relationship between patterns of individual action and social institutions. However, the relationship between the individual and the patterns of action he or she produces (which is then conditioned by the social and natural context) is not adequately described or theorized. I turn now to Bourdieu’s (1984: 101) ideas of habitus, “the objective relationship between two objectivities,” to further explore the relationship between individual motivations for economic activity and the economic institutions created by patterns of specifically motivated economic activity. I then relate the substantive theory of economic dispositions derived from Bourdieu to Marxian ideas of economic value to create further distinctions between provisioning and economic systems, and within substantive economies instituted through various types of exchange activities.

**Bourdieu’s social and economic habitus and valuations of economic activity**

A key gap in Polanyi’s idea of substantive economy as instituted process is the relationship between the actions of individuals that create instituting patterns, and the pre-existing social and economic institutions within which they act. Bourdieu’s theory of habitus provides an opening to clarify and push forward substantive economic analysis by reinserting the social individual into analyses of economic institutions. Habitus receives a range of definitions throughout Bourdieu’s writings, from the abstract analysis of interpretive actions that manifest in objective social settings to more straightforward explanations of socialization and internalization of social reality (Bourdieu and Wacquant, 1992). Habitus can be considered an individual trait
when individual is the unit of analysis, but the theoretical conceptualization sees habitus as “systems of durable, transposable dispositions, structured structures predisposed to function as structuring structures, that is, as principles of the generation and structuring of practices and representations which can be objectively ‘regulated’ and ‘regular’ without in any way being the product of obedience to rules” (Bourdieu, 1977: 72). Another angle on habitus offers explanation of how interpretive and objective analyses combine to characterize habitus: “habitus is socialized subjectivity, a historical transcendental, whose schemes of perception and appreciation are the product of collective and individual history” (Bourdieu, 2005: 211).

From a theoretical perspective, Bourdieu’s notion of habitus provides a partial response to the overly institutional approach generated by Polanyi’s substantive economics. Habitus recognizes that individual actors mediate, perpetuate and alter social institutions through their actions because social institutions are simply patterns of actions accepted and are referenced by future action. Taking the social individual as the unit of analysis, we can characterize dispositions as the orientation an individual has to social or economic institutions based on his or her personal and collective experience with those institutions. Disposition, or habitus, is the mediating force through which the past is interpreted and reinforced or shifted through present action to institute social and economic systems. In other words, “economic and political dispositions can only be understood by reference to the economic and social situation which structures the agents’ whole experience through the mediation of their subjective apprehension of their objective, collective future” (Bourdieu, 1979: 64). Economic dispositions reflect the social and natural settings within which they have been shaped, and in turn, economic actions are guided by disposition. To identify and characterize economic institutions in substantive economies, including a notion of habitus, or disposition, allow for analysis of individual experience that maintains the primacy of institutions while accounting for the humanness of those institutions.
In a conversation with Wacquant late in his career, Bourdieu made explicit his motivation for articulating the meaning of economic habitus: “the main purpose of this notion is to break with the intellectualist (and intellectualocentric) philosophy of action represented in particular by the theory of homo economicus as rational agent…it is to account for the actual logic of practice – an expression in itself oxymoronic since the hallmark of practice is to be ‘logical,’ to have a logic without having logic as its principle – that I have put forth a theory of practice as the product of a practical sense” (Bourdieu and Wacquant, 1992: 120). Bourdieu’s use of economic habitus to describe alternative, substantive economies goes back to his early ethnographic work in rural Algeria, where he characterized the internal logic of social and economic arrangements of the Kabyle people (Bourdieu, 1979). There is a consistent push against assumptions of the superiority of economic rationality in Bourdieu’s work, one that incorporates political economy and interpretive methodologies in an effort to highlight both the negative effects of forcing market logic where it has no history and the internal logics of alternative systems. Bourdieu’s theories of economic habitus have been developed through empirical induction much like Polanyi’s, and the two theorists reach similar conclusions using different language. Where Polanyi sees substantive economies, Bourdieu (2005) identifies reasonable economic dispositions, which are “endogenous and depending on a history that is the very history of the economic cosmos in which these dispositions are required and rewarded” (8).

The economic cosmos that provide the setting for most economic dispositions (indeed, for all prior to those set within globalized neoliberalism, which posits and creates a globally universal system and history (Harvey, 2006a)) is not necessarily based on rational economizing and utility-maximizing activity (Bourdieu, 2005). For Bourdieu, writing throughout the post-colonial period, evidence of reasonable rather than rational economic dispositions appears mostly in the effects of global integration for former colonies and communities. Describing the experience of the Kabyles in Algeria (though it could easily be many places in the world),
Bourdieu (1979) explains that “with growing adaptation to the capitalist economy and growing assimilation of the corresponding dispositions comes increasing tension between the traditional norms which impose duties of solidarity towards the extended family and the imperatives of an individualistic, calculating economy” (48). His analysis of honor as the main social institution that structures economic activity, which creates a system of symbolic reciprocity (because honor must be socially recognized), provides an example of a substantive economy and the relevant characteristics of the social setting that influence reasonable economic decision making in that context. Shifts in economic institutions at a higher level (in this case, the national and international systems), when “radically unprecedented,” can outpace the ability of habitus to provide “a practical mastery of situations of uncertainty,” leading to economic dispositions that are no longer reasonable and so are negative for the individual in the new context (Bourdieu, 2005: 214).

Bourdieu’s critiques of the incorporation of non-capitalist economies into capitalist systems are political economy analyses through the lens of habitus. He argues that the global market system throws “all social agents into an economic game for which they are not equally prepared and equipped, culturally and economically; by the same token it tends to subject them to the norm objectively imposed by competition from more efficient productive forces and modes of production, as can clearly be seen with small rural producers, who are increasingly wrenched from a state of autarky” (Bourdieu, 2005: 223). The impact on an economic habitus that has developed within a social milieu that prioritizes reciprocity or stability over potential individual gain, when forced into rational economic institutions, is an uncertainty that is destabilizing for social and economic dispositions, and the institutions they perpetuate. Bourdieu’s (1979) description of the disenchantment of the social world for the Kabyle people, through the force of rational markets, contextualizes the abstract understanding of reasonable and rational economic systems, and the dispositions and institutions that comprise them. The disenchantment comes
from a feeling that the things valued by one’s own disposition (derived from history and social setting, and so seemingly universal to the non-reflexive social actor) are not valued in the new system, and an understanding of what is to be valued does not fit into one’s habitus. Bourdieu goes on to argue that new values in the social setting will eventually be generated that reflect the ideals of a market economy but which are still filtered through the symbolism of a given place and time. In addition to shifts in habitus due simply to time and exposure to new values and systems, I see the dynamic nature of substantive economies creating new values that reflect the increasing reflexivity of many individuals and communities who have experienced the market system and have found it lacking.

**Economic and social value**

In the last section of this chapter, I will explore the specific concept of substantive peasant economies and social systems, and theoretical descriptions of reasonable economic and social dispositions in peasant agriculture. First, however, an additional note on the economic and social value associated with material goods is important here. Bourdieu (2005) suggests that to understand the value of goods in a specific substantive economy, “a full definition of the properties of the product requires an appreciation of the relationship between its objective characteristics, both technical and formal, and the inseparably aesthetic and ethical patterns of the habitus that structures the perception and appreciation of it” (22). This framing of economic value reflects and expands both Marx’s (1978) discussion of value in pre-capitalist and capitalist economic systems, and Romer’s (1990) and others’ articulations of the influence that characteristics of both social and economic systems, and the goods being accessed with them, have on how individuals value the goods being accessed. Much like Bourdieu’s (1992; 2005) nesting of economic habitus within social habitus, the economic value of material goods is
embedded within the broader phenomenon of social valuation; economic value is social value enacted through exchange activities (Schumpeter, 1909). As an analytical concept, however, I argue that the social value of material goods is defined as value based on symbolic rather than instrumental interests, and the access arrangements that reflect social value are those predicated on gifting or self-provisioning. The economic value of material goods is defined based on their instrumental ability to be exchanged. The Marxian description of economic valuation detailed below incorporates the symbolic social values of a given setting, further reflecting the theoretical assertion of substantive economics that exchange activities to meet material needs are organized based on principles that resonate with (or are symbolically relevant for) a specific social habitus.

Classical economic theory and pure market systems build on the hypothesis that economic value derives from the relative scarcity of and demand for material goods, and that these characteristics are comparable across goods and settings. Price-setting markets create and define commodity-value with the explicit goal of creating a standardized system of measuring and trading value. Marx (1978) identifies the generation and institutionalization of commodity-value as the ultimate goal of capitalist economics, but emphasizes that the possibility of economic value more generally emerged not from the market system but from initial exchange relationships among individuals. The Marxian categories of use-value, exchange-value and commodity-value derive from a range of social and economic characteristics and arrangements, and both new institutional economics and Polanyian substantive economics analysis of the relationships between the economic value of goods in a given setting and the economic institutions that provide access to those goods. Again, however, an important difference between economic and sociological analysis is the starting assumption that the basic motivation for economic activity is as a response to situations of scarcity and the type of interests, utility maximization or otherwise, embodied in economic valuation.
Use-value in substantive economic analysis is best described through the notion of simple circulation, where individuals within the same social context (and so sharing habitus that defines use-value) exchange use-values with one another (Marx, 1978). Simple circulation is one manifestation of appropriative transactions as described by Polanyi (1957b), and is conditioned by social principles (like those described by Aristotle and overviewed by Polanyi (1957a)) that limit the ability of an individual to accumulate or unduly profit from economic activity. As societies increasingly make use of exchanges in markets, questions begin to arise about the economic value associated with specific goods. Marx’s political economy sees the fundamental shift from pre-capitalist to capitalist societies as the moment at which economic habitus shifted to allow land and labor to be exchanged for capital (money). Capital is an economic abstraction that does not derive value from the social setting, except insofar as the social habitus institutes a market system within which capital has tautological value (it is valued because it creates value). The intermediate step in the metabolic rift and alienation of land and labor generates exchange-value, where capital and its ability to command land and labor are still conditioned by the social and natural context. In Marxian terms, the social organization of production is being objectified through a process of normalizing capital as the means to convert land and labor into exchange-value. The goal of economic activity oriented toward exchange-value is to generate not concrete products that provide use-value (by meeting contextualized material needs), but to test the relational values of a range of products and actions in order to ascertain the abstract exchange-value as it is filtered through the social and economic habitus of the moment.

Bourdieu (2005) argues as well that use-value and exchange-value are conditioned by the natural and social contexts within which an economic system is set. Material needs are determined in part by the natural environment, and products and resources that can meet those needs have inherent use-value. Social needs or imperatives are generated through the process of social interaction instituted by habitus and social structures, and so goods that meet social needs
can also acquire a use-value that derives from the social rather than the economic realm (since those goods do not meet material needs) but that is incorporated into economic activities. Bourdieu (1979) describes for example the social role that land plays in Kabyle communities, where there is an imperative against letting land fall into the hands of strangers. Because there is a symbolic value to the land that is not monetized, land can be used as collateral for a monetary loan among individuals within the community. “The sum lent may bear no relation to the value of the land; it may be greater or smaller, depending on the borrower’s needs” (Bourdieu, 1979: 21). There is use-value in the land remaining in the community, but land is not, as Marx (1978) also notes, an economic good in many non-capitalist societies, and the combination of social habitus that values communal land and an economic habitus that seeks reciprocity rather than profit will not leverage land as a financial asset.

In addition to the identification of different types of economic value expressed in exchange arrangements, economic and social theory identify other values associated with decisions about if and how to access material goods. Resource economics and ecological economics define total economic value of a good as the combination of current economic use value (usefulness in the current exchange setting), option value (the possible value of exchanging the good in the future), and existence value (the human preference for a good to exist, separate from its potential for exchange) (Smale, 2006). Existence value in particular is the purview of ecological economics, which, much like economic sociology, embeds economic activity and the economic value of goods, particularly natural resources, in the broader ecological and social context (O’Hara, 2010). For ecological economists, existence value derives primarily from objective aspects of the natural setting, with scarcity and exclusivity remain key drivers of the human preference for goods with natural existence value. Analysis of the human preference for the existence of goods that is motivated by the social setting rather than the natural setting, however, does not have a clearly defined disciplinary history.
Social value, or the socially situated human preference for the existence of and access to certain goods, was introduced in the economic literature by Schumpeter (1909), who drew on social theorists’ descriptions of the interactions between social systems and economic principles. In brief, “the concept of social value is chiefly instrumental in opening up a thoroughly optimistic view of society and its activities…the theory is that even in a non-communistic society each factor of production ultimately gets what its services are worth to the community…society itself is called upon to sanction what is actually happening [in the economy]” (Schumpeter, 1909: 222).

Schumpeter’s (1909) early articulation of social value is effectively re-stated by Granovetter’s (1985) description of how economic systems, and the valuation of goods embodied with them, are embedded in specific social settings. However, the epistemological differences between economic and sociological analysis are evident in the ways in which the concept of social value has been further articulated in each discipline. Tool (1977), for example, describes how social value has been applied in institutional economics, arguing that theorists have challenged the one-to-one correlation between social value and price put forth by Schumpeter (1909) and others. However, economic understandings of social value, according to Tool (1977), continue to assume that social value will be ascribed to goods with the instrumental ability, direct or indirect, to meet economic or exchange needs. Social capital, for example, fits nicely into the economic understanding of social value, as does gift-giving as a means of creating future reciprocal, exchange obligations (Keefer and Knack, 2008; Purkayastha, 2004).

Sociological understandings of social value, in contrast, do not assign instrumentality to all expressions of the social value of material goods (Bourdieu, 2005; Jordan, 2008). Instead, Schumpeter’s (1909) assertion that social value is assigned based on the worth of a good to a community is understood within the context of embeddedness. Material goods, and the arrangements used to access them, can have worth that derives from and is reinforced by the symbolic social realm rather than by the instrumental characteristics of the good itself. If the
symbolic realm emphasizes communal well-being over individual utility, then the social value of goods can be partially or wholly expressed outside of the exchange-based economic realm. For example, seeds are given social value and become a symbol of communal care when gifted rather than exchanged.

The relative emphasis on the social or economic value of a material good given by the habitus of an individual or social group influences the type of access possible for that good. The final goal of formal, rational economic systems is in fact to create the economic habitus that formal economics assumes from the beginning. If habitus shifts toward a value orientation that prioritizes utility maximization and economizing action above all other social and economic priorities, then this habitus will institute a free market system regulated not by combination of social and economic institutions but by price-setting markets alone. The value of land, labor and production in these markets will be standardized by the underlying principle of utility maximization and so will be objectively defined, in contrast to the subjective, social determination of value that happens in other economic arrangements based upon use-value and exchange-value. The standardization or objectification of value occurs through the modicum of money and prices, creating a decontextualized commodity-value as distinct from an exchange-value still conditioned by the social context within which it is recognized (Marx, 1977). The objectification of land and labor through the creation of institutions like free markets that recognize commodity-value above any other social value engenders the market system described by Marx, Polanyi (1944), Lindblom (2001) and many others. The formal, rational economic system assumes the emergence of a habitus completely defined by economic disposition, by curtailing the ongoing process of social learning and instituting of economic systems that meet social needs. However, as well documented by studies of peasant households and communities over time, the economic habitus of peasants has evolved with the rise of the global market system
to adapt and buffer against elements of rational economics that would preclude the persistence of peasant systems.

**Reasonable economic and provisioning systems in peasant agriculture**

The modern approaches to international agricultural development described in Chapter 2 are all ostensibly working toward agricultural change that will benefit farmers in developing countries. Who these farmers are and how they are defined affects assumptions about if and how to help them, but these definitions are often made clear. As seen in the rhetoric of the transfer-of-technology era and the first Green Revolution, traditional farmers were those whose agricultural practices made them poor and hungry, and who were lacking modern technology. The neoliberal era defined traditional agriculture as inefficient, failing to maximize available resources, and as disconnected from markets for land, labor, inputs and outputs (McMichael, 1997). Both of these characterizations are negative in the sense that they identify traditional agriculture and the farmers who practice it by what they are not. In the contemporary market-oriented sustainable development discourse, the farmers needing help are identified as smallholders, which though vague has a less negative, more neutral connotation. Smallholder farmers also continue to be described by their poverty, lack of technology and distance from markets (Toenniessen et al., 2008).

By defining traditional agriculture by what it is not, modernization theories create the dichotomy discussed in Chapter 2, where the singular goal of technological capitalism is the benchmark against which to measure all other production and economic relationships. Much as political economists building on Marx push back against this type of absolutism in certain strands of economic theory, there has been a consistent school of social theorists asking the agrarian question from another angle. How do traditional farmers arrange their social, economic and
production systems, and how are these systems used to mediate and challenge development paradigms that demand standardization and marginalize difference? Asked in another way, what is the economic habitus of the peasant that creates the defining characteristics of substantive peasant economies? And how have peasant systems changed over time in response to external social and economic influences?

The original agrarian question was made explicit by Chayanov (1986), as he observed that despite predictions by classical and political economists, as well as plans made by the Russian government, a peasant form of agricultural production and social systems persisted in Tsarist and communist Russia throughout the 19th and early 20th century. In seeking to understand this persistent agricultural form, Chayanov (1986: 41) adopted the notion of peasant households and peasant farming, defined not only in capitalist terms where “we must unite in the peasant both the entrepreneur capitalist and the worker he is exploiting,” but using new terms and concepts all together. The basic agrarian question asks who the peasant is, as defined by his social and economic institutions and activities. Chayanov’s (1986) answer: it depends. In a capitalist society, the peasant is a quixotic type of entrepreneur, who acting as “the head of the farm hires himself as a worker” (Chayanov, 1986: 42). Using the capitalist understanding of economic efficiency, the entrepreneur peasant will push the labor he commands (in this case, his own) to the point of maximum productivity, with the profit accruing from his labor returning to himself as the entrepreneur. If, however, the production system is not efficient enough to create a profit (as is posited by modern theories of traditional agriculture), the entrepreneurial peasant will eventually choose to transition from the risk associated with the pursuit of profit and take up a role in the capitalistic agricultural system, as a wage-laborer, contract farmer or some other non-entrepreneurial role.

What Chayanov first noted and what many others have explored since is that despite shifts in national economies toward the market system and capitalist agriculture, peasant
agriculture has persisted and adapted to the systems against which it is defined. Peasant studies challenge the assumption that if these peasant households had an economic habitus that was oriented toward utility maximization, they would have gotten out of the peasant agricultural sector. Chayanov (1986) concludes that peasant agriculture can exist for a short time within a capitalist system (before being consumed by the system’s economic logic) but that, to explain its persistence, peasant agriculture must also exist in another form that is not predicated on capitalist economics. The peasant farm as an organizational form, Chayanov (1986) declares, can exist in a range of economic settings, and its characteristics will then be determined by the social and economic habitus of the society, which will also vary. Chayanov builds a theory of peasant economies in 19th century Russia, effectively identifying the different dimensions of substantive economics as described by Polanyi (1957b). Shanin (1986) suggests that Chayanov’s characterization of peasant household decision making as a balance between meeting material needs and the drudgery of labor is a subjective process. In other words, peasant decision making reflects the habitus of Russian peasants, who had long personal and social history of living in a natural environment in which it is difficult to provide for basic needs.

The finer points of the Russian peasant habitus are too far afield here. Instead, I wish to highlight how Chayanov’s (1986) theory building about the nature of peasant social systems and economies that do not shift into capitalist systems follows closely on the more general notions of substantive economies being instituted through habitus. Both Polanyi and Bourdieu’s ideas about the relationship between social and natural context, and individual actions motivated by socially conditioned values that in turn create institutions that perpetuate and delineate specific economic systems, are implicit in articulations of peasant economies as non-capitalist systems. The agrarian question has been repeatedly asked over the past century in an effort to continually understand the process through which peasant agriculture persists, adapts, and reemerges even as the market economy has become increasingly globalized (Bernstein, 1996; McMichael, 1997). In
the contemporary economic setting, and particularly in response to globalized neoliberalism, theories of peasant economies have been sharpened and broadened, drawing explicitly on Polanyi’s notions of substantive economics, and implicitly offering characterizations of the peasant habitus and the reasonable economic and provisioning activities it institutes.

Shanin (1990) provides an updated framework for thinking about peasants as a social category: the term peasant can be an adjective with perhaps historical connotations but no present analytical power, peasants can be a distinct social group analyzed within the framework of general economic theory, or peasants can be by definition a distinct social and economic phenomenon that needs its own theory of organization and action. Theories of peasants and peasant economies span these three approaches, and I focus here on those that fall into the last category. I argue that in order to create space for alternatives to the dominant agricultural development discourses that are based on market capitalist theory, it is not enough to identify peasant systems using the same theoretical logic as the systems against which they are defined. Ellis’ (1988) definition of peasants, for example, uses language that echoes contemporary definitions of traditional agriculture: “peasants are household agricultural producers characterized by partial engagement in incomplete markets” (234). Though many contemporary economic and social theorists see a pragmatic value of situating peasants within the nation-state and global economic context in which they exist (see also Halperin, 1977b), Chayanov’s original distinction between peasant agriculture as an entrepreneurial concept and an organizational form suggests at the least the theoretical possibility that peasant households can be defined and analyzed on their own terms. To do so requires constructing an understanding of substantive peasant economies and systems that can provide a framework for identifying appropriate and relevant support offered from the outside (‘development’ in a situated, de-theorized form (Escobar, 1995)).

Halperin (1977a) provides an overview of the application of substantive economic theory to rural agrarian societies, and concludes that the heterogeneity of specific peasant economic and
production systems and institutions has as a foundation the unique situation of the peasant: “the point is that the peasant’s system of meaning results from their need to relate closely to their natural environment and to use and explain it” (13). Much like Hopkins’ (1957) more general warning against assuming generalizability of Polanyi’s categories of social mores that organized economic activity (reciprocity, redistribution and exchange), Halperin (1977a) and others (Shanin, 1990) suggest that the substantive approach to analyzing specific peasant systems requires that few assumptions be made, beyond the theoretical foundations that see economic activity as a social process guided by conditioned collective consciousness. ‘Doing’ peasant economics, then, requires an adherence to inductive methodologies and characterizations of contextualized economic institutions. Social scientists operating outside of the classical economic analytical frame are generally attuned to the role that social systems, structures, and settings play in conditioning other aspects of the human condition. Theories of embeddedness of markets in social systems are a clear example of this (Granovetter, 1985). Exploring the agrarian question, of how peasants institute systems that allow them to persist in parallel with the market system, also requires an awareness of the natural setting in which an economy is instituted. Halperin (1977a) rightly identifies that the natural environment in integral to the peasant condition, and though not often emphasized in critical theories about the development of human systems (Vayda and Walters, 1999; Foster, 1999), the role played by the natural environment in peasant systems is distinctly different than the way that environment is incorporated into capitalist economic theory.

Foster (1999) overviews the role that the environment has played both in sociological and classical economic theory throughout much of the past two decades, arguing that the natural environment plays a key role in Marx’s understanding of pre-capitalist economies and the shift in social and economic institutions that occurred with commodification of land. Starting from this more general analysis of the relationship between economic activity and the environment, peasant
studies theorists provide analysis and language that recognizes the centrality of natural resources to the peasant agricultural system (van der Ploeg, 2013). Individuals or households interacting with nature to meet their material needs are characterized as subsistence farmers within the utility-maximization framework, and are seen in peasant studies to have a habitus oriented toward provisioning (van der Ploeg, 2010). Van der Ploeg (2013) identifies the provisioning relationship between man and nature as co-production, a corollary to Marx’s (1977) understanding of reproduction in non-capitalist societies through the unity of land and labor. These interchanges meet individuals’ material needs not through social interactions but through an orientation toward the natural world, which is not in fact a co-producer in the social sense. I argue that the “interchange” between man and nature that Polanyi (1957b) includes in definitions of substantive economy are in fact personal and communal arrangements that should not be considered economic activity, because they are not predicated on exchange, which is necessary to create abstract economic value. Instead, provisioning activities are oriented toward meeting material needs for individuals and communities through systems based on reasonable, often material, individual or social value. Provisioning can also take on symbolic meaning when instituted in contrast to economic alternatives.

Van der Ploeg (2010) suggests that provisioning is the contemporary manifestation of subsistence, but that it is intentional and chosen in a way that subsistence in a Hobbesian pre-social world was not. Polanyi (1977) develops a similar theory toward the end of his intellectual career with the notion of householding. In basic terms, householding is “provisioning one’s self,” which Polanyi argues is only possible at a fairly advanced stage of social and agricultural institutions, since there is now an accumulated body of wisdom and experience from which to draw. Scott’s (1976) analysis of substantive peasant economies in southeast Asia suggests that the experience of subsistence demands is engrained in the social habitus of peasant agriculture, so that contemporary peasant systems develop within social settings where provisioning activity is
equal to, if not more prioritized than, economic activity. Recognizing the role that provisioning plays in the social systems within which modern agricultural development takes place provides additional clarity into the persistence and reorganization of peasant agriculture even as market-oriented economic activity is increasingly expected of (and championed for) peasant farmers. Bernstein (1996) reminds us as well that the diversity of contemporary peasant arrangements that exist in relation to the global economy includes both subsistence-by-necessity and provisioning as social action, which along with substantive peasant economies create a range of new peasant organizational forms and agrarian questions.

Shanin (1990) argues that one reason for the persistence of the agrarian question is the ongoing recognition that the peasantry, defined by Halperin (1977a) above as those whose values derive from close relationship to the land, has not disappeared. Instead, the contemporary peasantry has responded to global economic forces in ways that have allowed their social and economic institutions to adapt through a changing social and economic habitus that is in direct conversation with contemporary capitalist economic systems. Van der Ploeg (2013) describes this process of developing reasonable (though not necessarily rational) rural economies and systems as repeasantization. He emphasizes that movements in both the Global South and North have engaged in an implicit process of identifying and establishing the institutions necessary for a reasonable peasant economic system that meets certain social and environmental goals. For examples from the developing world, Desmarais (2008) explores how the Vía Campesina movement coalesced in response the neoliberal global economic demands in the 1980s, coining the term ‘food sovereignty’ to distinguish their demands for self-determination from the market-based solutions associated with food security as a modern development goal (see also Borras et al., 2008). Djurfeldt (2013) explores the implications of African “re-agrarianization,” suggesting that the use of language associated with peasant economics in contemporary agricultural
development rhetoric masks economic assumptions about the superiority of markets and an economic habitus oriented toward accumulation rather than provisioning or reciprocity.

In the developed world, Hinrichs (2000) describes how farmers’ markets are economic manifestations of a social desire to re-localize food systems, which could be seen as a peasant mentality that prioritizes social interaction about food over market efficiency. However, as Hinrichs (2000) suggests, an uneasy tension exists when social habitus that profess anti-efficiency sentiment are enacted within the framework of capitalist economics. Another example of reasonable agrarian social and economic arrangements is the Open Seed Source Initiative, described by Kloppenburg (2010) as promoting seed sovereignty, a corollary to Vía Campesina’s framing of food sovereignty. Kloppenburg (2010) calls for the process of open-source plant breeding and seed saving to be institutionalized in much the same way that Polanyi (1957b) describes the instituted process through which economic structures are created. The social imperative is the free use of genetic resources, and through learning and innovation processes, institutions are being created to protect that freedom of use from neoliberal demands for privatization as well as to facilitate economic activity based on the principles of seed sovereignty.

The role of space and scale in substantive economics

Examples from food and seed sovereignty movements, as well as analysis of peasant agriculture more generally, work implicitly across scales by characterizing local realities and identifying institutions that can interact with and counter the global market economic system. Applying the theoretical concepts of substantive economics and habitus to examples in the real world makes more explicit the underlying spatial element running through discussions of substantive economies, provisioning systems, and the institutions that comprise them. Spatial relationships, both material and theoretical, are key components of interpretive economic
analysis, and have to-date been under conceptualized in economic sociology (Peck, 2005). Rather than overview the extensive literature on conceptualizations of space, scale and relational measurements, I focus on recent contributions from economic geography and related disciplines to highlight the theoretical underpinnings of space in substantive economic analysis. Drawing on these contributions, I then relate different concepts of space and scale to the framework put forth in this chapter that relates substantive economy to habitus instituting reasonable systems based on a range of social and economic values.

Marston (2000) argues that contemporary approaches to understanding scale follow the general move among critical social theorists toward a constructivist view of categories that describe the human world. How and why scale is constructed in certain ways in particular settings reflects non-spatial social and economic priorities of a given place, and in turn reinforces or shifts patterns of social and economic interactions. Harvey (1989) describes the condensing of the time-space continuum that has occurred with modern capitalist development and the requirements of flexible accumulation, suggesting that space is perhaps no longer a differentiated category. However, idealized global markets and free flows of capital do not exist, and even if they did, those markets and flows continue to be by definition locational and relational. Marston (2000) suggests that social construction of scale must be understood as emergent from a given social or institutional process, so that the meaning associated with scalar definitions derives from their origin. In addition, an interpretive approach to social theory requires that the social reproduction of scale also be incorporated into analysis of how spatial relationships are reinterpreted over time. Bair and Werner (2011) elaborate upon the need for spatial understandings of contemporary economic change, focusing in particularly on the commodity chain approach and arguing for the reinsertion of scale into critiques of the differentiated impacts caused by global commodity chains.
Scale is talked about within the globalization framework as it relates to disarticulation (Bair and Werner, 2011), consolidation (Harvey, 1989), and complexity (Gibson et al., 2000).

How then can we think about scale as an analytical category or bounded process? Brenner (2001) offers a framing of the constructivist approach to incorporating scale into social theory by identifying various dimensions social spatiality, including scale, localization, and the creation of spatial networks. Scalar structuration, Brenner (2001) argues, is influenced by more than just the relations of production, the political economy understanding of scale that is reflected in world systems and dependency theories (Bair and Werner, 2011). Scalar structuration sees the construction of a specific scalar hierarchy as both embedded in the context from which it emerges and relational to other hierarchies and spatial orientation (Brenner, 2001). Peck (2005) offers a similar understanding of the social construction of scale, and broadens the conversation even more to incorporate multiple levels of socio-spatial production and reproduction.

Analysis using the concepts of substantive economics and habitus provides rich theory about the interactions among different social levels, as individual actions create institutions through which social imperatives are mediated. Peck (2005) argues that alternative theories of economic action will be strengthened by incorporating analysis of the “social, spatial and scalar constitution of economic systems, identities, processes, and development paths” (133). I find Peck’s articulation of the socio-spatial dimensions of the economy to provide analytical and methodological tools that help to more precisely characterize the interactions among habitus, individual actions and economic and social systems. To the social dimension of the economy, Peck (2005) adds geographic place, which acknowledges the social and natural history of physical places as they relate to the symbolic social realm. Spatial analysis of the economy must not only recognize the relationality of economic activities and institutions, but must also incorporate awareness of power and differentiation. Finally, building on Marston’s (2000) thesis of the social construction of scale, Peck (2005) argues that heterodox economic theory must be
explicit about the definition and application of scale in a given economic setting, in order to analyze the origin of processes being instituted within a specific place or space.

I see this methodological articulation of how to incorporate space into an interpretive substantive economic analytical frame as pulling together the three-part theoretical framework put forward in this chapter. Substantive economies, as defined by Polanyi, are patterns of interactions among men to meet material needs, and are conditioned by the social and natural environment. Incorporating place at the contextual level both reinforces the centrality of the natural environment to social processes, and also provides an appropriate analytical tool for comparing across economies or societies. Substantive economies and provisioning systems are generated and maintained by patterns of individual actions, and those actions are manifestations of a collective habitus that reflects shared social experience, symbolism and values. The symbolic realm that generates social and economic institutions is imbued with power insofar as there are hierarchies associated with social value that derive from the symbolic social world. The institutions that are produced and reproduced to constitute the economy in turn exist at a scale that is appropriate to values and social relations driving the institutionalization.

**Summary**

The intent of this chapter is to explore and extend the theoretical underpinnings of Polanyi’s (1957b) substantive economic framework and Bourdieu’s (1979; 2005) theories of social and economic habitus. I draw on these two social theorists in part because they work to extend classical Marxian categories of production relations and economic value, which I see as continuing to provide the most precise articulation of the limitations of market capitalism in meeting the material needs of all members of a (now global) society. I focus these theories and critiques on rural agricultural social and economic systems in order to better articulate the
changes occurring as a result of contemporary international agricultural development trends.

Peasant studies has a long history of the same type of analysis, beginning with Chayanov’s (1986) posing of the agrarian question and continuing through to van der Ploeg’s (2013) most recent synthesis of peasant agriculture as an alternative economic and agricultural production system.

The critiques associated with Polanyian political economy as it relates to peasant agriculture focus on the disembedding and disarticulation of agriculture, but there has not to date been adequate incorporation of spatial concepts and theories in economic sociology and related fields. Woods (2007) operationalizes the theoretical contributions of socio-spatial categories in calling for place-based studies of experiences with global economic forces in specific rural locations.

This is the approach I take in the remainder of this dissertation, by analyzing the experiences of farmers in Sahelian West Africa with the release of improved varieties of local grain crops and the creation of seed value chains.
Chapter 4

Research setting and epistemology

In this chapter, I overview key features of the natural and social settings of Sahelian West African countries of Mali, Burkina Faso and Niger, in which this research takes place. I highlight as well details of the agricultural systems predominant in the research area, and the institutional context within which plant breeding and seed dissemination activities are currently taking place. I then explain the genesis and collaborations of this dissertation project, to situate the analysis within the broader context. Finally, I articulate the epistemological foundations of my research approach, and my positionality as a researcher in the field. Providing thorough and detailed description of the research setting and conceptualization of the research project keeps with the theoretical approach outlined in Chapter 3 by emphasizing context and cross-scale interactions among social and natural systems, individuals and institutions. The description of research setting and epistemology offered in this chapter also provides a foundation for the mixed-methods approaches outlined in Chapter 5.

Research setting

This research project was conducted from 2010 to 2013 in the Sahelian West African countries of Mali, Niger and Burkina Faso. Figure 4-1 shows these countries and the specific research areas in each: Siby and Dioila, Mali; Dédougou, Burkina Faso; and Bokki and Serkin Haoussa, Niger. Though there are site- and country-specific differences in certain details, Sahelian West Africa can be considered a region based on the continuity in most defining characteristics of natural and social settings (Moseley, 2008). The description of the research setting that follows overviews
these continuities in the region, as well as highlights site-specific differences that might influence analysis and findings presented here.

Figure 4-1. West Africa and research field sites

![Map of West Africa and research field sites](image)

**Natural setting**

Mali, Burkina Faso and Niger are located in the Sahelian region of West Africa, just south of the Sahara desert, where rainfall ranges from 300 mm to 1,000 mm annually (SWAC/OECD, 2010; Jalloh et al., 2013). The rainy season lasts from late May to early October, though the season length and total rainfall can differ considerably from year to year (Swinton, 1988). Because of the extreme aridity, water is a defining feature of the natural landscape. The Niger River runs through western Mali before curving north and then east into Niger, where it then heads south toward the ocean. In northwestern Burkina Faso, the Black Volta is the main waterway in an otherwise dry region. Ecosystems surrounding the rivers are significantly different than the rest of the dry, Sahelian landscape. The rivers are used for fishing, rice
growing, minor irrigation and transport by communities situated along them, as well as for cultivating fruit and vegetable gardens in wet areas adjacent to the water. In addition to water, soil quality is another main feature of the natural landscape that influences agricultural production. Soils in sub-Saharan Africa inherently lack nitrogen and phosphorous, and fertility is particularly low and hard to build in the semi-arid Sahelian areas where organic material is not easily broken down (Breman et al., 2001; FAO, 2010).

Sahelian West Africa has little topography, though western Mali has some dramatic cliff escarpments. Across research sites in Mali and Burkina Faso, the landscape is savanna forest, with big, scattered trees and mostly low undergrowth that flourishes during the rainy season and in the cool months of November through January. Many native forest trees provide food, fodder, and fuel for rural communities. Certain nitrogen-fixing trees and those that provide tradeable goods (specifically the shea nut tree) are often left standing in agricultural fields. In Niger, there is less vegetation and fewer trees due to less overall moisture. The soils in Niger are also sandier and less nutrient-rich than in Mali and Burkina Faso (Raynaut, 1997). Deforestation in the Sahelian region has been a natural resource management issue since the 1970s, with mixed opinions about if and why it is happening (Raynaut, 1997; Mortimore and Adams, 2001). Recent assessments (in the past five years) suggest that forest cover might be increasing (Reij, 2010). The temperature is fairly consistent year-round, ranging from 90 to 115 degree Fahrenheit during the day. Harmattan winds, which blow off of the Sahara in January and February, bring dust from the desert and create a haze that brings cooler temperatures. The months of February through May are the hottest, with clear skies and still air.
Historical and social setting

There are many ethnic and language groups intermixed throughout Sahelian West Africa, a result in part of the expansion and conquering of different kingdoms and tribes over the pre-colonial centuries. The Fulani, the Songhai and the Bambara all had empires that spanned the Sahel at different times, and today all of these groups and many more are present within and across nation-state borders. I describe here the ethnic and language composition of my research sites. In Mali, farmers in both the Dioila and Siby areas speak Bambara or Malinké, with a few speaking French as well. In Burkina Faso, in the zone around the city of Dédougou, farmers speak Dioula, Bomu, or Mooré. In Niger, sites are located southwest of Niamey, near Bokki, where farmers speak Djerma and sometimes Fulani, and in the east around Serkin Haoussa, where all farmers speak Hausa (Lewis, 2009). In addition to ethno-linguistic diversity and the regional history it reflects, all three countries share a common history of French colonialism. French is the official language of the school systems and government in all three countries, and is often used as the common language among locals from different ethnic backgrounds. The legacy of French colonialism has also had an impact on government and institutional structures, as well as on inequalities at the national and sub-national scale (see Manning, 1998, for an overview of Francophone African history). Huillery (2009) analyzes the difference in colonial investments and contemporary economic well-being of several Francophone West African nations. She finds that Mali, Burkina Faso and Niger all had lower rates of financial and human resource investment than coastal Francophone countries, and that within countries, rural areas received less investment than urban areas. The nation-level inequalities are still apparent today, with the United Nations Human Development Index currently ranking these countries at the bottom of the global scale, with Mali at 182, Burkina Faso at 183 and Niger at 186 (out of 186) (UNDP, 2013).
Culturally, Sahelian West Africa remains ethnically diverse but is unified by predominant adherence to Islam. In Mali and Niger, over 90% of the population is Muslim, as is 50% of the population in Burkina Faso (mostly in the northern part of the country) (Kaba, 2005). Islam arrived in West Africa in the 10th century, and in many ways shapes the cultural and social patterns of daily life, especially in rural areas (Manning, 1998). Polygamy is common, and many households are comprised of one man, two or three wives, and a dozen or more children. In some areas with stricter interpretations of the Koran, women spend much of their time in their family compound, which has high walls for privacy. Women cover their hair, and in Niger, often wear a hijab. Work in both rural and urban areas is conditioned by prayer times, with a long break after lunch for the two midday prayers. Social structures are based in large part on family, lineage and place of origin, and both religious and social mores in Sahelian West Africa place a strong emphasis on care for family members and neighbors (Manning, 1998; Galvan, 2006).

The post-independence era in Mali, Niger and Burkina Faso has been marked by periods of stability in the governments and economies, as well as by military coups, economic crises and natural disasters. During the period of this research, several events influenced the research sites and research process. The rainy season of 2011 was extremely poor, and as a result, many people harvested little to no food, resulting in severe hunger in Niger and parts of Mali and Burkina Faso. Seed production, both by individual farmers and seed producing organizations, was also lower than usual, creating shortages for the 2012 season. On the political front, there was a military coup in Mali in late March of 2012, which has had lasting effects on regional political and economic stability, as well as on international funding and activities. In brief, the coup was launched by a part of the Malian military in protest over the government’s handling of the conflict with Tuareg separatists in the north, who have a long history of fighting for independence (Manning, 1998). In the power vacuum following the coup, Tuareg groups asserted authority in certain northern regions, and so did groups of black African and Arab fundamentalist Muslims
who ally with Al-Qaeda. In January of 2013, France intervened as Islamic forces moved toward Bamako, and by the end of the campaign, an African-led UN peacekeeping force had pushed the Islamic and Tuareg groups out of power. Refugees from the fighting fled to Burkina Faso and Niger, and the Muslim separatist groups also spread its influence across regional borders. One result of the instability and French intervention has been an increase in kidnapping of white foreigners, some of whom have been killed. This has severely changed aid organizations’ travel policies, with travel restrictions for foreign staff.

**Agricultural systems**

Agricultural systems in Sahelian West Africa are shaped by characteristics of the natural and social settings, which create both constraints and opportunities. Because of the semi-arid climate and lack of irrigation for the vast majority of farmers in the region, agricultural production is limited in scope and diversity by rainfall. Local, native grains are sorghum, pearl millet, and fonio, which can produce even in the driest years. In addition, there are native legumes (cowpeas and Bambara groundnut) and one species of African rice (BOSTID, 1996). These few crops have provided the foundation of agricultural systems for farming populations since the beginning of settlement in the region. Agricultural production historically was an integrated process at the farm, community and regional levels (see Richards, 1985). Individual farmers kept small livestock and used their manure as fertilizer, fields were planted for a few years and then let fallow, and seeds were saved year to year by selecting the best heads of grain (panicles) in one’s own field or a in that of a relative or neighbor. There are also herders and fishers in the region, who base their livelihood on the animals they raise and catch, and with whom farmers trade grain for animal protein in order to diversify diets. The ecology of agricultural livelihoods is also integrated at a regional level, with herders and farmers managing
soil, water and other resources jointly and in ways that created interdependence among different producer communities (Turner et al., 2012).

All of the elements of this ideal-type of historical agricultural system continue to exist in Sahelian West Africa, and the production systems have continually incorporated new possibilities and demands as well. During the colonial period, the French pushed peanut production throughout West Africa and today peanuts are a primary source of protein for most smallholder farmers. Colonial and post-colonial governments also emphasized cotton production as the main cash crop for the region, and to-date cotton is the most commodified and globally integrated aspect of the agricultural economies of both Mali and Burkina Faso (Moseley and Gray, 2008). Maize is now a primary crop in Mali and Burkina Faso, especially in areas where cotton production and connection to the cotton company provides access to fertilizer, which is necessary to increase maize yields in the relatively poor West African soils (Falconnier, 2009). Rice is also an important crop for both local consumption and export. In Mali and Niger, the Niger River is used primarily for rice cultivation, mostly of Asian varieties that have been improved for the African context. Because rice and cotton are commodity crops, they are supported by the input systems and value chains associated with global markets (Moseley et al., 2010).

Contemporary smallholder agricultural systems in Sahelian West Africa are fairly consistent across the three countries studied here, though because of the relative aridity of Niger, production is less diversified there. Table 4-1 shows the top five grain crops grown in each country (based on area planted).

Table 4-1. Top cereal grains in Sahelian West Africa by area planted (ha)

<table>
<thead>
<tr>
<th>Country</th>
<th>Grain species</th>
<th>Pearl millet (ha)</th>
<th>Sorghum (ha)</th>
<th>Maize (ha)</th>
<th>Rice (ha)</th>
<th>Fonio (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mali</td>
<td></td>
<td>1,873,644</td>
<td>858,698</td>
<td>598,833</td>
<td>617,109</td>
<td>43,809</td>
</tr>
<tr>
<td>Burkina Faso</td>
<td></td>
<td>1,300,000</td>
<td>1,620,000</td>
<td>850,000</td>
<td>170,000</td>
<td>23,000</td>
</tr>
<tr>
<td>Niger</td>
<td></td>
<td>7,600,000</td>
<td>2,500,000</td>
<td>8,500</td>
<td>25,000</td>
<td>12,000</td>
</tr>
</tbody>
</table>

From FAOSTAT (2012).
Pearl millet and sorghum are planted much more extensively than any other cereal crops, which is in part a testament to their adaptation throughout the region. Landraces make-up the vast majority of the area planted with pearl millet and sorghum; Alene et al. (2011) estimated that in 2011, less than 20% of the area for either crop was planted with improved varieties. The improved varieties that are planted are almost entirely conventionally bred, open-pollinated varieties. There are sorghum hybrids beginning to be released in some areas of Mali, but their use is not yet widespread (and they are almost entirely absent from this project’s sample). It bears noting that there are no genetically modified (GM) varieties of sorghum or pearl millet available in West Africa, and in fact, GM crops are banned outright in Mali. Burkina Faso has in the past few years allowed testing and now general use of GM cotton, but GM food crops remain unknown. In addition to crops species and varietal types grown, another aspect of the agricultural production system, farm size, is also consistent across Mali, Burkina Faso and Niger, with the average farm size in all three countries between 4 and 5 hectares, although these data have not been consistently calculated and should be taken as historical approximations only (FAOSTAT, 2012; Republic of Mali, 2005).

What does a typical smallholder farm system look like in Sahelian West Africa? In Mali, Burkina Faso, and eastern Niger, fields are arrayed around the edge of the village, with more powerful or well-established households having land closer to the village (which facilitates transport and protection from animals). Land is managed at the village level and is officially a common good, to be reallocated with changing demographics or settlement patterns (Berry, 2006). In other words, if a family shrinks or moves away, their land is reincorporated into the common pool and distributed to those still living in the village. Men manage the family fields outside of the village, and women and children from the family provide labor in those fields. Women sometimes have their own, smaller fields around the edge of the household compound. In southwestern Niger, families tend to live in one or two household units rather than larger
villages, and work the fields directly around their compound, in part because of the extremely poor soils and the need for extensive plantings. Across the Sahel, most people use some type of short or long-handled hoe to prepare and turn the soil, as well as to weed. Simple metal plows and pairs of oxen to pull them are also a fairly common, though costly, agricultural asset and many farmers will off-set the cost by renting them out to neighbors. Planting begins with the first serious rains, sometime between early June and early July, and harvest generally starts in the middle of September and lasts six to eight weeks. With pearl millet and sorghum, as well as other grains, the stalks and panicles are harvested and bundled in the field, and stored in granaries or in protected piles in the household. Seeds are sometimes selected from the best plants in the field and kept separately, and sometimes are simply taken from the granary at the start of the next season.

Institutional context for plant breeding, seed production and dissemination

International agricultural research has historically been organized through the CGIAR Consortium (formerly the Consultative Group for International Agricultural Research), which is best known for its role in developing improved varieties of wheat, rice and maize associated with the Green Revolution (CGIAR, 2011). Today, the international agricultural research centers that make up the CGIAR Consortium continue to be organized around certain ecosystems and the crops that are predominant (and largely native) within them. The International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) focuses, as expected, on the semi-arid tropics, which includes Sahelian West Africa. ICRISAT-West Africa has research stations in Bamako, Mali and Niamey, Niger, and research focuses on pearl millet, sorghum, cowpeas and groundnuts – locally grown, mostly (except for groundnut) native species. ICRISAT research scientists are generally European or American, though there are a few who are West African, are based in
either Bamako or Niamey, and have long-term research appointments within ICRISAT. In all research projects, ICRISAT researchers work closely with scientists from the national agricultural research systems (NARS) in each country, and research funding is generally received for joint projects between ICRISAT and NARS. Other major agricultural research projects in Sahelian West Africa include the United States Agency for International Development (USAID)-funded SMIL Crop Research Support Program (formerly INTSORMIL) and West African Seed Alliance (WASA) projects; McKnight Foundation Collaborative Crop Research Program projects; and Alliance for a Green Revolution in Africa (AGRA) funding for agri-business development and graduate education in agricultural sciences.

Funding for ICRISAT research comes from large grants, sometimes from within the CGIAR common pool but more often from outside funding agencies like the Gates Foundation or developed-country international development agencies. However, as Busch (2010) notes, despite the deep pockets of international donors, the amount of funding channeled into agricultural research and development through the CGIAR system remains a small fraction of that spent by private agribusiness. To date, there is little private investment in research and development for pearl millet and sorghum, which means both that few improved varieties have been developed, and that seed production and distribution systems have not been widely improved (Lynam, 2011). Those varieties that have been developed and released over the past ten years by ICRISAT and NARS partnerships have largely been the result of participatory plant breeding (PPB) efforts (Weltzien et al., 2008; vom Brocke et al., 2010). PPB projects have now released over a dozen varieties of sorghum in Mali, three in Burkina Faso, and at least six varieties of pearl millet in Niger. All breeding is conventional – there is no biotechnology component. Varieties are registered in the national catalogue and can then be produced, certified and distributed.

Once new varieties have been developed, seeds are produced and distributed through various channels in the seed system. Coulibaly et al. (2008) overview the national seed
production system in Mali and how new varieties have been produced and distributed mostly through the NARS, which has limited funds and limited ability to reach the majority of farmers. With the shift toward market-oriented agricultural development, governments and donors are increasingly supporting the creation of private enterprises for seed production and distribution (Dalohoun et al., 2011). The transition toward private seed enterprises as the producers and distributors of seeds is perhaps most advanced in Mali, where several seed companies having received support from AGRA are now solvent and expanding their market shares (Dalohoun et al., 2011). In Niger as well there are a handful of private enterprises entering the seed supply system. Many of these enterprises focus on seed production and contract out the seed distribution and sales to agro-dealers, who are also often supported by internationally-funded development projects (Scoones and Thompson, 2011). In places where private enterprises do not yet have market activities, international funding for seed system development has also focused on creating and supporting seed producer organizations and farmer unions (Coulibaly et al., 2008; Weltzien et al., 2008). These organizations generally receive support in seed production practices, subsidies for seed certification costs, and marketing and commercialization training in order to sell the product (seeds) that their members are producing.

Louwaars and de Boef (2012) provide a concise overview of the institutional roles and changes overviewed above. They describe how the current field of plant breeding research and seed system development is differentiated by the stage of the process. Public sector institutions like ICRISAT and NARS receive funding primarily for the research related to the identification and improvement of new varieties, and the state provides certification services as well.

Historically, the state also provided seed production and dissemination services, often at no cost to farmers (through seed aid) (Rohrbach, 1997). Louwaars and de Boef (2012) describe this institutional arrangement as focusing on development-oriented seed systems, with the goal being to increase access to new varieties and to increase their production. With seed production and
distribution increasingly shifting from being a public-sector activity to one of private enterprise, a profit-oriented seed supply system is emerging out of the more general market-oriented approach to agricultural development. In this system, public institutions focus on creating new varieties, which are then produced and profited from by private seed enterprises. In some ways, this is a public-private partnership on a smaller scale than that on which it is usually conceived, but with similar results. Scoones and Thompson (2011) offer a political ecology analysis of this profit-oriented seed system approach: “too often participatory plant-breeding becomes an outsourced approach to testing varieties developed by accredited breeders, and farmer-based seed multiplication becomes a route by which farmers are co-opted into private sector projects for the multiplication and delivery of seed on a low-cost, decentralised basis” (16).

An interesting twist on this critique is the incorporation and creation of farmer organizations within efforts to develop seed systems. Farmer organizations have a long history in the Sahelian region, and have long provided an important link between formal agricultural research and development projects, and rural communities (Coulibaly et al., 2008; Diakité et al., 2008). In each site for this research project, there is a farmer organization or union that anchors ICRISAT’s PPB work and that is a key partner in the development of seed markets. The organizations are run much like cooperatives, and have varying degrees of institutional capacity and geographic reach. In Dioila, Mali, and Dédougou, Burkina Faso, the unions (ULPC and UGCPA, respectively) have several paid staff that provide financial and technical support to farmer members, as well as provide marketing support for production. In Siby, Mali and Bokki, Niger, the farmer organizations are smaller and mostly organized around an input shop, through which members can purchase inputs like fertilizer and herbicide at lower costs. In Serkin Haoussa, Niger, the union is part of a larger federation based in nearby Maradi, and runs an input shop and a radio station. All farmer organizations have a network of local farmer-technicians,
called animateurs in French, who receive training from the farmer organization in improved techniques and technologies associated with farmer organization activities.

Farmer organizations were originally created through a variety of interactions, including support from national governments, international NGOs and ICRISAT funding, and are at various levels of self-sustaining. All of the organizations employ local farmers as technicians to spread new information and now new seeds. One aspect of the PPB projects at ICRISAT has been to train these farmer organizations and their members in seed production and certification requirements, so that their members are increasingly producing the seeds that are being sold, also by the farmer organizations and their representatives. The seed systems projects provide marketing and commercialization training to these organizations in an effort to build a local foundation for seed markets. This shift from working with farmer organizations on development-oriented seed systems to profit-oriented seed systems, but with the goal of keeping profits at the level of the farmer organization, reflects the contemporary approach to market-oriented agricultural development. The goal is to build capacity in local and national supply chains, which challenges the classic development critique that capitalism privileges economies of scale (and profit accruing to extra-local actors) over local economic development.

**Genesis of the research project**

This dissertation project built on my master’s thesis research, which was also conducted with ICRISAT-West Africa. I originally contacted ICRISAT in the fall of 2009, as I was interested in the ongoing PPB projects and the social implications of them. That initial contact led to the development of a research project that focused on farmers’ and research technicians’ experiences of participation, and different types of outcomes that might emerge from the PPB process. I conducted that research in the summer of 2010, as the PPB projects at ICRISAT were
being expanded to include a new seed systems development project. Both the PPB and seed systems projects were funded by several sources, but primarily by the McKnight Foundation.

The seed system project included funding for a Ph.D. student in the social sciences to help with impact assessment and studies characterizing changes in pearl millet and sorghum seed systems as a result of the project. Initially funding was meant for a West Africa student, but given the lack of agricultural social science in higher education in the region, in the end ICRISAT hired me as the primary researcher and we agreed that I would find undergraduate or master’s students with whom to work in a mentorship role. In 2011, I had an undergraduate agronomy student working with me in Niger, and in 2012, a geography undergraduate student, also in Niger. It was difficult to make university connections in Mali and Burkina Faso, so I did not have a research assistant in either of those countries. In 2013, however, I trained the geography student from Niger and a master’s student in agricultural economics in Mali to conduct the fieldwork that I was unable to do because of security concerns.

The seed system project funded by the McKnight Foundation is jointly coordinated by ICRISAT, the NARS in all three countries, and the farmer organization in each project site. The two objectives of the project are: 1) to increase men and women farmers’ access to seed of new sorghum and pearl millet varieties; and 2) to monitor and improve variety adoption process, and to assess the effectiveness of different activities to improve knowledge and availability of new varieties (ICRISAT, 2010). Project tasks include conducting initial studies to characterize existing seed systems and to measure changes in the seed systems with project activities. The specific approach to seed dissemination taken by the McKnight Foundation-funded seed systems project has been the promotion of mini-packets of new varieties of sorghum and pearl millet seeds. The mini-packets are 100 grams each (enough to plant two or three rows of 100 meters), and cost between 50 and 100 FCFA (between $.10 and $.20). The idea behind mini-packets is that they address the contextual constraints to the adoption of new improved varieties, which in
Sahelian West Africa includes low rates of available cash and high opportunity cost for trying something new and unknown.

The McKnight Foundation-funded project follows literature on the final stages of PPB, which suggests that participatory seed diffusion should be the end goal of the development-oriented seed systems that guide PPB (Badstue et al., 2012). Some practitioners suggest that participatory seed diffusion should be approached at a household or village-scale, since that is the scale at which many other aspects of the production decisions and seed access occur (Rios Labrada, 2009). Mini-packets take a similar approach but focus instead on the scale at which exploration of new production practices often occurs – through interactions with fellow farmers and in small areas to minimize initial risk. There have been few scholarly studies of this approach to seed dissemination (see Thiele, 1999, for an example from the Andes), and the idea for ICRISAT’s mini-packet approach came primarily from researchers’ interactions with farmers during the PPB process. Many farmers wanted to be a part of field trials in order to receive small quantities of seed, which they could then try for themselves and incorporate into their production systems slowly and only after some experience (an example, perhaps, of a preference for skilling (Stone, 2004)).

The mini-packet approach to seed dissemination included goals of increasing the marketing and commercial capacities of seed producer organizations and farmer unions. However, implicit in the mini-packet strategy was the awareness that selling small quantities of seeds was a way to diffuse new improved varieties, which would then be incorporated into agricultural systems at the individual and community level in a variety of ways, including through saving and sharing; this was a side-effect already observed from the PPB field trials. Shortly after the McKnight Foundation-funded seed systems project was accepted, ICRISAT received a global-level grant from the Gates Foundation to support ongoing PPB activities, including seed diffusion. Unlike the original seed system project, relevant objectives of the Gates Foundation
project are explicitly market-oriented: 1) to discover and develop improved market strategies for sorghum and pearl millet to stimulate adoption; and 2) to enable technology adoption of sorghum, pearl millet, and finger pearl millet by improving access to inputs and markets differentiated according to both women and men’s needs. In conjunction with AGRA funding for private seed enterprises and agrodealers, as well as with the establishment of regional seed certification standards and laws, the mini-packet project now is now working as part of a larger push toward the establishment of markets for local cereal grain seeds, which is a new phenomenon in rural Sahelian West Africa.

I have been funded throughout this dissertation project on the McKnight Foundation Seed Systems II grant, as previously mentioned. The contract has been that I will provide ICRISAT with the social science support necessary for ongoing monitoring and evaluation of project activities, as well as a more comprehensive impact assessment, while also conducting dissertation research. Relevant indicators of impact/change and measurements of them were not made explicit in the original project proposal, and so I initially developed research questions that explored different elements of the seed system from the point of view of individual farmers, and the types of changes that they identified as having experienced. This was in keeping with my own theoretical interests in alternative economic systems and reasonable economic decision-making. Once the Gates Foundation project objectives were overlaid on top of the original seed systems project, however, the indicators of change were both more clearly and more narrowly defined. In the objectives outlined above, adoption should be measured as instances where seeds are accessed through markets, and adoption should in turn be related to increased connections to output markets. These objectives do not have a place for seed saving, seed exchanging, and non-certified seed production, which were elements of seed systems that I initially identified as potentially changing in order to facilitate adoption of improved varieties. The two projects do share an interest in gender-differentiated approaches to seed dissemination.
As a result of the relative lack of concrete impact indicators at the outset of these projects, as well as the increasingly narrow definition of adoption and access, I have conducted several types of analyses as both a research associate at ICRISAT and a Ph.D. student with my own conceptual interests. For ICRISAT, much of the monitoring and evaluation has focused on rates of seed sales each year, the rate of repurchase by the same individuals and the changes in gender makeup of the sales. I have consistently tried to include indicators of seed saving and seed sharing to broaden the results for “breadth of adoption,” but this has been met with resistance by the plant breeders who coordinate the projects. As I will explore further below, it is unclear whether there is truly an institutional orientation at ICRISAT that gives preference to market-oriented approaches to dissemination, if it is the worldview of the individual researchers, or if there is simply an instrumental approach to impact assessment that focuses on the demands of the largest donor. Regardless, in the end the analysis I present in my dissertation follow more closely from the original objectives of the McKnight Foundation seed systems project, which sought to characterize different dimensions of the seed system that might be affected by seed dissemination and sales, and to identify indicators of change within those different dimensions.

**Research epistemology**

As a sociologist as well as an individual, I take a dialectical understanding of the social world and ways of knowing it, and incorporate into that understanding a commitment to partial and situated knowledge, as well as to reflexivity at every level of the analysis and theory-building process. I privilege inductive ways of knowing over deductive formulae, but recognize that theory is built by abstracting from patterns of empirical observation and expressions of experience. This approach incorporates modern ideas of phenomenological research, interpretive approaches to analysis and synthesis, and feminist understandings of positionality.
Phenomenology and a theory of practice

I used phenomenology as a guiding approach to initial research design and analysis for this project. Given the context for this study, in Sahelian West Africa, where seed markets for local cereal grains are currently being established and expanded, it seemed reasonable to treat market formation as a phenomenon being experienced by farmers in the given project areas. Schutz (1967) describes phenomenology as an analysis of the general patterns of individuals’ lived experience of a common phenomenon. In other words, phenomenology takes as a frame of reference an empirical event or process, and uses individual experience as the unit of analysis to understand the impact of the phenomenon at different scales. Because individuals exist in a social context, patterns of similarity in experience allow the analysis to aggregate up a higher social scale – the community, institutional or regional level, for example. Variegated patterns of experience demonstrate the differentiated experiences and impacts of the phenomenon, which will vary based on group-level characteristics.

As a sociologist with a dialectical bent, identifying the patterns in experience as well as the differences is the first, not final, step of the phenomenological approach. Bourdieu (2005) warns of the dangers of “hyper-empiricist” qualitative analysis that does not situate phenomenological patterns of experience within a specific social (and I would argue also natural) context. Both quantitative and qualitative analytical approaches that take patterns at face value, and do not explore the relationship between discrete patterns and the conditioning contextual effects, take a positivist approach to knowledge generation that seeks an ultimate generalizable theory of experience (Bourdieu, 1977). Bourdieu (1977) develops instead a theory of practice that begins with a phenomenological investigation of the social world, situates that analysis within a given context and explores the interactive effects between the two, and then moves up one level of abstraction. The dialectical theory of practice gives legitimacy both to the ‘objective’
structures of the social and natural context, and to the lived experiences of phenomena within those structures by individuals. Crucial to this theory of practice is the recognition that lived experience is not only conditioned by objective structures but in turn perpetuates, subverts and challenges the objective understanding of phenomena as identified through analysis of patterns of lived experience.

Taking a phenomenological approach to studying market implementation and economic change has a long history within economic sociology – see Polanyi’s (1966) study of trade in Dahomey and Bourdieu’s (1979) analysis of changing household economies in Algeria. Halperin (1984) argues that Polanyi’s approach was more Marxist than he made explicit in much of his writing, in that his actual unit of analysis was institutions, as defined by patterns of individual actions. Halperin’s analysis provides a perfect example of Bourdieu’s (1977) first two levels of a theory of practice: phenomenological analysis of individual experiences of change lead to ‘objective’ theories of economic or social institutions that result from a given historical moment. This type of theory-building is dialectic in the classical Marxian sense, but Bourdieu’s dialectical theory of practice takes us one step further, by returning to the research setting (or site of knowledge generation). By resituating the generalized rule of social interaction derived from patterns of experience in a given context, Bourdieu (1977) argues for an interpretive approach to knowledge that continuously destabilizes absolutes or any type of positivistic theory building (Rabinow and Sullivan, 1979).

An alternative but complimentary approach to Bourdieu’s theory of practice is apparent in the iterative approach to analysis and theory building within a feminist understanding of partial, situated knowledge (Haraway, 2001; Naples, 2003). Feminist research approaches start from the principle that all individual experience is contextual and so in some sense partial, and yet it is the partiality of experience that provides specific insight into the human experience (Brabec, 2004; Hartsock, 2002). Haraway (2001) argues that feminist analytical approaches
seek to be open without being completely relativistic, and make knowledge claims that are
historically and socially contingent. I see this approach as a corollary to Bourdieu’s (1977) calls
for a higher-level epistemological approach to research and knowledge creation that makes
explicit the interplay between lived experience, context, enduring institutions and any single
individual’s ability to make claims for another about the impact of institutions in a given context.
As part of a commitment to an epistemological approach that makes explicit partiality and
positionality, I offer below some personal reflective thoughts on my own role in and experiences
of this research and analysis process, as well as farmers’ experiences of my presence both initially
and over time. I also provide some reflections from individual farmers who were interviewed for
this project on their experiences with the research process and possible impacts that participation
had on their own understandings of their lived reality.

**Researcher positionality**

I came to this dissertation project having spent two years as a Peace Corps volunteer in
southern Senegal. Senegal is also generally considered part of Sahelian West Africa, and much
of my initial desire to work in the region for graduate studies was shaped by my specific
experiences in Senegal. I felt able to jump right into planning research in part because many
aspects of doing fieldwork in the region were known to me – how to dress, what to eat, the
vagaries of travel, appropriate requests and expectations given my gender and status as an
outsider. These details and many more are all aspects of doing fieldwork that do not generally
enter into the analytical frame, but that are important to consider when making initial research
plans as well as throughout the analysis process. I continue to feel that my experience in Sahelian
West Africa prior to this research project greatly eased the potential difficulties in establishing
research in a new place, and also allowed me to focus on specific aspects of the research without
having to spend much energy thinking about personal issues associated with fieldwork. A particularly interesting aspect of this familiarity with the region surrounded language. In addition to French, I speak Pulaar/Fulani, one of several local languages, but one that I rarely encountered doing research because Pulaars are mostly herders, not farmers. I did not use Pulaar much in the research context, but given that it is related to many other local languages (in the same way that Romance languages are related in structure and syntax), I often thought about the phrasing of my questions in terms of how they would translate into Pulaar. If a question formulated in French or English did not seem to make sense in Pulaar, I would look for other words in those European languages that were more likely to be translatable into local languages.

Familiarity with language and lifestyle helped me to make my research process relevant and appropriate more quickly than would have otherwise been possible. However, my assumptions or hopes about how I was being perceived and the lengths I took to facilitate that role were not always reflected in farmers’ experiences of the research process. One of my personal goals when spending time in Sahelian West Africa is to minimize the perceptions of me as an expert, or as someone with status (because of white skin, education, nationality, etc.) (see Adams (1979) for discussion of expert status). The idea that my presence is somehow legitimizing to a project or an activity makes me uncomfortable. For this reason, I dislike arriving in a village in a white NGO car (or any car), and prefer to go by the most simple transport possible. However, as farmers’ expressed to me their experience of my presence, I came to realize that there are more than two dimensions to insider/outsider status. One farmer explained ‘that when there are visits like this, that allows them, it’s encouraging for them. They know that there is someone interested in what they’re doing.’ Many other people expressed similar sentiments, saying that having someone take an interest in their work gives importance to what they are doing. It continues to make me uncomfortable that my presence would convey importance on decisions and work that individuals are already doing for their own reasons and to
their own ends. However, I recognize that given the international development context, there is a long history of uni-directional communication, where farmers are not asked their opinions or experiences, and so in some ways my presence provides a type of validation that is not often enacted within this system.

Another aspect of positionality about which I became acutely aware through this research project is my own threshold for danger and possible harm when weighted against research goals and commitments. I was in Mali when the coup happened in 2012, and managed to get out on the one flight that left the country one the eve of the initial unrest. I had planned to finish up fieldwork in April in Niger, and after much soul-searching about the relative risks of returning to the region, decided to finish that fieldwork season. It was trying and tiring to be constantly worried about the possibility of unrest spreading to Niger (which seemed very possible in those first few months), and it made me less focused on research and the type of person I wanted to be in the field and in the research process. I was less present, more distracted, and found myself suspicious of people in a way that I had never been before. With the intrusion of fundamentalist Islam into the public sphere of Sahelian West Africa, I no longer felt certain about trusting people, about knowing which settings were safe and which were not. This was a shift from the general conception I held of West Africa, as a region in which I understood the setting and possible risks within it, and my own self-conception, as someone able to make safe decisions within that setting (see Gokah, 2006, for a discussion of safety in fieldwork). The experience of continuing fieldwork during the remainder of the spring in 2012 made me re-evaluate my own understanding of travel and life in West Africa, which felt, as I read headlines of kidnappings and killings of Westerners, outdated or naïve.

The changes in and new awareness of doing fieldwork in the Sahel ultimately forced me to assess the commitments I had made to ICRISAT, my own research project, farmers and communities, and balance those against commitments to myself and family and friends, which
included at a very basic level a desire to be safe and not take on unnecessary risk. I decided in the end that I could not return to do fieldwork in 2013, given the continued instability in the region. However, the research project I had proposed and invested much time in was longitudinal in nature and so it felt important to continue gathering information if possible. In the end, I returned to Mali in late 2012 and trained two local research technicians, with whom I’d already worked, to conduct structured questionnaire-style interviews in early 2013. That process forced me to challenge my self-image as someone committed to doing my own fieldwork, and also required a new identity as a research supervisor responsible for balancing the safety of the research technicians with the needs of the research project.

**Farmer positionality**

At the beginning of interviews with farmers, I would always explain who I was (a student from America) and why I was there (working with ICRISAT to understand how to support the spread of new seeds). At the end of interviews, I would ask them if they had anything else to add and if they had any questions for me. I did not specifically ask them what it was like to be interviewed, but often people’s concluding remarks had something to do with the experience of being interviewed. For many people, as previously mentioned, being asked their opinion was encouraging, as ‘it brings morale to their work.’ These sentiments tended to be stronger in places that are further afield from a regional capital or from the center of the farmer organization. Some farmers also expressed a half-joking feeling of obligation to continue to use the new seeds, because they had been selected to be interviewed. The sentiment that ‘next year, I will do even better in case you come’ is exactly what makes me uncomfortable as a foreign expert whose presence validates farmers’ efforts. Again, however, the flip side being expressed here is that in
the development world, with lots of solutions being offered and implemented without much follow up, it is meaningful that I would come to ask their opinions.

Even more meaningful to me are the sentiments expressed by a few farmers with whom I’ve talked for the past two or three years, a few of whom have mentioned that the suggestions about seed dissemination that they made in previous years were reflected the next year. They felt a direct relationship between what they had suggested, like larger packets, and the changes made. A few people also mentioned that if researchers ‘come to their field to see what they are doing, to have information,’ farmers can provide novel insight. Because some farmers have several years of experience with the new improved varieties, from field trials and now with seed sales, their own perception as being as knowledgeable about these seeds is supported by interviews and visits to their homes and fields.

In contrast to some expressions that being interviewed dovetailed with self-perceptions of knowledge, other farmers expressed that being interviewed after only one year of using the new seeds challenged their own feelings of not having enough experience to provide information. Some people who expressed uncertainty about voicing their opinions seemed unsure that the information they would provide would be useful to me. Others seemed to simply not feel like they had had enough time with the new seeds to accumulate knowledge. One person expressed a more reflective version of this sentiment, saying that ‘at the beginning, it’s dangerous to get into the debate…Next time, no problem. You can have a lot of things to say. To take an example, in relation to a foreigner. If you are a foreigner, you can’t say a lot at first. If a stranger is going to understand, he has to spend a while.’ Rereading this quote later, I think it could well be a warning to me as well, not to make assumptions or ask too many questions. Certainly, this approach to gathering and sharing knowledge fits nicely into my own theory of practice, in which I as the stranger have tried to spend time understanding the lived experience of farmers in Sahelian West Africa. From the farmers’ point of view, I am both legitimizing outsider and
unknowing outsider. My presence and process of being interviewed seems to both make them question their own experiences with seeds and ability to articulate knowledge of them, and to reflect on their own role as local experts being asked to share their unique insight.

Summary

This chapter provides the general context, social, natural, agricultural and institutional, within which is occurring the phenomenon of the establishment of market sales of improved varieties of pearl millet and sorghum seed. I describe as well the origins and orientation of this dissertation research project, paying particular attention to the way that I sought to incorporate both theoretical and abstract interests for dissertation analysis with the empirical needs of ICRISAT and its project partners. The epistemological approach put forth by Bourdieu’s (1977) theory of practice reflects the complexity of doing applied research in the context of international development, and provides a foundation for the methodological approach I describe in Chapter 5. By basing the research on primary data gathering and fieldwork, I encounter a range of positionalities, and I reflect here on my own experiences as researcher-as-instrument, as well as those of farmers-as-cases, experiences which they expressed often at the end of interviews. Combining my reflections on the role of an outsider with those of farmers being interviewed complicates and broadens my understanding of appropriate research methods, and leads in particular to a desire to share back my research findings at the end of this dissertation process.
Chapter 5
Methodology

Research questions

Given the context within which this research project takes place, as well as my specific theoretical approach and interests, I use a mixed-methods approach to ask the following research questions:

1) How do the natural setting and social context influence seed systems in Sahelian West Africa?
2) How and why are farmers incorporating improved variety seeds and seed sales into existing seed systems?
3) Do seed access decisions differ by gender?
4) Do seed access decisions differ by crop?

Mixed methods research design

This complete dissertation project has been designed and executed using a range of mixed methods research approaches throughout the stages of conceptualization, sampling and data collection, data analysis, and data synthesis and presentation. Mixed methods research has been present in social science for several decades, and as Small (2011) argues, has been characterized and implemented in a variety of ways by different disciplines and scholars. I build here on descriptions by Small (2011) and others (Creswell and Plano-Clark, 2011; Brewer and Hunter, 2006) of the different mixed methods approaches within each stage of the research process.
Mixed methods conceptualization and planning

Though epistemological and logistical challenges are often discussed at the end of articles and overviews of mixed methods, I see them as foundational to the design and execution of a mixed methods research project and so start here with a discussion of the conceptualization and planning process. The epistemological underpinnings of mixed methods have not been well-developed in the literature, and I think can be expanded by the inclusion of the constructive dialectics (Rabinow and Sullivan, 1979) present in Bourdieu’s (1977) theory of practice. Small (2011) highlights the adherence to pragmatism as an underlying research philosophy for many mixed methods proponents who see ‘complete’ positivistic knowledge as impossible but appreciate the ability to gather multiple types of data and analysis to provide insight into multiple dimensions of a social phenomenon or setting. Brewer and Hunter (2006) make explicit the modernist approaches to most mixed methods research, but do not differentiate among various modernist traditions and epistemologies, which fundamentally influence the foundations of the research process. Though they do not explicitly engage with Bourdieu’s (1977) theory of practice, I see an interpretive post-structural epistemology, which sets both subjective and objective ways of knowing within an ongoing dialectic, reflected in many types of mixed methods research designs.

One way to think about the theory of practice in mixed methods approaches is to assess during project planning the motivations for using mixed methods. Small (2011) identifies confirmation/triangulation and complementarity/testing as the two goals of mixed methods projects. Triangulation through the use of multiple data sources makes more robust the subjective, phenomenological first step of knowing by acknowledging the specific contributions that multiple types of data and analysis can make. These data can be qualitative or quantitative, since the underlying framework of phenomenology suggests that they are all representations of
certain lived experiences rather than reflective of universal rules. The testing motivation of mixed methods research, whether it follows triangulation or is the starting point for a project, reflects the second step of Bourdieu’s (1977) theory, where objectification and generalization occurs in order to identify and bound the structures that influence individuals’ realities. Subjective triangulation and objective testing are present throughout much of the mixed methods research design and implementation process. Final synthesis and presentation of findings, however, is often limited by the commensurability of subjective and objective epistemologies. Bourdieu (1977) argues for a theory of practice that explicitly recognizes the constructive dialectic inherent in the entire process of knowing. This means identifying the contextual characteristics that condition generalized patterns, reflecting on the conditions of knowledge generation and their influence on the knowledge generated, and maintaining an autonomous role for both individual habitus and structural forces in the generation of theory.

What then does the theory of practice approach to mixed methods research design look like? I began this research process with the idea that mixed methods would allow for triangulation. Because I was interested in taking a phenomenological approach to understanding the effects of market creation on existing seed systems, I took as a starting point that there would be a range of impacts and so a range of data types that could capture those impacts. Once I began the research process, I realized that to fulfill my obligation to ICRISAT, I needed to do ongoing analysis to provide them with the monitoring and evaluation feedback they required each year. This analysis was largely confirmatory, in that I combined thematic analysis of qualitative data with descriptive statistics to paint a more complete picture than would otherwise exist. However, I also began to develop my own theories about what was happening to seed systems in Sahelian West Africa with the creation of seed markets, and became particularly intrigued by the idea that the combination of decisions farmers were making with regard to seed access and use might reflect distinct seed economies or system. The final research design for this project reflects a
comprehensive use of mixed methods to first develop a theory of seed system change (using qualitative, quantitative and visual data) and then to test that theory using quantitative and qualitative analysis techniques. Finally, I synthesize the research findings by placing the analysis within the context, as described by research participants and depicted with visual data, and offer implications that reflect my own specifically stated positionality.

Sampling

As Teddlie and Yu (2007) emphasize, sampling procedures for mixed methods studies have not been well-defined in the literature, and are often under reported in mixed methods research projects. All language used to discuss this sampling procedure derives from Teddlie and Yu (2007), who provide a typology of different combinations of quantitative and qualitative sampling techniques as they are used in mixed methods research. This project overall utilized a concurrent, multilevel mixed methods sampling design, where a single sample is generated using both probability and purposive techniques (see Teddlie and Yu, 2007: 91). Because I seek to develop both a theoretical characterization of farmers’ seed access decisions and an inductive model (that can be operationalized using quantitative indicators), I used a concurrent sampling design. I gathered quantitative and qualitative data from the same sampling unit (individual farmer) to provide consistency and the ability to both triangulate and test hypotheses with the data. I used purposive cluster sampling to define the sampling sub-frames and random sampling was then employed to select individual farmers, which are the unit of analysis for all of the qualitative and quantitative work done in this project.¹ In this sense, the sampling methodology is sequential, in that the sampling frame follows a more qualitative strand while the selection of

¹ In addition, seed diffusion maps (visual data) utilizes village as the unit of analysis to model the spread of improved variety seeds.
individual units of analysis follows the quantitative techniques of random probability sampling. However, because the research design also calls for a stratified sample to better include different types of farmers, the ongoing back-and-forth of qualitative and quantitative sampling strategies can be best categorized as a concurrent mixed methods approach.

At the outset, this study employs multilevel mixed methods sampling approaches that are primarily purposive. There are nine project sites involved in the overall mini-packets/seed systems projects – six supported by the McKnight Foundation’s CCRP seed systems project, and all nine also supported by the Gates Foundation HOPE project. A site is defined as the area in which a single farmer organization that produces and sells improved variety seeds works and has members. The radius of influence from an organization’s central office varies from 50 km to 100 km or more. My sample sites were chosen through a purposive sample that accounted for different histories of work with ICRISAT, the feasibility of travel to the site, and past social science research conducted there. As described in Chapter 4, I have selected a total of five sites in three countries, four of which are McKnight Foundation-supported and one (Bokki) which was added with the Gates Foundation-funded project.

Once the sites were selected, the theoretical population of interest for this study became all farmers with access to improved variety seeds, as the research questions seek to understand the range of ways that farmers incorporate new seeds and new markets into their existing seed access systems. Because of time and resource constraints, as well as the monitoring and evaluation imperative of this project (that the research and analysis must document the effects of specific research for development efforts), I took a purposive stratified sample from the overall population. The sample strata are based on both past empirical work and analytical considerations that emerged during early analysis of qualitative and quantitative data on possible points of seed access. The sampling frame for this study, then, is based upon three strata of the overall population: those farmers who purchase improved variety seeds through sales of mini-
packets, those farmers who received improved variety seeds through exchanges or gifts from original buyers, and those farmers (testers) who conduct varietal trials as part of PPB activities and so receive improved variety seeds directly from researchers. Table 5-1 provides population estimates for each stratum based on the lists used to create the sample frame for this study. Lists of buyers are kept by seed sellers throughout the period of seed sales, and shared with ICRISAT at the end of the season. Lists of testers are kept by ICRISAT technicians. Lists of seed receivers, however, do not exist, and so sequential sampling (through snowball sampling) was used to generate this list.

Table 5-1. Full population estimates for each stratum

<table>
<thead>
<tr>
<th>Field Sites</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>Siby, Mali</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buyer</td>
<td>30</td>
<td>6</td>
<td>36</td>
</tr>
<tr>
<td>Tester</td>
<td></td>
<td></td>
<td>37</td>
</tr>
<tr>
<td>Receiver</td>
<td>0</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>Dioila, Mali</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buyer</td>
<td>113</td>
<td>3</td>
<td>76</td>
</tr>
<tr>
<td>Tester</td>
<td></td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>Receiver</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Dédougou, Burkina Faso</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buyer</td>
<td>127</td>
<td>7</td>
<td>118</td>
</tr>
<tr>
<td>Tester</td>
<td></td>
<td></td>
<td>21</td>
</tr>
<tr>
<td>Receiver</td>
<td>17</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Serkin Haoussa, Niger</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buyer</td>
<td>194</td>
<td>69</td>
<td>219</td>
</tr>
<tr>
<td>Tester</td>
<td></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Receiver</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bokki, Niger</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buyer</td>
<td>54</td>
<td>2</td>
<td>46</td>
</tr>
<tr>
<td>Tester</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiver</td>
<td>10</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>518</td>
<td>87</td>
<td>556</td>
</tr>
</tbody>
</table>

<sup>1</sup> I did not receive seed sale lists from Siby and Bokki in 2012
With the stratified sample populations identified, purposive cluster sampling was used to identify the range of villages that it was realistic to visit in each site, given time and resource constraints. Depending on the site, the radius from the farmers’ organization headquarters to potential villages to visit ranges from 10 km to more than 100 km. In some sites, my primary means of transportation was by motorcycle, which limits the possible travel range. The stratified lists are thus purposively narrowed to include only those individuals in villages that are feasible to visit. From these final lists, each year I selected a random sample\(^2\) of farmers who purchased mini-packets of improved variety seeds directly from seed sellers. These “first-order” farmers were interviewed about their seed purchase decisions during the 2010 growing season, and I continued to follow a cohort of first-order farmers from 2010 through the 2011 and 2012 seasons, to provide a small panel data set that documents seed access decisions over time.

In addition, I randomly selected testers from each village included in the purposive sample to provide representative information on this stratum of the population. The inclusion of testers in the overall population of interest reflects a type of sequential theoretical sampling common in qualitative research – after the first year of interviews, it became clear that women were underrepresented in the sampling frame but do indeed have access to improved variety seeds through field trials. An additional stratum was therefore added during the second year of research to increase the representativeness of the subsamples with regard to the overall population of interest. After the 2010 season (during which there were only first-order seed purchasers), I used snowball sampling to follow the exchange of seeds, interviewing farmers who received improved seeds from those who originally bought them; that is, I began to snowball to “second-order” farmers (Biernacki and Waldorf, 1981; Barnes, 1979). Snowball sampling is another purposive sequential sampling technique employed to create a sampling frame suggested by past research or

\(^2\) Random sampling is done by assigning a number to each name on the list (in the order that they were recorded by the seed seller), writing numbers on small pieces of paper, and drawing these pieces of paper out of an envelope.
theoretical assumptions. During interviews conducted after the 2011 season with farmers who had originally purchased seeds for the 2010 season, I created a list of farmers who received seeds through gifts or exchanges from those first purchases in 2010 and who then planted them during the 2011 season. As many of these farmers as possible were interviewed after the 2011 season.

Table 5-2 shows the distribution of individuals across strata for the overall sample, from which both qualitative and quantitative analysis was conducted. The table depicts the individuals interviewed in each stratum (buyer, receiver, tester), in each year, and is further differentiated by gender. It should be noted that because there is a panel subset within this overall sample, some individuals were interviewed more than once and are included in Table 5-2 in each year that they were interviewed. Therefore, the sum of the yearly totals are larger than the overall sample size. Farmers interviewed more than once are identified by the stratum in which they entered the sample; for example, a farmer who purchased in 2010 and was interviewed again in 2011 remains in the buyer stratum, even if he did not repurchase in 2011. In Chapters 5, 6 and 7, I provide detailed descriptive statistics of the sample being used for each of the specific analyses.
Table 5-2. Sample size by site, stratum and year

<table>
<thead>
<tr>
<th>Field Sites</th>
<th>2010</th>
<th></th>
<th>2011</th>
<th></th>
<th>2012¹</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td></td>
<td>M</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Siby, Mali</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buyer</td>
<td>19</td>
<td>3</td>
<td>27</td>
<td>12</td>
<td>23</td>
<td>14</td>
</tr>
<tr>
<td>Tester</td>
<td>0</td>
<td>11</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>Receiver</td>
<td>0</td>
<td>1</td>
<td>12</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dioila, Mali</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buyer</td>
<td>47</td>
<td>0</td>
<td>36</td>
<td>3</td>
<td>33</td>
<td>2</td>
</tr>
<tr>
<td>Tester</td>
<td>1</td>
<td>14</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiver</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dédougou, Burkina Faso</td>
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<tr>
<td>Buyer</td>
<td>73</td>
<td>6</td>
<td>66</td>
<td>8</td>
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<tr>
<td>Tester</td>
<td>2</td>
<td>14</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiver</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serkin Haoussa, Niger</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buyer</td>
<td>36</td>
<td>15</td>
<td>65</td>
<td>36</td>
<td>47</td>
<td>35</td>
</tr>
<tr>
<td>Tester</td>
<td>n/a²</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Receiver</td>
<td>5</td>
<td>27</td>
<td>2</td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bokki, Niger</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buyer</td>
<td>22</td>
<td>1</td>
<td>27</td>
<td>3</td>
<td>23</td>
<td>2</td>
</tr>
<tr>
<td>Tester</td>
<td>n/a³</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Receiver</td>
<td>1</td>
<td>0</td>
<td>9</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total¹¹¹</td>
<td>197</td>
<td>25</td>
<td>236</td>
<td>130</td>
<td>169</td>
<td>114</td>
</tr>
</tbody>
</table>

¹ In 2012, the only buyers and testers interviewed were in the panel data set; some receivers were new to the sample
² No testers were interviewed in Serkin Haoussa because women were well-represented as buyers
³ No testers were interviewed in Bokki because there were no individual women testers
⁴ Totals for each year sum to more than the overall sample total due to the inclusion of individuals in the panel data set who were interviewed all three years

Data collection

Following Small’s (2011) terminology, I used a concurrent mixed-data collection design in order to maximize the limited time in the field and to minimize demands placed on research participants. I gathered qualitative, quantitative and spatial data at the same time, and also used multiple techniques to gather the data. To gather much of the qualitative and quantitative data, after the field seasons of 2010 and 2011, I conducted semi-structured interviews with farmers
who have bought improved varieties of seeds as well as those who received improved variety seeds from others (see Appendix C, for interview guides). These interviews asked questions of how farmers perceive their seed networks and markets – where they receive information and materials, how and why they access them, and what this access means to them in terms of their agricultural and social context. In addition, I asked specific questions of changes they have seen in information and seed sources, why those changes have come about, and how they have experienced them. I also asked a series of questions about discrete actions to gather quantitative data that could be analyzed using statistical techniques. Due to the regional instability in 2012, I decided not to do my own fieldwork and so developed a structured survey that was implemented by local research assistants after the field season in 2012, so that I could continue gathering quantitative data from those in the panel data set (discussed further below) (see Appendix C for survey questionnaire). In addition to semi-structured interviews, in 2010 and 2011 I conducted group meetings in six villages in Burkina Faso, six in Niger and one in Mali, to gather qualitative and spatial data. During the meetings, we discussed ideas of seed networks and how people share agricultural information and inputs. To help elucidate experiences in a different medium and to gain spatial data, I also used participatory mapping techniques (see Fortmann, 2008). Each year we drew a map of the community seed networks, depicting the places from where the village received seeds and to where they send seeds. In 2011, we compared any changes from the previous year, which led to further discussion of the changes in seed systems at the village and regional level. Finally, I used a GPS unit to record the coordinates of every village I visited, to create maps that depict different aspects of the seed system as well as changes over time.

In addition to primary data collection, I also used a range of secondary data sources to supplement the quantitative and spatial data. Most importantly, I used the lists of seed buyers kept by farmer unions and seed sellers not only as a sampling frame (which will be discussed below) but also in analysis performed for ICRISAT’s ongoing monitoring and evaluation needs,
and to provide a description of the context of seed sales. I also used ICRISAT project documents to identify spatial characteristics of the social context, including the distribution of field trials in each area. Finally, I used a database of geographic coordinates for every village in Mali, Burkina Faso and Niger that was collected and provided to me by colleagues at ICRISAT.

**Fieldwork logistics and data management**

Many aspects of the logistics associated with fieldwork have been touch upon earlier in Chapters 3 and 4, but I will summarize them here and then focus on language issues, which have not yet been addressed. Questions of translation and transcription are part of the larger issue of data management, which I will then address.

Devereux and Hoddintott (1993) characterize the three phases of fieldwork as getting there, being there, and coming home. I got to Sahelian West Africa to conduct fieldwork by connecting to a regional research organization that had funding and the need for a social scientists, as well as ongoing relationships and projects in all of my research sites. The logistics of being there were figured out in conjunction with ICRISAT – I stayed in short-term housing for ICRISAT affiliates and in the homes of researchers when in capital cities. When in the field, I stayed in the villages in which I worked, sometimes with a local family, sometimes at a government rest house or tourist camp. I tried to travel by the simplest means possible, which often meant by public bus to the research area and by motorcycle once there (see also Newhouse, 2012). In some places, I took a white ICRISAT car, as the villages are scattered fairly far apart. Other times I walked or took a donkey cart between villages. I spent about two weeks in each research site, each year. As previously mentioned, I worked with either a local student or an ICRISAT technician, who served as an assistant and translator. Most of the actual logistics about which villages to visit on which day, as well as letting people know ahead of time (when
possible) that we were coming, were done by the farmer organization technicians or representatives, with whom I worked very closely and without whose help I could not have done this research. Each day in the field, I and my assistants would go to an area comprised of several villages and meet up with the local farmer technician there. He would then travel with me and my assistant to all of the villages in his zone, helping us identify the individuals to be interviewed, providing context and legitimization of my presence, and sometimes helping with translation issues when the research assistant had difficulties.

Language in fieldwork plays several roles – as a way to show respect, as a way to integrate and gain access to new knowledge, and as the means of gathering data. As Devereux and Hoddintott (1993) argue, “the primary objective of fieldwork is to collect data, and learning the language is only one means to that end” (16). In Sahelian West Africa, there are over a dozen local languages that are spoken along regional and ethnic lines, as well as French as the official language of all three countries (Lewis, 2009). I speak French fluently, and I also speak one local language, Pulaar, at a high degree of proficiency. At the outset of this project, I did not speak more than a few words of Bambara/Malinke/Dioula or Hausa, the two most common local languages in the project areas. I bought Bambara and Hausa dictionaries to teach myself, and I also took Hausa lessons from an international student at Penn State for one semester. By the end of this project, I could get around marketplaces and have small, pleasantry conversations in both of those major language groups. I learned the greetings in several other languages, because greetings are an incredibly important social custom without which I would have been disrespectful. I also found that I learned enough Bambara and Hausa to follow along as interviewees responded to questions that involved numbers, crops and a few other basic types of information. Language, then, facilitated several secondary aspects of fieldwork, but in the end, the primary objective was still to collect data, and to do that, I used a translator.
The research assistants and local students with whom I worked served primarily as translators whenever a farmer did not speak French and I could not speak directly to him or her. I wrote my questionnaires and other materials in French, and would ask the questions in French. The translator would translate into the local language, then back to French for me. I recorded all interviews and group meetings with a digital recorder, and took notes in my own notebook (in French, as that was easier for me in the moment than translating into English). I later transcribed the recordings and while transcribing, translated the conversations into English, for ease of analysis and presentation. The decision to translate while transcribing makes formal discourse or content analysis impossible, but given the layers of translation that occurred in the field, these approaches would have already been inappropriate. Instead, taking as a starting point Temple and Young’s (2004) assertion that translation in an ongoing aspect of qualitative research, I feel confident that the care with which all translation has occurred in this project maintains the meaning and intention of farmers’ individual comments, so that thematic analysis is an appropriate and accurate use of the qualitative data.

The logistics of how data was collected and how it is then managed provide the shift from being there to going home. Going home from fieldwork means many things, but from the point of view of the research project, the primary task once home is data management, analysis and presentation. I will describe in detail below the mixed-data analysis approaches used in this dissertation (Small, 2011). Data management, however, was ongoing in the field and after. In brief, while in the field I created a database with a unique ID number for each farmer interviewed, and used these IDs for random sampling lists, and eventually to identify the digital recordings and transcripts from each individual. This management technique fits with the nested approach to data collection, where different types of data from the same individuals or units of analysis are collected (Small, 2011). The database is comprehensive, and from that data set subsamples, such as the panel data set, have been created for certain types of analysis. Keeping an updated
database of information allowed me as well to meet ICRISAT’s requests for ongoing monitoring and evaluation information. All of the data is stored on my personal computer, in the Penn State computer system, and on ICRISAT’s servers in Mali.

Data analysis

I initially approached data analysis with the goal of using triangulation to describe different aspects and characteristics of seed systems in Sahelian West Africa, and the ways that they might be changing with the introduction of seed markets. This phenomenological approach to mixed-data analysis proved to be meaningful in order to describe and analyze the components of the natural setting and the social context that influence farmers’ decision-making about type of seed and type of activity used for seed access. In Chapter 6, I use a sequential approach to mixed-data analysis, first analyzing the qualitative data from interview transcripts and then identifying and testing relationships between relevant quantitative indicators of the natural and social contexts, and dimensions of the seed system (Creswell and Plano-Clark, 2011). Spatial data provides visual representation of seed system indicators identified from the coding, and also can be used to assess the scope of Sahelian seed systems. Chapters 6 and 7 then focus on in-depth analysis of single types of data, qualitative and quantitative, respectively, and Chapter 9 synthesizes these deeper analyses and relates the results to theories and literature overviewed in Chapters 1 and 2.

Analysis of the qualitative data is done in Chapters 5 and 6 through thematic coding and ‘horizontalization’ of the data (Coffey and Atkinson, 1996; Creswell, 2007). Taking a phenomenological approach to qualitative data analysis, I use the approach of horizontal data analysis to identify and present as complete a range as possible of non-overlapping specific sentiments expressed by those I interviewed about both the context of and decisions about seed
systems (Creswell, 2007). Therefore, the data (quotations) are presented as representative of a specific code or theme within the categories that I identified throughout the process of initial data analysis; the data are often not attributed to particular individuals because they are representative of a common experience expressed by several of those interviewed (see Weiss, 1994, for discussion of presenting qualitative data). In addition, the data are presented in single quotation marks rather than double quotation marks, to remain consistent with the multiple layers of translation described above. Halai (2007) reviews literature on presenting translated qualitative data and finds no clear rules or best practices for attributing translated quotations. Because of the multiple layers of translation in this research project, and because the qualitative data I present in Chapters 5 and 6 is used to characterize specific codes or groupings of common sentiments, I see the translational and proximate designation of single quotation marks as the most appropriate presentation style for qualitative data in this analysis (Peters, 1973).

In Chapter 6, I first coded interviews for the general themes of elements of the natural and social settings that influence farmers’ seed access decision making. I then used the conceptual framework developed in Chapter 2 (Figure 2-1) as the starting point for broad categorization of farmers’ experiences with the dimensions of seed systems. In this way, the context for seed systems and decisions made about seeds are defined by farmers’ own identification of relevant characteristics, and organized or grouped by my perceptions as a researcher. I present the qualitative data analysis in Chapter 6 as a kind of first-order abstraction, of the ‘what’ and ‘how’ questions, from which to build analysis in Chapter 7 of the essence of farmers’ experiences with the formal market-oriented seed systems (see Creswell, 2007, for elaboration on qualitative data analysis in phenomenological research).

Once the thematic coding in Chapter 6 was complete, I generated a list of indicators that describe the natural and social contexts and could be quantified or categorized, and populated a database with the necessary information for each case, drawing from interview transcripts. The
goal with the quantitative analysis in Chapter 6 is to characterize the patterns in indicators described by farmers in the qualitative data, and to test for relationships between contextual and individual characteristics, and seed access actions. Espeland and Stevens (2008) describe the ‘sociology of quantification’ in the constructivist tradition as necessarily demonstrating how measurement is influenced by context and in turn further conditions understandings and future actions. The indicators of seed system context and dimensions identified through qualitative coding and then used in quantitative analysis in Chapter 6 were also incorporated into visual representations of the seed system, which provide an additional type of data depicting how seed systems and individuals are situated, and at what scale seed systems function. In addition to qualitative and quantitative data analysis, I used GPS data to create visual representations of relationships among different aspects of context and seed system dimensions. The analysis described above is presented in Chapter 6 in step-wise fashion for both the natural and social contexts, with qualitative data analyzed to establish a comprehensive understanding of emergent themes in the data, quantitative indicators then identified and the sample characterized accordingly, and visual representations used to depict the patterns being described.

As the research project and my experience with both the actual setting and the ideas presented in Chapter 2 and 2 progressed, I continued with additional layers of analysis that seek to test the descriptive analysis generated through the phenomenological coding process against the empirical phenomenon and context (Creswell, 2007; Small, 2011). The objectification of the individual description and experience could be seen to challenge the epistemological underpinnings of phenomenology, which privileges lived experience over generalized rules. However, the goal of complementarity through testing is just that – to complement or interpret individual expressions of the context and dimensions of seed systems with an analysis of how the

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3 All statistical analysis presented in Chapters 4 and 5 was generated using SPSS software.
4 All digital maps were created using ArcGIS 10.1.
patterns described by individuals are spread across space and over time. In Chapters 6 and 7, I build on thematic analysis of individuals’ primary experience by relating farmers’ descriptions to sociological theories of diverse habitus and system embeddedness, as well as by developing and testing a statistical model that looks at the ways in which those patterns are differentiated based on contextual and individual characteristics (Bourdieu, 2005; Polanyi, 1957b; Granovetter, 1985).

Chapter 7 presents a deeper engagement with the qualitative and visual data using the theoretical framework developed in Chapter 3 and the primary analysis presented in Chapter 6. I start with the ideas of provisioning and substantive economic systems, economic habitus and context-specific value to organize codes related to experiences of different seed systems, motivations for seed access decisions, and the value associated with the output of improved variety seeds. I continue within the interpretive phenomenological analytical approach, and lay out the breadth of experience and perceptions associated with improved variety seeds, in order to have as complete an understanding of the field of experience as possible (Creswell, 2007). For this reason, the data (quotations) are presented as representative of a specific code or grouping within a theme, and the themes are organized as they relate to theoretical concepts. I also present visual representations of seed systems using both hand-drawn maps, made by farmers during group meetings in villages, and digital maps made by me.

Chapter 8 focuses on the quantitative testing of the themes that emerge from initial mixed-data analysis, and extends the regression analysis to build a model of emergent seed systems. Using latent growth curve analysis (Bollen and Curran, 2006), I create a theoretical model of dimensions of seed systems and hypothesize that individual farmers will make patterns of decisions that both integrate farmers into a range of possible types of seed systems and also institute those seed systems through the combined effects of decisions made within each dimension of the seed system. I used MPlus software to conduct the analysis, and took a supplementary short-course through the Inter-university Consortium for Political and Social
Research at the University of Michigan in the summer of 2013 in order to hone my structural equation modeling skills. The structural equation modeling approach and incorporation of growth curves will be discussed in depth in Chapter 8. I developed but was unable to test a full theoretical model, due to a lack of data in the panel data set, which was in part a result of the political instability in Sahelian West Africa and my decision to shift and curtail fieldwork for this project.

The final synthesis of data in Chapters 5, 6, and 7 is intended to present a ‘narration’ of the variegated experiences of farmers in the Sahel with the phenomenon of newly established seed markets and the institution of the formal seed system (see Creswell, 2007, for discussion of the final representation of phenomenological research). In Chapter 9, I connect the analyses in a side-by-side comparison that challenges and deepens specific results from each of the previous chapters (Creswell and Plano-Clark, 2011). The data synthesis presents the field of farmers’ experiences as organized by description of and engagement with different types of seed systems. I draw on seed systems literature presented in Chapter 2 to broaden understanding of integrated seed system in light of the integration described and tested with the qualitative, quantitative and visual data analyzed throughout this dissertation.

Presentation of results

The outputs of this research project are varied because of the many actors and priorities associated with it. As a Ph.D. student, I have produced this dissertation. With it, I seek to demonstrate my own capabilities in core areas of rural sociology and research methods, as well as to contribute to specific theoretical schools and areas of academic literature. I also hold a personal commitment to applied work, which means both an epistemology that privileges primary data and emergent analysis, and also outputs that are meaningful in the research context. I
therefore make programming and policy recommendations in the conclusion of this dissertation, in order to connect the abstract analysis to potential action. In addition, for this project, I have generated yearly reports on seed sales and seed use, changes over time and issues related to the seed systems projects, for ICRISAT and McKnight Foundation use. I have worked with the farmer organizations to develop their own questionnaires in order to assess their effectiveness in the realm of seed marketing and sales. I would like to make data relevant to the individual farmers who have been interviewed for this project, but it remains difficult to figure out what exactly would be a useful contribution. The village-level seed maps that we make each year I leave with someone in the village and take just a photograph for myself, in an effort to leave at least that knowledge in the place in which it was generated. I hoped to make individual seed maps for certain farmers who produce or otherwise distribute improved variety seeds (including through exchanges or gifts) and to bring them to those farmers during the final year of fieldwork. That did not happen, due to changing timelines and regional instability, but remains a possibility for the future. Given the institutional nature of international development, I do think that drawing conclusions and making recommendations at the programmatic and policy level is one way to make findings relevant for individual farmers. The desire to share information at the individual level, however, remains one that is important and yet elusive for me.
Chapter 6

Characterizing context and dimensions of Sahelian Wes African seed systems

Farmers’ experiences of historical and contemporary seed systems are influenced by the natural and social settings within which agricultural production and seed access occurs. In turn, the natural and social settings are impacted by the decisions that farmers make within different dimensions of the seed system. The following mixed-data analysis presents farmers’ descriptions of their natural context and social setting, and how those relate to two dimensions of the seed system described in the conceptual framework presented in Figure 2-1. I draw on literature presented in Chapters 1 and 3 to characterize the relationships between the natural and social settings, and the type of seed and type of access activity used by farmers. The data presented here comes from transcriptions of interviews from the full sample described in Table 5-2. Within each section, I first present qualitative data as representative of common codes and groupings within the themes of context and seed system dimensions. The data are therefore not always attributed to a specific individual, as they are precise examples of common sentiments that have been identified and organized throughout the analysis process. I then identify relevant measurable variables and present basic regression analysis to further define the relationships between natural and social context, and different dimensions of the seed system. I also include maps created using digital data to provide visual representation of different aspects of the natural and social contexts.
Natural environment and type of seed

The relationship between natural context and type of seed is analyzed here to better understand the relevant characteristics and pressures of the natural system that influence farmers’ decision making about which phenotypic or genotypic traits they look for in seeds. In some ways, this type of analysis builds on PPB approaches that emphasize the genotype by environment interaction (Ceccarelli and Grando, 2007). As Dawson et al. (2008) explain, heterogeneous natural environments require a range of traits, often in different combinations, meaning that no single variety will provide a silver bullet genotype. Richards et al. (2009) describe the genotype by environment interaction in traditional West African seed systems as being focused more on phenotype than genotype, with natural pressures driving farmers’ desire for certain phenotypes, like short cycle or pest resistance, regardless of the specific configuration of genes or genetic purity. The following analysis explores farmers’ characterization of the natural environment in the Sahel as it relates to seed systems, and also presents the various ways that farmers categorize improved, creolized and landrace seeds.

Natural environment

A consistent and fundamental theme in farmers’ discussions of the contemporary natural environment in the Sahel is rainfall, and how it has changed over time. The rainy agricultural season is generally considered to be May to October, but many older farmers describe that in the past, the rain started earlier and continued longer. However, ‘now the rain is very rare, it stops before the pearl millet is ripe.’ Long-term data analysis shows uncertain results about whether rainfall has been decreasing over time in the Sahel (Zhang and Delworth, 2006; Reij, 2010); a recent report on the effects of climate change on Sahelian agriculture (Jalloh et al., 2013) argues
that more erratic and less overall rainfall is likely in the region as global temperatures rise. Farmers describe this phenomenon in terms of the length and reliability of rain. One man, who is 55, explained that ‘when we were young, in school, the month of April it would rain. We would even leave to plant…and sometimes you would even harvest when there was rain…now, sometimes the real season is in June. We start planting in June, July, August, September. And sometimes in the middle it will stop.’ Farmers emphasize also that the unreliability in rainfall throughout the season is more concerning and a bigger change than an absolute lack of rain. Now ‘the rain isn’t the same. Before, there was regularity of the rain, but now it’s not regular, sometimes it stops, sometimes it doesn’t rain. We can go one or two weeks without rain.’ The unreliability is not only a change to be noted, but a variable to take into account as farmers make seed and production decisions.

In addition to rainfall, many farmers discuss soil fertility as a key feature of the natural environment. ‘The soil, the fields, they have had them a long time, since their parents. So the soils is degraded, they’re no longer rich, so they have to bring inputs to nourish them.’ Though changes in soil fertility are certainly related to agricultural practices, Aune and Bationo (2008) and Breman et al. (2001) highlight the naturally poor soils in Sahelian West Africa, arguing that soil quality has historically been more fundamentally limiting for agricultural than has rainfall. Agricultural communities have developed ways of managing land that accounted for low soil fertility and slow rates of nutrient replenishment, mostly through fallowing and the incorporation of livestock for manure. Farmers describe that ideally, ‘you find a place where nothing has happened for ten years. So, if you cut those trees, you will get a lot there.’ Historically, the relatively low population in the Sahel allowed for a soil management approach that relied primarily on fallowing. With increasing population pressures, however, rotations occur more quickly, so that now, farmers describe using a new field ‘for two or three years, and then it’s done.’
In addition to the abiotic stresses on agriculture that come from rain and soil, farmers describe how pests, most notably birds, affect their agricultural systems. Many of the birds in Sahelian West Africa are migratory, and they arrive toward the end of the rainy season, when food (including planted fields) is abundant. However, their arrival is variable and so is their impact: ‘it all depends on the time that the birds come…sometimes they come just at the maturity of the improved variety and they attack the variety, so the local variety is fine.’ The threat of losing just ripened grain is grater for farmers near seasonal water sources, both because birds tend to congregate at the water and because fields near water tend to flower earlier due to increased moisture. Other birds remain year round, and often eat seeds out of newly planted fields, meaning that farmers have to replant several times, driving up the amount of seed required. In addition to birds, the other major biotic stress in Sahelian agriculture is the parasitic weed *Striga hermonthica*, resistance to which has been one goal of ICRISAT’s PPB projects based on farmers’ identification of striga as a major concern (Haussmann and Kapran, 2007).

A final aspect of the natural environment that influences seed systems in particular is the physiological traits of the species being grown. Sorghum is largely a self-pollinated plant, but cross-pollination is possible and dependent both on wind and variation in how open the panicle is, which differs by variety. Pearl millet is usually cross-pollinated, due to a staggered flowering process (BOSTID, 1996). There has been much concern by project scientists that farmers do not understand cross-pollination, which will lead them to make decisions about saving and reusing seeds based on an expectation of genetic purity for each subsequent generation. However, many farmers I spoke with explained that ‘even with the local varieties, they’ve noticed the same situation.’ Farmers rely primarily on phenotyping to identify varieties, seeds, and changes in them, and because cross-pollination is a possible feature of all types of sorghum and pearl millet (though to varying degrees), it came as no surprise to farmers that saved seeds slowly changed over time. ‘She noticed this type of thing in her field. She said that…can change the improved
seeds until she can identify local seeds. Even local varieties, they also, they can change.’ How farmers incorporate knowledge of cross-pollination into their seed systems will be discussed in detail below; for now, it is important to note that cross-pollination is a fundamental component of the natural environment with which farmers have much experience.

**Type of seed**

As was discussed in Chapter 2, definitions of varieties and types of seeds can include both biological and socially constructed components. The ways that institutional and social contexts affect perceptions of seed type will be discussed further below, although the genetic standardization that comes from certification is included in the description of improved variety seeds here. Building on the seed systems literature presented in the conceptual framework, I here apply the heuristic of improved variety seeds, creolized or rusticated seeds, and seeds of local landraces to farmers’ explanations of their own categorization of seeds, to better understand how the biological traits of seeds (both genotypic and phenotypic) provide the foundation for seed identification (Bellon et al., 2010). Improved varieties and landraces are both described by farmers primarily in terms of standard phenotypic traits and production constraints. Improved varieties are also characterized by the socially constructed standardization of presentation and packaging. Creolized or rusticated seeds, falling somewhere in the middle, are described by farmers in the Sahel as seeds from improved varieties that have been saved and reused up to a specific threshold of change or heterogeneity, beyond which the seed shifts from being distinguishable as creolized to being characterized as old and too impure to be desirable.
Improved

Improved varieties are identified by most farmers based on specific visual traits in the field and while being processed. Color and size – for example, ‘the grains are big and white’ – provide a simple way to distinguish among varieties in general, and in combination help to describe specific new varieties that are otherwise unfamiliar to farmers. Direct comparisons to landraces could imply that landraces as well are thought of by differentiated phenotype: ‘he noticed, the candles are very long, compact, and at the same time there is a type of barb, that comes out as it gets hot. And here, their pearl millet doesn’t have that.’ Other comparisons seem to fit the more standard definition of landraces as everything else that is not specifically improved (Lipper et al., 2010). The traits of improved varieties that relate to biotic and abiotic stress are often characterized against the negative landraces that do not possess these traits: ‘with local seeds, there are lots of illnesses right now. But with improved seeds, he has seen that right now, these illnesses aren’t a problem.’ Improved varieties are also defined by their harvest and post-harvest characteristics, most often in terms of yield and whether they make local dishes with the same taste or texture as landraces. All of these relational descriptions of varieties suggest that for many farmers, direct comparisons of known landraces to unknown improved varieties help to define each.

In addition to relational definitions, improved varieties are sometimes described in terms of genetic purity, based on knowledge of cross-pollination and education by farmer organizations about the specific standardization of improved varieties: ‘yes, they degrade. The new variety of HKP [a pearl millet variety] is very good, very pure.’ Improved varieties are those that are planted so that ‘there won’t be mixing, contact, between other varieties.’ There is again a relational component here, in that the specific undesirable traits of landraces are contrasted with the desirable traits of improved varieties. However, the more immediate concern is that improved
varieties maintain maximum levels of the specific traits that make them better or more desirable in a given context. One way that farmers discuss the degree to which seeds are improved is in terms of changes in yield over time: ‘the base seeds give more yield than the seeds that are replanted.’ ‘Base seeds’ are assumed to be genetically standard improved varieties, while the seeds that are saved are inherently creolized in some way (unless very specific land and production management techniques are used).

In terms of genotype, even improved varieties are not completely standardized. However, the certification process and observations of phenotypes suggests to farmers that improved varieties are genotypically superior and ‘trustworthy.’ Germination rates are often mentioned as evidence that improved varieties are in fact improved, in contrast to landraces. ‘The local varieties, for example, if you plant ten in a pocket, there are six that will germinate and the four others, they are already bad. For the improved varieties…germination is good.’ The presentation of improved varieties, in sealed mini-packets, reinforces the idea of purity: ‘since they’re sealed, when they arrive…they know that they are real seeds.’ In addition to being sealed, the improved varieties come with information about specific traits, which provides an additional layer of standardization and certainty. Finally, seed producers identify improved varieties as those seeds that ‘go to the laboratory. Those will be sold for a price.’ The added value that comes from certification is based on genetic purity and germination rates, again reinforcing the farmers’ experiences with improved varieties as standardized and consistent.

Creolized

Given the emphasis on the purity and standardization, it might be expected that creolized seeds would be defined as being variable or unreliable. Dalton et al. (2010) suggest that informal or creolized seeds can be either recycled improved varieties or seeds bought in informal markets
or acquired through saving. Meng et al. (1998) define creolized or rusticated seeds as seeds that have been mixed by nature or farmers and selected by farmers over a period of years. For farmers in the Sahel, a type of seed that is in between the new, improved varieties and their traditional landraces is defined by the presence or absence of a few specific traits, so that decisions about use can be made based on experience and observation. Change in yield is one of the biggest signifiers of creolization, though the direction of yield change differs. For some, ‘the first time, [improved varieties] give a big production, and all the plants are the same. The second year, there is a small change.’ Other farmers report that with creolized seeds the ‘yield changes, but it’s always better than the local varieties.’ As long as creolized seeds still perform better than those of the landrace, based on the desired traits, it will be considered as somewhat improved. Perhaps even more interesting, many farmers report that when they reuse seeds, ‘the second year is higher yield than the first year.’ One breeder described this to me as unintentional hybrid vigor, where the mixing that occurs naturally through cross-pollination can make the second-generation seeds more productive. Defining creolization relationally builds on the constructivist approach to characterizing seed types, and captures both farmers’ and plant breeders’ understandings of creolized seeds as deriving from improved variety seeds.

Other relational definitions of creolization refer to phenotypic traits that can be observed in the field. People notice ‘that the number of days to the end of the cycle increases from the base seed. Five more days each year. Also, the one with short candles, the second time, when you plant it again, they become a little longer.’ Recognizing more discrete changes that occur in creolized seeds, like the additional five days it takes for the crop to mature, helps farmers make decisions about their own thresholds for change and about how to reuse seeds of what were once improved varieties. Skilling with creolized seed often combines with previous experience with cross pollination: ‘they know also that when you have your own pearl millet, maybe two, three, four, five years, that will start to change. So you have to change it.’ The relationship between the
skilling process and seed reuse decisions will be further discussed in following sections on the relationship between the social context of skilling and seed decisions. The definition of creolized is inherently socially constructed, and at the same time, experiential learning helps farmers identify what creolized means in their own social and natural milieu. As one man explained, ‘people said that if you use [improved varieties], and use them the second time, you will have, they will change. Fortunately, he planted them the second time, he didn’t notice that. So he plans to plant them again this year.’ The degree of change it takes to define a seed as creolized, whether the connotation is negative or positive, will differ by farmer and should not be taken as a discrete category. However, creolization, defined as farmer management of seed that maintains a mixture of traits from improved varieties and landraces, is reflected in farmers’ descriptions of identifying and reusing seeds as long as the desired traits exist at specific minimum levels.

*Landrace*

Interestingly, in the seed system literature creolized and landrace seeds are often lumped together into a catch-all category of everything else that is not standardized, improved varieties. For farmers, however, local landraces are identified in both precise and wide-ranging ways, creating a distinct category for landraces that derives from their historical experience of seed systems and the contemporary incorporation of certified, improved varieties. For some farmers, improved varieties are ‘new, and what he plants is old. The seeds are old.’ Old can mean tired, and old can mean known: ‘what I have, the local variety, everyone has that. All of my neighbors have what I have.’ These definitions have are implicitly relational to improved varieties as whatever is new, and as will be discussed further below, use of new and old seeds both bring a range of opportunities and risks. One important aspect of local seeds being familiar and old, in
contrast to new, is the ease of access that defines local seeds. ‘Improved varieties are difficult to have. The local varieties, since they’re our varieties, we get them amongst ourselves.’

The fact that landraces are reproduced locally, outside the purview of modern certification and standardization, leads seed system literature to categorize them as informal or creolized. The common definition of formal seed markets is that formal or improved seeds are certified and are sold as seeds, not at grain (Lipper et al., 2010; Dalton et al., 2010). It is true that for many farmers landrace seeds are purchased in local markets as grain. ‘Then, when you bring it to eat, when you don’t have something to plant, they use it as seeds.’ However, local access is part of what defines landraces, and is distinct from seed of both creolized and improved varieties. For some farmers, the local seed systems, and the seeds within it, are more reliable than those of improved varieties: ‘he said that he planted his local variety for a long time, and there aren’t changes, either in the grain or the panicles. But with the improved varieties, there are changes.’ Landraces are genetically heterogeneous, but can still be consistent in terms of the mix of traits that exist in the population. As the skilling process occurs with improved varieties and their standardized traits, some farmers have started to shift their understanding of landraces. ‘Before with their local varieties, they didn’t have just one variety. All was mixed...in the field, there were tall sizes, short sizes, red glumes, white glumes.’ Landraces might be as consistent as improved varieties, but they are not as genetically pure, and so look different in the field.

**Relationship between natural environment and type of seed used**

Building on the genotype by environment interaction heuristic, I now explore the relationship between the natural environment and farmers’ decisions about the type of seed to use. I categorize some aspects of the natural environment – rainfall, soil and land, and pests – as factors that push farmers toward a certain type of seed. Genetic traits of seed, which are naturally
occurring even if combined in specific ways by plant breeders, are pull factors that influence farmers’ seed use. Cross-pollination is an ambiguous phenomenon, and can be understood as both pushing and pulling farmers’ decisions.

**Push factors**

Lack of rainfall is the most defining feature of Sahelian agriculture from the perspective of farmers I interviewed, and it drives their seed decisions in a range of ways. Over and over, people explained that ‘things are changing, the rain isn’t the same, so you have to change the variety, for one that is faster.’ Faster maturing, that is, with a shorter cycle. And because ‘improved varieties, in terms of early maturing, they are better,’ changes in rainfall push people toward improved varieties. For some farmers, experience with improved varieties’ shorter cycles means that ‘they have abandoned planting local seeds, to benefit from improved seeds.’ The implications of seed decisions on agrobiodiversity will be discussed further in Chapter 7, and it is important to note that pressure from changing rainfall is also pushing some farmers toward varietal diversification as a way to buffer against the unpredictable natural environment. ‘With climate change, we can’t ask farmers to leave their local varieties, but to have more varieties. Because if one doesn’t work, another will.’ The ecological rationale (Zimmerer, 1996) for diversification is both reinforced and challenged by the variable rainfall, which means that some years farmers cannot save seeds, especially those of late maturing varieties. ‘He said that, the flowering, when they flowered there wasn’t rain. And he only harvested a little bit.’ Seed decisions related to rainfall are also sometimes hampered by the institutional context of the formal seed system. ‘The biggest problem, after the first rain, they can’t get [improved varieties] fast, and that’s what makes people plant local pearl millet.’ Farmers’ experience with their own
natural environment has taught them to plant as soon as the rain starts, which makes seed availability a primary variable in seed decision making.

Other push factors that influence seed decision making include soil fertility and pest pressures. Many farmers’ experience with improved varieties is that ‘they are well-adapted, but with fertilizer, fertilizer or manure.’ A common perception of improved varieties is ‘that you have to bring fertilizer or it’s not even as good as the local.’ Access to chemical fertilizer varies by country, with cotton-growing regions of Mali and Burkina having access to credit to buy fertilizer (Tefft, 2010; Moseley and Gray, 2008), whereas farmers in Niger have very little access to credit for inputs. In places where synthetic inputs are prohibitively expensive, and organic fertilizer is scarce (as is the case across the Sahel), ‘people have started to focus on local seeds. Because with local seeds, you put fertilizer or you don’t put fertilizer…we know how to use them to succeed.’ Variation in abiotic and biotic features of microenvironments also influences individual farmers’ decisions about the type of seed to use: ‘this local variety, red sorghum, he produced that. Because rice won’t work there, and the humidity isn’t very good for certified varieties, but the local is good there.’ The presence of pests like striga varies on a very small scale, within the same field, while birds tend to vary across the landscape, congregating near water, for example. The spatial aspects of pest pressures relate to varietal selection within microenvironments, and also on a larger, community-level scale. If the improved variety pearl millet seed that one person plants ‘has a short cycle, and if your neighbor has local pearl millet that has a long cycle, the predators will attack it a lot.’ Pest pressures mean that individual farmers’ varietal decision making is also influenced by decisions made in neighboring fields.
Pull factors

Most pull factors that draw farmers to certain types of seed are naturally occurring genetic traits that can be found in different seeds as a result of either in situ genetic shift, intentional selection by farmers, or formal breeding projects that create certified improved varieties. Traits that relate to the natural environment include length of cycle and yield, as well as ability to be conserved and to provide non-food outputs. Variable rainfall pushes people toward seed with a short cycle, and improved varieties are generally earlier maturing than landraces. Yield levels depend on rainfall, soil fertility and many more complex characteristics of the natural environment, and so in some cases, for people using improved varieties in comparison to ‘people who planted local varieties, he got more yield than those people.’ In other cases, ‘there are local varieties that are higher yielding than kalamani [improved sorghum variety], and the grains are heavier.’ In certain conditions, long cycles and higher potential yields will be preferable; pest pressure, for example, means that if improved varieties ‘will mature fast, the birds will get it. So the cycle isn’t adapted to their zone.’ In settings where rainfall remains the key feature of the natural environment that influences individuals’ seed decisions, there will be a pull toward seeds with a short cycle: even if the landraces are higher yielding, ‘the rain is rare, so kalamani is earlier, now kalamani is better than the local varieties.’ In addition to the pressures of precipitation, soil and pests, the natural characteristics of different varieties make them more or less desirable in specific settings. In Niger, pearl millet is harvested by cutting the stalks and bundling the panicles for easier transport and storage (see Figure 6-1 below). ‘When you finish, at the harvest, all of the candles are attached in bots [local measurement]. They don’t thresh right away. They attach them in bots to put in the granary.’ Grain is left in the panicle, which helps with long-term storage, as insects and rodents have a harder time prying grains from the panicles.
than they would if the grains had been removed. Because of these storage needs, farmers prefer varieties with long candles, since ‘long candles are easier to put in bots than short candles.’

Figure 6-1. Bots of pearl millet in Niger

Cross-pollination

The biological reality of cross-pollination is well known by farmers and has been consistently incorporated as well into seed decisions with the advent of improved varieties: ‘once he bought seeds…he noticed that the seeds he bought, in the seeds, there are those that look like local pearl millet. That allowed him to save that experience. He said that it’s something, he’s done this for 30, 40 years.’ Creolized seeds are familiar, and their use is an intentional choice, not an unaware hold-over from traditional seed systems. For some farmers, cross-pollination and the creolized seed it produces creates time limits on seed reuse. ‘I save seeds in one year, the second year, when I keep the seeds, then third year we come to the shop to change.’ As previously mentioned, farmers’ skilling experience with creolization suggests that in some cases, ‘the base seeds give more yield than the seeds that are replanted, while in other cases, if you plant the first year, the next year it will be better.’ These experiences are consistent with the genotype by environment interaction described by some plant breeders, but the possibility that creolized seeds might be acceptable or even preferable to farmers for reasons related to the natural setting is
not often admitted by plant breeders (Cleveland, 2001). As certified improved varieties are introduced into Sahelian agricultural and seed systems, farmers are engaging in skilling – ‘what he saved and what he bought, he will plant the two and see the differences’ – in order to make their own decisions that admit the possibility of incorporating creolization into their seed decisions.

**Quantitative analysis and visualization of the natural environment and type of seed**

Based on the thematic analysis presented above, I identify rainfall and crop species as elements of the natural environment that are incorporated into farmers’ seed access decisions. I also derive indicators of the type of seed used by farmers based on their descriptions of improved variety, creolized and landrace seed. I incorporate these indicators into basic bivariate analysis presented in this chapter, as well as in the structural equation model presented in Chapter 8, to test the statistical significance of the relationship between the natural environment and dimensions of the seed system. Rainfall is by far the most discussed variable of the natural environment that influences both farmers’ preferences for certain seeds and the options they have for seed use each year. Rainfall affects the possibilities for farmers to save seeds to reuse the following year, since lack of rain can lead to some varieties not maturing and to overall lower yields. Figure 6-2 below shows rainfall maps of the Sahelian region for 2010 to 2012, with each research site identified. Table 6-1 then presents average total rainfall from May to October for each research site from 2010 to 2012. The data for both Figure 6-2 and Table 6-1 were derived from the Physical Sciences Division of Earth Systems Research Laboratory at the National Oceanic and Atmospheric Administration (NOAA, 2013).
Figure 6-2. Average total rainfall from May to October

<table>
<thead>
<tr>
<th>Field site</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siby, Mali</td>
<td>1012</td>
<td>828</td>
<td>1196</td>
</tr>
<tr>
<td>Dioila, Mali</td>
<td>1104</td>
<td>920</td>
<td>1196</td>
</tr>
<tr>
<td>Dédougou, Burkina Faso</td>
<td>1150</td>
<td>920</td>
<td>1196</td>
</tr>
<tr>
<td>Bokki, Niger</td>
<td>736</td>
<td>460</td>
<td>828</td>
</tr>
<tr>
<td>Serkin Haoussa, Niger</td>
<td>644</td>
<td>368</td>
<td>552</td>
</tr>
</tbody>
</table>

Table 6-1. Average total rainfall from May to October (measured in mm)

By comparing definitions of types of seeds in the seeds systems literature to farmers’ descriptions of improved variety, creolized and landrace seed, I develop here several indicators for the type of seed being used. All indicators are ordinal, on a scale that orients toward ‘improvedness’ (so the higher on the scale, the closer to improved the variety is). The indicators of seed type are: type of certification, years seeds are reused, identification of the variety, and type of packaging. Details of the scales of each variable are presented in Table 7.1. These indicators all characterize the dimension of the seed system related to type of seed, which I theorize as a continuous spectrum of combinations of genotype, phenotype and social perception.
of standardization. Therefore, each individual ordinal indicator can also reasonably be considered to have an underlying continuous distribution that can only be measured empirically by identifying observable categories relevant to the Sahelian context.

The qualitative analysis presented above suggests that rainfall plays an important role in influencing farmers’ decisions about seed use, and the visual data demonstrates that there is significant variation across research sites and over time in total annual rainfall. I initially planned to directly analyze the relationship between rainfall and type of seed, as measured by the indicators enumerated above. However, the truncated data collection period (three years instead of four) and small sample size meant that original coding of the variables to match the categories identified above provided too fine a characterization to be statistically meaningful. Because the dependent variables are all ordinal, a generalized linear model using a logit function would have been appropriate, but the data were still skewed and had excess kurtosis. Instead, I recoded two variables that provide approximations of farmers’ seed decision making: seed saving (a choice for creolized seeds) and repurchase (a choice for continued use of improved varieties). Both dependent variables are dichotomous, with a yes/no=0/1 coding. Table 6-2 presents the ordinal regression analysis using a probit function (because the dependent variables are now dichotomous. To test the relationship between rainfall and seed saving, I used rainfall level of the same season as the saving, since saving occurs at the end of the growing season and is affected by that year’s precipitation. For the relationship between rainfall and seed repurchasing, the hypothesis is that the previous year’s rainfall will influence the following year’s seed decisions, based on performance of the seed the previous year. The analysis presented here assesses the relationship between rainfall in 2010 and 2011, and seed repurchasing in 2011 and 2012 respectively.
Table 6-2. Relationship between rainfall and seed decisions

<table>
<thead>
<tr>
<th>Year (sample size)</th>
<th>Parameter estimate</th>
<th>Std. error</th>
<th>Significance</th>
<th>Distribution of dependent variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall and seed saving</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010 (n=219)</td>
<td>.001</td>
<td>.000</td>
<td>.004</td>
<td>Yes 73%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No 27%</td>
</tr>
<tr>
<td>2011 (n=328)</td>
<td>.001</td>
<td>.000</td>
<td>.000</td>
<td>Yes 75%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No 25%</td>
</tr>
<tr>
<td>2012 (n=218)</td>
<td>.002</td>
<td>.000</td>
<td>.000</td>
<td>Yes 90%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No 10%</td>
</tr>
<tr>
<td>Rainfall and seed repurchasing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011 (n=124)</td>
<td>.001</td>
<td>.001</td>
<td>.017</td>
<td>Yes 30%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No 71%</td>
</tr>
<tr>
<td>2012 (n=221)</td>
<td>.002</td>
<td>.000</td>
<td>.000</td>
<td>Yes 56%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No 44%</td>
</tr>
</tbody>
</table>

Link function: Probit

The null hypothesis being tested in the analysis presented in Table 6-2 is that there is no relationship between rainfall and seed saving, or between rainfall and seed repurchasing. Across all years, we reject these two null hypotheses. The relationships between rainfall, and seed saving and repurchasing are highly statistically significant. The parameter estimate of a probit regression is not easy to interpret substantively, but we can see that there is a positive correlation between rainfall and not saving. There is also a positive correlation between rainfall one year and not repurchasing seed the following year. Keeping in mind that the analysis presented here is only of decisions made about improved variety seeds that were originally purchased, the results suggest that in areas of higher rainfall, there is less interest in improved variety and creolized seed than in areas of lower rainfall. This is likely because improved varieties are much more drought resistant than landraces, and in areas of little rainfall, the marginal improvement provided by improved variety seed is likely enough to convince farmers to save or repurchase the following year. In areas or years of higher rainfall, in many cases landrace perform nearly as well as
improved varieties, perhaps leading farmers to prioritize those varieties over improved varieties if the landrace better meet other needs or priorities.

The possibility of cross-pollination and the genetic changes it brings is another element of the natural environment that affects farmers’ decisions about which type of seed to use. Because cross-pollination is more common for pearl millet than for sorghum, one hypothesis is that farmers using improved variety seed of pearl millet will be less likely to want creolized seed, because of the significant genetic change after one year, and will be more likely to repurchase each year than farmers using improved varieties of sorghum. Table 6-3 shows results for the chi-square cross tab analysis of the relationship between crop species, and seed saving and repurchasing. The distribution of the dependent variable within each crop species is shown in the final column to aid in interpreting the results of the chi-square test.

Table 6-3. Relationship between crop species and seed decisions

<table>
<thead>
<tr>
<th>Year (sample size)</th>
<th>Chi-square (degrees of freedom)</th>
<th>Significance</th>
<th>Distribution of dependent variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Species and seed saving</td>
</tr>
<tr>
<td>2010 (n=219)</td>
<td>11.878 (1)</td>
<td>.001</td>
<td>Pearl millet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sorghum</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>88%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>66%</td>
</tr>
<tr>
<td>2011 (n=328)</td>
<td>13.726 (1)</td>
<td>.000</td>
<td>Pearl millet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sorghum</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>84%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>67%</td>
</tr>
<tr>
<td>2012 (n=217)</td>
<td>21.808 (1)</td>
<td>.000</td>
<td>Pearl millet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sorghum</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>97%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>77%</td>
</tr>
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</tr>
<tr>
<td>2011 (n=124)</td>
<td>5.258 (1)</td>
<td>.022</td>
<td>Pearl millet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sorghum</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>42%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>22%</td>
</tr>
<tr>
<td>2012 (n=221)</td>
<td>32.594 (1)</td>
<td>.000</td>
<td>Pearl millet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sorghum</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>72%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>34%</td>
</tr>
</tbody>
</table>

The null hypothesis being tested in the analysis presented in Table 6-3 is that there is no significant difference in the distribution of saving and not saving, and repurchasing and not
repurchasing, between those who use pearl millet and those who use sorghum. What we see is that in all cases, we can reject the null hypothesis and conclude that there are significant differences between pearl millet and sorghum users in terms of seed saving and seed sharing. In terms of the crop species and the use of creolized seeds (measured with seed saving), we see that pearl millet users save seeds at a higher rate than do sorghum users. This is counter to the assumption that because pearl millet is an open-pollinated species and so more susceptible to cross-pollination, farmers using improved variety pearl millet seed will be less likely to accept creolized seed. The results in Table 6-3 can be interpreted in light of those in Tables 5.1 and 5.2 above. Niger, where improved variety seed of pearl millet is being sold, has consistently lower rainfall than Mali and Burkina Faso, where sorghum is sold. Table 6-2 shows that lower rainfall is correlated with more interest in both creolized and improved varieties, and since the analysis in Table 6-3 demonstrates that pearl millet users prefer creolized and improved varieties more than sorghum users, despite pearl millet’s susceptibility to cross-pollination, a pattern emerges that tentatively suggests that rainfall exerts a stronger influence on seed decision-making than does the crop species and its predilection to cross-pollination. This statistical analysis corroborates the qualitative analysis presented above, which identified rainfall as by far the most influential element of the natural environment on farmers’ seed decisions.

A final theme that emerged in the analysis above is the risk that comes from planting early-maturing varieties in areas where other varieties being grown mature later, since there is a risk that pests will attack the lone ripe fields. This risk comes mostly from birds, and is particularly acute when a farmer’s field is near water, since birds congregate around bodies of water. Figure 6-3 below shows seed sales in Dioila, Mali across 2010, 2011, and 2012 (drawing not from my sample but from lists of sales kept by seed sellers). In the case of Dioila, seeds were sold to individuals in villages near water sources in 2010. However, seed sales to villages near
water decreased in the following years, perhaps in part because of the pest pressure that comes from being in the micro-environment around a water source.

Figure 6-3. Seed sales near water sources in Dioila, Mali

Social context and type of exchange-based access activity

The natural environment as a discrete entity that affects and is affected by human action is seemingly easier to identify and describe than the social context, in part because of the epistemology of natural science that gives standardized language with which to talk about natural phenomena, and in part because human experience generally sees natural systems as outside of direct control or influence. The social world is far more ambiguous an element in human experience, and so subject to a range of theoretical conceptualizations. In the following section, I take primarily a phenomenological and subjectivist approach to analyzing the social context of seed systems through farmers’ own descriptions of elements of the social world that influence and are influenced by elements of the seed system. I begin by characterizing the aspects of the social context identified by farmers as being relevant to seed use decisions. I then describe the exchange portion of the access activity dimension of the seed system (as depicted in Figure 2-1),
and argue that exchange as a phenomenon is fundamentally a manifestation of social realities and priorities – economies, in other words, are embedded in societies (Polanyi, 1944; Granovetter, 1985). After exploring relationships described by farmers between the social context and exchange decisions, I derive appropriate indicators of the social context and types of exchange, and provide statistical analysis to explore relationships between them. I also include visual data to characterize the social infrastructure that conditions farmers’ exchange decisions (see Pretty et al., 2011, for discussion of social infrastructure in agriculture).

Social context

Elements of the social context identified by farmers’ as influencing exchange decisions and other elements of the seed system range from specific elements of the agricultural and food system, including seed saving, and to gender dynamics and social infrastructure in Sahelian West Africa. The advent of market-oriented seed system development approaches has strengthened existing social infrastructure, like farmer organizations, and in places has created new types of social infrastructure, like local seed producer organizations. Farmers describe their engagement with these new aspects of the social setting as being conditioned by ongoing skilling (Stone, 2004) and in order to maximize reliability and reduce risk (see also Aune and Bationo, 2008).

Agricultural and food systems

Agricultural systems are emergent natural and social systems overlapping and influencing one another, and it is therefore difficult to separate decisions made based on ecological imperatives from those made in response to pressures from the social sphere. In Sahelian West Africa, the pressures of population growth and the history of settled agriculture sharing the
landscape with seasonal herding are related to both the natural and social context (Turner et al., 2012; Breman et al., 2001). The ways that people respond to these interconnected pressures, however, are then incorporated into social systems and continue to influence individual decision making. Farmers describe how soil fertility is changing, due to both population pressure and other agricultural decisions, and with those changes, some people have decided that using a metal plow and cows ‘will ruin the soil…so that’s why he chooses to work by hand, to draw the number of lines he wants.’ Shifting to a more labor-intensive land management system, particularly when labor is provided from within the household, can support a general intensification of the agricultural system that does not have to rely on external inputs purchased with cash (Aune and Bationo, 2008). However, for many farmers with a bit of money to use in agricultural production decisions, it is preferable to have ‘tools for work. Like plows, fertilizer. The inputs, everything. Seeds. Because with all of that, when you have all of those things available, you can get a lot, and feed yourself.’ In much of the Sahel, the decision to invest cash or time in agricultural production relates in part to the presence of livestock and diligence of the herders who move with them. In areas where the agricultural population is increasing, and so fields are expanding into former grasslands, investments in field production can be lost to marauding cows when ‘the owner of the cows, he didn’t make a fence for his animals. He just let them run through people’s fields.’

For many farmers, saving seeds is foundational to the traditional agricultural system. Farmers describe that with ‘local varieties, when you produce them, you see the seeds that are good in your field, the big heads, that’s what you cut and keep. And next year, you replant them.’ Seed saving is synonymous with accessing landraces, and can be done in a variety of ways. Generally, ‘first, they select in the fields the good panicles.’ Seeds can be kept in the seed heads and hung in a tree (see Figure 6-4 below) or hut, or taken ‘to the granary. When the rainy season starts, he takes it out of the granary, he threshes it and plants it.’ With the incorporation of
improved varieties into agricultural systems, many farmers continue to save the new seeds, so that ‘next year, if seeds aren’t brought, I have this variety as seed.’ Self-provisioning at the individual and the community level is built into the social context of agricultural communities, in part because historically there were no other options, and continues because of the uncertainty of both the natural climate and the newly created social infrastructure that facilitates formal and informal economic exchanges to access seeds. The possibility of market exchanges, however, is effectively shifting some farm households toward an entrepreneurial form of peasant agriculture, which precludes seed saving: ‘he said that in the past, they harvested the best panicles, attached them, and saved them as seeds. Or if you didn’t have seeds, you could ask another farmer and he would give you a little as seeds. But now you have to pay to have seeds, you buy them.’

Figure 6-4. Sorghum seed saving in Burkina Faso

In addition to some social aspects of the agricultural system, culinary tastes and preferences play an important role in the social context as it relates to the seed system (and the grain that seed decisions produces). Sorghum and pearl millet are two of the three grains (fonio is the third) indigenous to West Africa, and so Sahelian cuisine is based largely on a range of preparations of them (Osseo-Asare, 2005). In Mali and Burkina Faso, the rural staple is tô, a sorghum or pearl millet-based thick porridge that is shaped into dumpling-like patties and eaten with sauces made from local leaves, peppers and tomatoes. Tô is based on steaming, and part of
the preparation process includes slightly fermenting the flour before cooking, which increases the length of time that tô can be kept at room temperature (generally, 24 to 48 hours). This conservation is important in rural areas, where refrigeration is not possible, and where there is an important social expectation to have some type of food available when men arrive home from the fields, and in case of unexpected guests (Osseo-Asare, 2005).

**Gender**

Gendered aspects of the social context that relate to seed systems include differentiated access to land and cash for women, as well as power dynamics that limit the decision-making ability of both women and junior male members of a household. A woman’s involvement in agriculture is generally either that ‘she works with the men, in the family fields, or closer to home with other crops: here, the women do peanuts, peanuts are for women, and beans. But sorghum is for men.’ Women often intercrop pearl millet or sorghum with peanuts (see Figure 6-5 below), and self-provision sorghum seeds by saving a bit from the family granary. As women have been integrated into PPB activities, the gendered nature of grain production means that often, ‘what she saved, she gave to her husband,’ rather than expanding her own sorghum fields, ‘since as she said, she doesn’t have land.’ However, even if the areas women plant continue to be small, they often report that ‘in the past, women had difficulty accessing seeds. But now with varietal tests, the women have seeds.’ In addition, because agricultural activities are integrated at the household level, women have access their husband’s experiences through discussion and observation, and with the advent of seed sales, women have a less socially differentiated way to build on this experience: ‘her husband had this variety, he planted them, and she saw the importance of them. That’s what pushed her to buy them last year, to have the advantages.’
Gendered experiences of seed systems are also conditioned by the fact that women’s sphere of movement and activity is generally more limited than men’s. This means that women have historically almost exclusively engaged in seed saving activities, since there is less possibility for women to engage in marketplace-based economic activities that generate cash. In the past, ‘when you asked for seeds, you could have them. But now to have seeds, you have to pay.’ Without the ability to generate cash, women continue to have difficulties accessing improved varieties. Trials help women to access seeds in a new, non-market way, and the skilling that comes from participating in field trials allows women to make seed purchasing decisions based on their own experience, which is particularly important when women’s overall cash flow is small and a seed purchase could be a significant investment. In addition to the need to buy seeds, many people, both women and men, discuss the need for some kind of fertilizer to strengthen the performance of improved varieties, and possibly also landraces. Again, women’s lack of cash and bargaining power in economic settings limits their ability to maximize an investment in seeds: ‘she said that the men are ahead of them, they have strength, they are stronger. So the women, when they arrive, they are too late. There are men, buyers, they buy a lot and stock it in shops. So then they increase the price of fertilizer.’ Experience to-date with male-dominated formal input markets is likely one reason that many women have mentioned the

Figure 6-5. Pearl millet and peanuts intercropped in Niger
need to include women in seed selling activities. ‘If women bring them to sell, they will buy them. But if it’s the men, they won’t.’

The gendered dynamics of decision-making in the Sahel privileges the priorities and preferences of the head of household over other members, male and female alike. Because very few households are female-headed (if their husband dies, women usually return to their father’s home or remarry a brother-in-law), women’s decision-making is often limited by the head of their household. When looking for seeds as a gift, ‘it’s the head of the household that you ask. Not her. Here it’s like that. It’s not with women that you can ask.’ Even if she makes the decision to spend her own money on seeds or other inputs, in part because her mobility is limited, a woman ‘doesn’t choose [the variety], she just gave her money to be bought and that’s what he bought.’ If they wish to save seeds, ‘after the harvest, they thresh and save the grains…they are in the men’s hands. When they finish, after threshing they will weigh the grains…and then they will it to the women, to use.’ In short, the gendered nature of decision-making and agricultural roles means that a seed system managed and sustained by other women, perhaps with non-formally certified seeds that can be accessed through informal channels, might be the most accessible for many women. However, market-oriented approaches are predicated on standardization rather than differentiation of access arrangements and product, making it difficult to account for gender dynamics. In addition to women’s experience of gendered seed systems, men in junior roles in the household (younger brothers or adult sons of the household head) also feel a limited ability to make decisions related to varietal or seed selection. Often, this is expressed in the fact that a type of seed or variety has not been fully adopted or deemed legitimate until it is planted in the family fields, rather than just in an individual’s small parcel. One man in Mali, for example, explained that ‘the chief of the family hadn’t seen the improved varieties. But when he planted Tieble, he saw reality. He said this year all of their fields will be Tieble.’ In this case, seed markets create
the opportunity for junior men to make their own decisions in their own fields by creating an
access point outside of the family decision-making system.

**Social infrastructure**

The social infrastructure of seed systems in Sahelian West Africa is identified as those
institutions and organizations in which individuals and communities are engaged in order to
facilitate access to seeds, improved and local. Social relationships that emphasize sharing within
families and communities, and local economic arrangements that are instituted in local
marketplaces, provide social infrastructure that facilitates traditional and informal seed systems.
Market-oriented development proposes and institutes a new set of social infrastructure, one that is
designed to facilitate market access to improved varieties of seeds. Much of the description of
market-oriented social infrastructure by farmers relates to the ways that the institutions and
interactions do or do not support access to improved varieties via market exchanges. However,
farmers’ experiences with government, NGO and union projects, as well as with local institutions
like radio emissions, and seed production and sales within their own villages, suggests that new
social infrastructure can also provide a negative contrast to more traditional social infrastructure
that supports non-commodified seed access.

The project-based seed system social infrastructure that exists in Sahelian West Africa is
a mix of linkages to outside institutions, one of which is connections between local communities
and development practitioners in PPB projects. In Burkina Faso, for example, the government
provides seed aid at random times, perhaps as a way to shore up political support, which leads to
confusion about seed sales. As one seed seller explained, ‘if you want to sell, people will say,
maybe the government gave money so that you could give people a gift, and then you are
reselling. So they won’t pay.’ Most of seed system development projects are based with
international organizations, including ICRISAT, and the benefits that people have felt from being connected to these projects lead to an increased interest in maintaining connections to outsiders. Development projects cannot necessarily be considered social infrastructure, but the PPB approach, with its support for farmer field schools, feedback sessions and other types of group learning, does seek to build social infrastructure that can lead to endogenous community change (Okali et al., 1994). As mentioned in Chapter 4, the conversations I held with farmers through the interview process built upon general positive sentiments about the PPB projects. ‘Now people stop, they rest, they talk, and they have started to benefit from the seeds.’ Field trials in particular create new social opportunities, for example, by empowering women to request larger fields: ‘if it’s called a test, even if it’s a half hectare, the men will accept it. So like that she can grow sorghum.’ Not all development projects lead to social infrastructure, however. ‘It’s not enough to help people, with just one time. You have to diversify things. And in diversification, there is reciprocity. It can’t always be the same people who benefit.’

Agricultural development practitioners have increasingly recognized that the transfer-of-technology approach to innovation, and the static assumptions that go with it, does not build community capacity to further innovate. One response to this critique has been to support and encourage the creation of farmer organizations or unions at the regional and village levels, through which individuals can build local and ongoing connections. At a sub-national, regional level, the farmer organizations provide the social infrastructure to spread information about and access to improved varieties. The organizations have organized seed fairs, where ‘people came to look at [seeds], people came to buy them. She asked about them, and she got information like that’ (see Figure 6-6 for an example of a seed fair in Niger). The organizations also run input shops, because ‘in the past, they just had the idea that there were varieties that were fast. But now with the initiative of the union, and building an input shop, that allows them to easily access seeds.’ A few farmers voiced appreciation for the social infrastructure that is built by local farmer
organizations’ efforts at seed dissemination, in contrast to before, when it was the project that ‘created access. And sometime they brought them late. With local organizations, there are people in the union who hear him,’ and so specific requests or needs are more likely to be incorporated into the seed system. Village groups, which are generally affiliated with the regional farmer organization, provide even stronger social networks from which to learn and innovate. One woman in Niger explained that now that there is a village group, ‘they have a line, they are informed of new varieties. All about agriculture, they have networks to get information.’ The line is not only to an outside entity, but is also to the local input shops, other farmers’ fields, and most importantly, shared experience.

Figure 6-6. Seed fair organized by local farmer organization in Niger

The downside of this social infrastructure is that it is all largely market-oriented, so that the spaces being created and knowledge being shared are based on a cash economy and formal economic exchanges of seeds, and do not incorporate any type of individual or communal seed provisioning or sharing. Some farmers expressed uncertainty about whether the union, from which they bought improved varieties, had a claim over their output: ‘he produced, he saved, he hasn’t touched any of it, before doing something, giving a quantity to someone, in any case, since it’s something from the union, he hasn’t done anything.’ For seed producers, as well, the social infrastructure that supports the commercialization of seed production also limits the potential for
other types of marketing. Seeds must be certified through the union, and cannot be sold as seed without being certified, so that if the union buys fewer seeds from an individual, they ‘sell the rest as grain, and that’s a loss.’ The presence of farmer-producers of improved variety seeds is an ambiguous type of social infrastructure, since it both creates local connections to knowledge and experience with improved varieties, and is also situated within the context of market-oriented seed system development by farmer organizations. Some farmers report that access to improved varieties is ‘now easier than in the past…there are seed producers, that’s what allows access.’ Many seed producers, however, report no longer giving or selling seeds directly from their fields with the advent of input shops, instead sending people to the shop so that the shop can ‘get more clients and benefit, to attract others.’

Seed sales can be thought of as an aspect of social infrastructure, since exchanges in local markets create a type of social connection that can condition future possibilities. For farmers, ‘if you go to the market, you pass by and see that people are really interested in this variety. That’s why he was motivated also to buy them.’ Interest and knowledge are generated and passed through market interactions, but can also be generated through observation and sharing. Increasingly, however, the social infrastructure supporting the seed systems is oriented toward market exchanges. ‘What she’s noticed is that there are people who refuse to give seeds for free…if you want them as gifts, there are people who refuse them, they say they aren’t seeds. When you give money, you will have something.’ Seed producers also report that for the most part, they now sell seeds rather than share them. However, some make a distinction between those seeds sent to the laboratory, which ‘will be sold for a price,’ and those that ‘I did personally. I can exchange that. To [help others] better understand these varieties, to know if they are good or not.’ Seed sellers also report mixed results from the market-oriented social infrastructure being implemented. Some use seed sharing and reproduction as a marketing tool: ‘each year the number of clients increases. Because they see these seeds in his field, he tells them
to come buy. And those who plant, two years later, when they have replanted, they have to again take the base seeds, because the yield is better with base seeds.’ Others report that they must utilize the non-market oriented social infrastructure in order to sell, ‘because if he informs people, people will use them, because they know each other.’

A final element of the social infrastructure related to seed systems is the existence of local radio stations that transmit information about seed sales, varietal traits, agricultural production techniques and much more. Many farmers describe the radio as playing an important role in terms of spreading information about new seeds: ‘he heard on the radio from Siby. So, they said it, and he went to the seller, his friend, and he went there and saw the seeds, and bought them there.’ Other programs ‘talk about the new seeds. They said that the new seeds, people shouldn’t be scared, they should try them and see.’ The radio is seen as social infrastructure rather than outside intrusion, a sentiment perhaps most clearly demonstrated by the request from a farmer in Mali, for an increase in points of sale and information about the sales to be passed over the radio. ‘He said that if we bring seeds in the month of April, with someone, with a farmer, and inform the other farmers on the radio, so that they can come get seeds, that would be a good thing…In the past, information came with the agrodealers, but when you put them with a farmer, others will be informed by the radio, and those can buy who are in villages that are around.’ The radio supports local social infrastructure that provides access to outside materials, whereas information from agrodealers in weekly markets, which located in regional towns, exists outside of the local milieu.

**Risk, reliability and skilling**

As many scholars and practitioners working in developing country agricultural research and development have noted, marginal environments and lack of natural and financial resources
can make smallholder farmers vulnerable to both short and long-term changes and events that challenge food security and other basic needs (Chambers, 1991; Aune and Bationo, 2008; Thompson and Scoones, 2009). Chambers (1991) argues that farmers make decisions to buffer against risks that manifest in their own social and natural settings, decisions that in some settings prioritize diversification of agricultural production and in others emphasize stability. Smallholder farmers also often seek reliability over maximum potential payoff. Farmers in Sahelian West Africa describe the risks that derive from the social context and their responses to them, as well as the elements of contemporary seed systems that support reliable access to seeds. As seed markets and improved varieties become available, farmers engage in a skilling process, which is described by Stone (2004; 2007) as a process of second-hand observation and social learning, and first-hand experience, that allows them to make decisions about seed exchanges and use in ways that build reliability and buffer against risk.

The main risk against which all agricultural production decisions are made is the potential that a household will not have enough food to meet its food needs. ‘Our life is to have something to eat, something for the family.’ Food security is related to seed security insofar as this year’s grain production provides next year’s seeds as well as food, so that food shortages can (but do not necessarily) lead to seed shortages (Sperling and McGuire, 2010). Seed shortages are often considered at the community level, with many people expressing the imperative that ‘if she is food secure, if someone else comes, she can’t refuse them.’ With the advent of the market-based seed system, there is an additional option: because of food needs, ‘he didn’t save anything. So he plans to buy when the shop opens.’ Reliance on seed purchasing, rather than individual seed saving or seed sharing at the community level, buffers against the risk that all of one’s neighbors could also lose their seeds to a bad harvest or difficult year for food. However, in places where having access to cash is variable, there is a different risk associated with planning to buy seeds: ‘to have access to these seeds, it’s not easy. It’s difficult. The price is a little high.'
That’s one thing. And then often, if you have money, you will find that there are no longer seeds.’ The risk that food needs or social demands will consume a farmer’s entire seed stock for the next year leads people to frame seed saving in terms of buffering: ‘here for us, for seeds, it depends on you yourself. Because at the moment of harvest, we think about a part for next year.’ The risk associated with having to ask others – ‘if you don’t have seeds, after it rains, if you have to look for seeds, that will make you late’ – reinforces seed saving as an important aspect of seed security. With improved variety seeds now available through seeds sales, there continues to be a risk associated with relying on others to supply seeds. Saving then becomes a backup plan, in case seeds aren’t accessible. ‘But the next year, if there are packets, he will eat what he saved to again get packets and plant them.

In light of the risks to food and seed security inherent in the natural and social settings, many farmers discuss seed systems in terms of reliability. Seed saving is the most reliable way to ensure seed access, since ‘if you have the seeds in place, then it just rests with you. It depends on you, if you want to plant early or not.’ Communal sharing of seeds is also reliable, both because of the social underpinnings of the system and because of the practical reality of there always being someone in the community with grain, which will be shared: ‘we know that we are always here with fields of sorghum. And because they know with whom they can get seeds, if you don’t have seeds, you can go ask.’ For other farmers, the new seed markets are more temporally reliable than seed saving and systems that rely on sharing, since ‘before, you had to go to a farmer, ask for seeds, and he could tell you that first he had to finish his work, before giving a bit of seeds.’ Now, however, with input shops, ‘if it rains, when you’re ready, in a few minutes, you can go buy them and plant them.’ Mini-packets in particular provide a level of assurance that seed sales will be accessible because of their small size and associated low cost: ‘if you don’t have a lot of money, and if they are in bigger sacks…the price is expensive. But with the mini-packets, if you buy one or two, you can have some.’ The standardization associated with seed
sales in general, and mini-packets in particular, also reassure people that they can rely on the seeds in which they are investing, since ‘the seeds are treated, and also there are labels, in Bambara. So you can read and really understand the variety.’

Analysis of the ways that improved varieties, seed sales and mini-packets have been incorporated into farmers’ decision-making about seeds provides an understanding of how skilling processes affect seed systems in Sahelian West Africa. Stone (2007) describes skilling as a process of both social and experiential learning that allows individuals to gain knowledge about a new technology or technique, and to then innovate based on that knowledge. Social learning is second-hand observation of other’s actions or conversation with those actually using the new technology. In contemporary seed systems in the Sahel, farmers are used to observing others’ fields and asking about what they see, in order to learn about new types of seeds and varieties. ‘He said that he planted on the edge of his field, allowing people to see it, so that they would be motivated and ask, and exchange with local pearl millet. And they will also save it to replant.’ Sometimes observation of a new seed leads to conversation: ‘when he harvested, and collected, he put it in a cart…Kapelga and Gnossiconi [improved varieties], they were on top. So people came by and saw them, and started to discuss.’ In other cases, ‘there have been changes that she’s noticed, in the fields, in Serkin. That’s what she’s noticed, which motivated her to buy also and change things.’ In addition to actually observing the new varieties and then making decisions based on what they’ve seen, some farmers describe how they’ve ‘just heard people say that this is a very good variety. That’s why she also was excited to see it, and buy it, and try it in her fields.’ For the most part, however, farmers in the Sahel emphasize that ‘if you don’t see, you won’t be convinced. Even if you talk a lot, that won’t convince them. You have to see.’

Stone (2007) argues that skilling is a combination of social and experiential learning, with social learning making up the bulk of the skilling process, since farmers can observe and converse about a range of possibilities that far exceed their own experimental potential.
However, Stone also warns that social learning without first-hand experiential learning is dangerous, since the variability and high-risk nature of smallholder agriculture means that decisions appropriate for one individual might not be for another, even if the two are neighbors. This description of the need for experiential learning in the skilling process with new seeds builds on the genotype by environment interaction mentioned above, but here we can broaden the aspects of the environment to include the social and agricultural context. For example, some farmers mentioned wanting to experience the output of improved varieties: ‘I’d never seen them. That’s why I said, I’ll buy those, plant them to see if they are good for dolo [sorghum beer].’ Others feel strongly about more general skilling through first-hand experience, since if ‘it’s new, he prefers to buy and try, that’s better than if someone gives you a story.’ Because of this desire for skilling that incorporates social and experiential knowledge, people really appreciate the sale of mini-packets. ‘They are good, the mini-packets, to let people do trials, to see if they’re good. If you buy mini-packets, and you plant them, next year you can diffuse them, and replant again.’ Skilling fits into seed systems embedded in social relationships, which place some responsibility on the seed provider to know what he or she is giving. And skilling in a high-risk setting means that selling small amounts provides an appropriate type of access for new and unfamiliar seeds. It was this sentiment – a desire for small amounts of seeds for farmers to try themselves – expressed by farmers to ICRISAT project staff that led to the development of the mini-packet approach (see also Thiele, 1999, for discussion of small quantities of new seeds).

**Type of access activity**

The social context of seed systems creates two distinct routes to seed access – seed provisioning through saving and gifting, which is based on social priorities and value, and seed exchanges, which reflect the economic value of seed. Lindblom (2001) argues that the use of
exchanges and markets for economic access to goods into a social system can occur in a variety of ways, and that the ‘market system,’ based on capitalistic rationality, is only one particular manifestation of the use of exchanges and markets. Hart’s (2010) distinction between formal and informal markets further elaborates on the relationship and distinctions between the market economic system and economic systems that include markets. Non-formal, peasant economies that incorporate exchange and expectation of quality also make use of markets, though the terms of market exchanges are defined and enforced through social mechanisms. In this section, I characterize the exchange types of access activities that farmers’ describe in Sahelian seed economies as formal, informal and non-formal. All three are relational, though formal exchanges derive their form from expectations of market systems that are external to the Sahelian context. Informal exchanges adapt aspects of the formal market system to the social context, effectively embedding markets within society. Finally, non-formal exchanges make use of the exchange principle entirely within the social context.

**Formal exchange**

Formal exchanges occur in formal markets, which can in general be defined as standardized in terms of process and price. For seed systems, this means that the setting of the exchange and the good being exchanged are ensured in some way to be impersonal and homogeneous – context should not influence the terms of formal exchanges. Farmers highlight several aspects of formal exchanges for seeds in the Sahel that create a standardization not found in other types of exchanges. In terms of the setting, one seller explained that people are skeptical of seed sales outside of an input shop, wondering if a seed seller ‘is just taking the production of some farmer and bringing it to sell to use here.’ Having a set place to purchase seeds creates a degree of reliability not found in other types of exchanges, but the lack of personal connection to
input shop sellers can be an impediment to seed sales: ‘farmers don’t always have faith in the seed sellers. Sometimes, they say that if it’s a certain seller who comes, he is just looking for money, it’s not a good variety…but if this variety passes by them, as representatives of the farmers, then they have confidence and they will buy these varieties.’ The incorporation of the local farmer organizations into the formal seed system has allowed the market-oriented seed system development approaches to overcome farmers’ hesitation to buy seeds from an unknown person, since the assurance of standardization comes not from an outside source but from the organization’s representatives.

Formal exchanges are expected to be standardized both in process and in product, and many farmers talk about market-based seed sales as providing a level of assurance that is new to the Sahelian context. ‘He said that accessing seeds [in the past], you had to ask another farmer. When you ask another farmer, maybe they will not give you what you ask for. But when you buy, you know that what you want is what you bought.’ Part of the standardization in formal exchanges is that the assurance comes not from an individual, who could be wrong or misleading, but from an outside entity (in this case, government certification, and national and international plant breeders). Farmers’ descriptions of formal exchanges reflect the seed systems literature that characterizes formal seed systems as having officially certified seed being sold as seed, not grain: ‘he made an allusion to, you know, if people go to the market they buy whatever kind of grain, that they will plant and say that it’s seeds. But they don’t know what it is. Another element of formal seed exchanges is the ability to choose among a range of known varieties. ‘You go when you need them, you buy seeds, they are available, you make a choice of varieties, and you plant.’ Formal exchanges eliminate many of the vagaries of the social setting because they are structured by acontextual expectations. Figure 6-7 below shows an example of mini-packets of pearl millet identified and for sale in Niger.
A final element of formal exchanges is the presence of money and the existence of a standardized price. This means that the ability to access seeds ‘depends on the farmer. Because there are farmers who have the means, they will buy a lot. Others don’t have, so they like them but can’t buy them.’ In a completely formal market economy, there are no exceptions made for those who lack cash – instead, alternative access options are pushed into the informal economy, where price or currency can be negotiated. The mini-packets approach to sales of improved variety seed that ICRISAT is pursuing in Sahelian West Africa provides another adaptation of the formal market system that incorporates local realities, that many farmers lack large amounts of cash, into formal exchanges. With mini-packets, ‘they allow for everyone, each within his means, to buy.’ Farmers are used to set prices in local markets – ‘if you are someone who produces cereal, the price is the price. It’s fixed’ – that reflect local realities, and mini-packets, with an appropriate price and quantity, in some ways provide a link between informal and formal exchanges. Another element of appropriate prices is whether the pay-off or output is ‘worth’ the initial cost of seeds. Most farmers who continue to buy improved varieties in formal markets feel that ‘if the price is high, you buy it because of its value.’ Those familiar with market-based exchanges do a cost-benefit analysis, and many conclude that ‘the price is good. Because it
produces more than you spend.’ An interesting twist on the formal cost-benefit analysis being described here is that the benefit (and its value) is not necessarily a return on investment through profit. In Chapter 7, I analyze in detail the value of the output to farmers, and how the value is conditioned by the natural and social context.

**Informal exchange**

Hart (2006) describes informal markets as those that are directly relational to formal markets, but that incorporate elements of the social setting left out by acontextual formal market structures. In the case of seed systems in Sahelian West Africa, informal exchanges of both improved variety and landrace seeds embed exchanges for standardized seeds within the social context, and at times alter the type of standardization of the seeds themselves. Perhaps most importantly, the price is set by the social context, rather than by an outside entity or abstract invisible hand. In terms of the exchange process, informal exchanges often occur in weekly markets or in the homes of seed producers, and assurance that the sale is legitimate in terms of the value of the seeds comes from social trust and familiarity rather than from the objective guarantee of an input shop or formal seller. ‘She said that the best way to spread the seeds is to have a point of sale in the market, so that all who need them, since there are meetings in the market, that will motivate them, they will talk, and they will buy them to try them.’ Sales in the weekly market are usually done by farmer organization technicians, who have a level of credibility related to their connection to formal training systems associated with the farmer organization, as well as to their local ties. Mini-packets are also often purchased in bulk by an individual farmer who has experience with them and then are resold further afield, in their own village and others: ‘there is a woman in Massigui, she bought with [the technician], 500 packets. Then the woman also did a tour of markets.’
Informal exchanges happen in a range of settings that are credible because of contextualized social connections and trust. Sometimes these exchanges are still of officially certified varieties (as with mini-packets), but sometimes the seed itself is assured not by an outside standard but by the producer themselves. One woman in Niger explained how she shifted from informal sales of formally certified seeds to sales of socially certified seeds (Sperling and McGuire, 2010): ‘She doesn’t produce certified seeds. But since she was trained, and she has also found that with a lack of seeds, they were gone and people always asked her, and someone suggested that she sell what she produced last year. That’s what motivated her to sell. With the same price.’ Social certification of improved varieties is predicated on observations of one another’s fields and the ability of farmers to discern who among them can be trusted to provide them with a reliable product. As an aspect of informal exchange, social certification is relational to formal certification, with the goal of reliable standardization the same in both; it is the legitimate (and appropriate) certifying institution that differs. It is also important to note that informal exchanges happen with landraces in Sahelian West Africa. When farmers need seeds, they will go to the market and buy ‘grain intended to eat’ to use as seed, based on their own knowledge of local varieties’ characteristics. These exchanges happen in a setting that is socially connected (buyers and sellers often know one another), and the quality of the product is also generally known, since farmers are familiar with using grain as seed the following year (see also Smale et al., 2008, for description of women’s role in local market seed sales in northern Mali).

Perhaps the most interesting aspect of informal exchanges in Sahelian West African seed systems is way in which prices are set and currency is defined. In the past, exchanges happened in equal measures, reflecting a use-value basis for economic exchanges, because there was no provision or possibility for profit accruing to the seller. However, as formal markets have long been established for certain goods, people are well-versed in the logic of for-profit economic exchanges. In informal exchanges, this means that the economic rationale is incorporated into the
broader context of social and economic priorities, leading to a range of price-setting mechanisms. Informal sales sometimes happen at the same price as formal sales – ‘because if I sell for less, they will stop buying them with the union’ – and usually reflect the reality that for seed producers, ‘to produce improved seeds, they can’t sell them at the same price [as local seeds].’ However, because of the increase in production cost (due to the need for training and inputs), improved varieties are often monetarily out of reach for many farmers. The incorporation of the influence of formal markets into informal exchanges is in part a direct reaction to new formal seed markets. As one farmer explained, ‘if you don’t have another variety to exchange, as seed, you have to buy in the market. So exchanges and buying are the same for them.’ This sentiment, set within the traditional seed sharing and saving context of Sahelian West African seed systems, echoes Lindblom’s (2001) argument that markets exchanges can be incorporated into a range of economic systems that are not necessarily predicated on the specific logic of the capitalistic market system.

**Non-formal exchange**

Non-formal exchanges are what Hart (2006) refers to as peasant economies, and what others have included in primitive or pre-market economic systems (Polanyi, 1957b). Based on analysis of farmers’ experiences of non-formal exchanges, it is also appropriate to think of this type of economic activity as use-value exchange, as exchange logic instituted completely in the social context with non-profit oriented economic motivations. The process, product and price of non-formal exchanges can be distinguished, and rather than being clearly relational to the formal market, these elements of exchange reflect an economic logic completely embedded in the social milieu, without the use of market infrastructure or form. Non-formal exchanges occur in fields and homes, where ‘farmers see the best varieties, and then give and exchange amongst
themselves.’ As detailed above, seed sharing is based on personal and social commitments to family care, community well-being and spreading new information to care for others. As seed systems shift to incorporate markets, exchange logic now conditions much seed sharing, but non-formal exchanges continue to be largely motivated by social goals rather than profit calculations. ‘If you want you can give, or you can say how much.’ Since seeds of improved varieties have to be originally accessed through formal or informal cash transactions, ‘they’re seeds that you can’t give for free.’ However, ‘if there isn’t anything to exchange, he gives as a gift.’ Social priorities underlie non-formal exchanges, which is at times exasperating to seed producers who have shifted more fully than many of their neighbors into the market-oriented formal seed system. One seed producer in Burkina Faso explained that farmers will ask him, ‘do you have those seeds, and if you say yes, they say that they will come and bring you seeds from their grain…they think that if you produce it, you can exchange, no problem. People don’t want to buy, they want to exchange.’

Non-formal exchanges that involve a seed producer can provide improved variety seed to other farmers, but more often provide some kind of creolized seed. Some certified seed producers are willing to take some kind of non-monetary trade, like labor or grain, and so improved varieties can at times be accessed through non-formal exchanges. More often, however, it is second-generation improved variety seeds that are accessed through non-formal exchanges: ‘they saw that I produced it and the yield was good, so they came to exchange with me…they brought their seeds for me, local seeds.’ Accessing creolized seeds through exchanges is compelling to farmers who would like the benefits of improved varieties but don’t have economic access to informal or formal exchanges for improved varieties. However, ‘if you come, and you can’t pay, you exchange, and you don’t know what it is and isn’t, because there isn’t also a paper for that.’ For the receiver, there is a risk associated with the lack of information that comes with creolized seed and non-formal exchanges. For the giver of seeds, there is the
potential for a ‘loss’ in terms of overall value, since ‘when he exchanges for local pearl millet, it’s just to eat, not to plant.’ When viewed in the market context, exchange quantities need to be unequal in order to compensate for the value-added associated with seeds as opposed to grain, and with improved varieties in contrast to landraces. However, for many farmers, social goals prevail: ‘he exchanged a little, so that they could have seeds…it was equal, exchanges were done equally.’

Farmers’ evaluation of the type of seeds being accessed through non-formal exchanges, and the underlying logic guiding the exchanges, helps to set the ‘price’ or relative quantities required in the exchange. As mentioned above, the sharing ethic suggests exchanges of equal quantities, since the social setting does not include the sale of seeds and so a price differential. As formal markets are established and the exchange logic associated with them is instituted in the social context, many people have ‘adopted a system of exchange: one measure of improved seeds for two measures of local seeds.’ The possibility (and at times necessity) of accessing improved varieties through formal exchanges, which include a standardized price, means that ‘they’re seeds that you can’t give for free.’ Non-formal exchanges reflect the standardized price in currencies that is socially appropriate for those without access to cash. In addition to using local grain, other currency includes sweat equity: ‘since the times are hard, people make exchanges. You can work in someone’s fields and he will give you seeds.’

**Relationship between social context and type of access activity**

Elements of the social context influence the possibility for different types of exchanges to be instituted in Sahelian West Africa. Contrary to the assumptions made by market-oriented development approaches, the creation of seed markets does not necessarily mean that the entire seed system will move toward an only market-based system. Instead, different types of
exchanges and the markets they create will be incorporated into the social context in ways that both embed new experiences with exchange-based seed systems in the social context and also influence elements of the social setting. For example, culinary preferences in many parts of the Sahel have shifted over the past ten years away from local grains toward rice and maize (Moseley, 2011; Osseo-Asare, 2005). As a result, non-formal exchanges between different types of grain are no longer possible. ‘If it is maize for sorghum, people who have maize don’t want sorghum. And with seeds, if you wanted sorghum seeds you would buy them. Because some people didn’t want maize.’ Formal seed markets can facilitate the transformation of one grain into another by, for example, guaranteeing that if other types of seed access are not possible, a farmer can sell his excess maize production and use the cash to buy sorghum seeds.

Gender dynamics within the seed system also influence the type of exchange that farmers choose to pursue in order to access seeds, be they improved or local. The mismatch in information between men and women, due in part to women’s more limited possibilities to engage with the entire range of social infrastructure related to markets, means that women do not necessarily trust men to facilitate formal exchanges. One woman in Niger described how when mini-packets are brought to a central location, ‘there are men who go there to get them. And now that there are sales, they don’t sell them at a price that the women like. So she gives her money to the [extension] agent, and that’s who buys her the variety that she plants.’ Interestingly, connecting to the market-oriented social infrastructure allows women to subvert some of the gendered aspects of the seed system, but they often still relegate an element of choice to the uniformly male extension agents and technicians through whom they engage with the formal exchange process. Other impacts of gender that influence exchanges relate to the type of currency appropriate for non-formal exchanges. Many women do not have access to cash, but they do have time and energy, and so ‘to have seeds, they go to the [male] producers, and after they work, he gives them seeds…one sack for one day of work.’ Women also use the field trials
present as part of the PPB project-based social infrastructure to facilitate new opportunities for non-formal exchanges: ‘women from the house exchanged with her to plant. She explained that if they don’t have trials, she saves, and they bring grain to her.’

Experience with and an ethic for seed saving also condition the way that people think about exchange-based seed systems, and the different types of possible exchanges. An orientation toward saving means that a farmer will often report that ‘she won’t buy, because she already saved part of her harvest, so she has all that she wants.’ However, the knowledge that formal exchanges are an increasingly reliable seed access option means that others have stopped saving at least improved varieties, ‘because they know that when you need seeds, you can find them with COOPROSEM [the union].’ Similarly, some farmers have experienced a change in terms of sharing now that seeds are available for sale: ‘before, there was solidarity. People gave seeds, and others exchanged. But now you now you have to pay.’ Informal and non-formal exchanges stand in contrast to formal exchanges in terms of their ability to incorporate social priorities like family and communal care. Many seed producers report that they sell and exchange what are effectively socially certified seeds to family and neighbors outside of the formal market created by seed system projects. ‘The cost is not expensive. Since it is family, it’s among us. Sometimes we do exchanges. You bring one or two bot, and then I give you two bots. Because people don’t have the money to buy. If your brother comes and says, I want that variety, you have to exchange.’ Other seed producers sell socially certified seeds on credit, with collateral being the assurance and ability to observe that people ‘work in the field during the rainy season. And after the harvest, it’s paid back in money.’

The market-oriented social infrastructure being built by development projects, farmer organizations and individuals to support a fully commercialized seed system creates the possibility for exchange-based seed access, and farmers’ experience with this infrastructure in turn influences their interest in different types of exchanges. PPB projects and the field trials that
are a part of them strengthen traditional seed systems by providing an alternative source of new and possibly better adapted varieties. ‘In the past, they only used local varieties…so they got seeds among themselves. But now with varietal trials, they have started little by little to take those varieties and use them in their fields.’ Membership in a farmer organization or union also influences the types of exchanges in which farmers are interested in engaging. In the research site in Burkina Faso, membership in the farmer organization as a seed producer seems to preclude the possibility of informal or non-formal exchanges with other farmers. Some members, knowing that union membership allows for seed access through formal exchanges, will only ‘give to a non-member. But if you are a member, you have to go to [the union].’ Some seed producers simply no longer save seeds to share or exchange with others, ‘because it is against [the union]. We cannot, there are laws.’ In other cases, however, formally certified seed production creates the possibility for informal as well as formal exchanges: ‘the quantity that [the union] takes from me, what’s left, since I have my certificate, I can sell them to farmers.’

Sales of mini-packets of improved variety seeds are an element of the market-oriented social infrastructure that is adapted to the social context. ‘With the arrival of mini-packets, the price is affordable,’ and the small amount of cash needed to buy one mini-packet facilitates formal exchanges for a wider range of farmers than other types of formal seed sales. Expanding market-oriented social infrastructure might challenge seed sharing arrangements, however, if exchange logic begins to supplant other social priorities: ‘people asked [for seeds] and she said that they aren’t aid, to give to someone…since she invested money in them, they should buy also.’ The resounding refrain is that increasingly, ‘if you want seeds, you have to pay.’ The cash element of formal exchanges presents a challenge in rural areas with little consistent opportunity to earn cash. Some farmers have suggested another system of access, ‘like credit…because people really like [the seeds], but they don’t have the money to buy a lot to plant a lot.’
As the infrastructure for formal seed sales is instituted and experienced as reliable and consistent, farmers are increasingly interested and skilled in formal exchanges as a way to buffer against the risks associated with non-formal exchanges and provisioning. ‘In the past, accessing seeds, it was a little complicated. Because if a farmer had seeds, when you asked, he could tell you to wait until he was done with the seeds, and then he’d give to you. But now, there are sales. You can buy directly, and you won’t take time.’ Other farmers see seed sales as a complement to, rather than a replacement for, provisioning: ‘if we bring them to sell, she will buy some. She said that she saved a little, and if we don’t bring any more, she will plant what she saved.’ The major pressure on all types of seed access decisions, provisioning and exchange alike, is the demands of household food needs and the consistent risk that they will not be met. In this way, the presence of standardized seed sales helps buffer against the possibility that a household didn’t save seeds because ‘during the harvest, there wasn’t enough grain, so they just started eating it.’ Seed sharing is also difficult because, as one woman in Mali explained, ‘she can’t save part as seeds, and give them. She also has to eat.’ Seed sales can provide community-level seed security, although a conditional security, since formal exchanges require always-scarce cash.

Finally, the skilling process that farmers’ have experienced through PPB projects and now with the sale of mini-packets allows them to do a cost-benefit analysis about different types of exchanges that is based on economic calculations that are reasonable within the social context. For those who have seen improved varieties perform well and provide a payoff, with surplus production leading to profit beyond food self-sufficiency, ‘after the harvest they consume. They don’t save.’ The decision to transition wholly to formal exchanges for seed access suggests that these farmers’ experience a level of reliability in the market-oriented social infrastructure, perhaps due to their place within it (as union members, for example). Individual farmers’ skilling processes influences not only their exchange decisions for personal access, but also the types of exchanges they are willing to facilitate for others: ‘she said that she gave to her younger sister,
but she said that next year, you have to buy, I won’t give to you. (Why?) She said that they have become something important…that’s why for free has begun to disappear.’ Skilling by seed producers with both formal and informal markets and exchanges is incorporated into the range of prices and points of sale with which they engage. One man in Mali explained that ‘the seeds that I have done, they go to the laboratory. Those will be sold for a price…but what I did personally, I can exchange that. [For others] to better understand these varieties, to know if they are good or not.’ Formal certification and exchange functions outside of the social context, but informal exchanges can incorporate the social ethic toward sharing and diffusing useful new information.

Visualization of social infrastructure and quantitative analysis of the relationships between social context and type of access activity

The social infrastructure described and identified as important by farmers in terms of seed access possibilities includes local weekly markets, the presence of agrodealers and animateurs (farmer-technicians), and the presence of PPB field trials. The relationships between proximity to elements of social infrastructure and type of activity used to access seeds will be tested below. In addition, Figure 6-8 depicts differences in the spatial extent and spread of social infrastructure in two research sites, as an example of the spatial differences in social infrastructure across sites that might influence the potential for market-oriented seed value chains to be instituted.
The two maps presented in Figure 6-8 have the same scale, and depict differences in the extent to which social infrastructure is available in two different sites. In Mali, agrodealers are a part of the market-oriented social infrastructure, and are generally found in local market centers, as seen in the map on the left. In Mali as well, field trials are the most common type of social infrastructure. Across all research sites, as seen in Figure 6-8, the presence of an animateur is often coincidental with field trials, as the trials are implemented and supported locally by these representatives of the farmer organization. Local markets are also generally sites of other types of social infrastructure, and in Siby especially there is a consolidation of social infrastructure in the central local town. The farmer organization and one of two agrodealers are based in the same town as one of a few weekly markets, and there is an animateur present as well. Social infrastructure in Dédougou is more diffuse, with more distance between weekly markets, and more animateurs and field trials spread out around these market centers. Relationships between
social infrastructure and different types of seed systems will be explore in depth in Chapter 9. The maps in Figure 6-8 are representative depictions of social infrastructure meant to provide examples of the extent and distribution of the different elements.

The qualitative data analysis presented above suggests that the skilling process with market-oriented social infrastructure has the potential to influence farmers’ preference for or against different types of exchanges. The goal of market-oriented development approaches is to provide the necessary foundation for economically rational decision making, and the assumption is that individuals will prioritize formal, rational exchanges over other types of exchanges once they have access to market-oriented infrastructure. To test these broad hypotheses, I identify below several elements of the market-oriented social infrastructure in Sahelian West Africa and here test their relationship to decisions about exchange-oriented activities. In addition to social infrastructure, gender is an important element of the social context that conditions farmers’ experience with different types of exchange activities. Presenting gender-disaggregated analysis here builds on Doss’ (2013) argument that gender should not only be considered in the sampling portion of a research study, but also incorporated into analytical approaches in which gender might condition the nature of the outcome being studied. Because consistent themes of gendered differences in access to information, mobility and cash emerged in the qualitative analysis above, I test below for significant differences between men and women in terms of exchange activities.

Based on the qualitative analysis above, I identify several key elements of the social infrastructure that could influence farmers’ decisions about what type of activity to use for accessing seeds. Indicators of social infrastructure, union membership and animateur presence in the village, are measured on a no/yes scale. In addition to exogenous variables related to social infrastructure, in order to test the causal relationships posited by market-oriented development approaches (that infrastructure leads to formal exchanges) it was also necessary to derive indicators of types of exchanges. Based on the literature and farmers’ descriptions of exchanges,
I created several measures of the type of access activity dimension in Sahelian seed systems, all on ordinal scales so that an increase means a move toward formality. These indicators include place seeds were accessed, price of seeds. Full explanation of indicator scaling is presented in Table 8-1. The measures of exchanges incorporate seed saving activities (accessing with oneself, for example) because Sahelian seed systems only recently incorporating exchanges at all, so that provisioning remains interconnected with exchange decisions. In addition, because one aspect of ICRISAT’s seed system project being evaluated here is a desire to understand the impacts of market-oriented development on local seed systems, it is important to look at relationships between provisioning and non-formal exchange activities (foundational to local seed systems), and the presence of market-oriented infrastructure. Indicators of local seed system activity, seed saving and seed sharing, are measured on a yes/no scale.

Given the qualitative analysis above, I argue that market-oriented exchanges are being connected to local seed systems as an additional type of buffer against the natural risks (like drought) and social impediments (like gender expectations) to seed access. However, market-oriented exchanges do not supplant seed sharing and seed saving activities. I test these hypotheses using a chi-square analysis of the relationships between elements of the social infrastructure, and exchange and provisioning activities, and present the results in Tables 6-4 and 6-5.
The relationships between union membership, an element of social infrastructure, and measures of exchange types and provisioning activities show for the most part a significant relationship between participation in a union and formal exchange activities, non-formal exchanges and traditional provisioning activities. There are significant differences between union members and non-members in terms of where they access improved variety seeds – 56% of union members bought in settings of formal exchanges (an input shop or market stall), whereas only 37% of non-members did so. Interestingly, there is no significant difference among members and non-members in terms of the formality of the price paid – the majority of all farmers pay for seeds in cash, rather than non-formal, non-cash currency. These results suggest that the presence

<table>
<thead>
<tr>
<th>Year (sample size)</th>
<th>Chi square (degrees of freedom)</th>
<th>Significance</th>
<th>Distribution of dependent variable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relationship between union membership and access place</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011 (n=326)</td>
<td>46.671 (3)</td>
<td>.000</td>
<td>Self: No 40%, Yes 29% Field: No 23%, Yes 15% Market: No 20%, Yes 5% Shop: No 17%, Yes 51%</td>
</tr>
<tr>
<td><strong>Relationship between union membership and price paid</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011 (n=326)</td>
<td>3.709 (2)</td>
<td>.157</td>
<td>Self: No 29%, Yes 22% Non-monetary: No 15%, Yes 22% Monetary: No 56%</td>
</tr>
<tr>
<td><strong>Relationship between union membership and seed sharing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010 (n=142)</td>
<td>6.757 (1)</td>
<td>.009</td>
<td>No: Yes 46%, No 54% Yes: No 33%, Yes 67%</td>
</tr>
<tr>
<td>2011 (n=314)</td>
<td>9.194 (1)</td>
<td>.002</td>
<td>No: Yes 57%, No 43% Yes: No 26%, Yes 74%</td>
</tr>
<tr>
<td>2012 (n=179)</td>
<td>2.783 (1)</td>
<td>.095</td>
<td>No: Yes 72%, No 28% Yes: No 41%, Yes 59%</td>
</tr>
<tr>
<td><strong>Relationship between union membership and seed saving</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010 (n=164)</td>
<td>4.341 (1)</td>
<td>.037</td>
<td>No: Yes 66%, No 34% Yes: No 20%, Yes 80%</td>
</tr>
<tr>
<td>2011 (n=321)</td>
<td>12.275 (1)</td>
<td>.000</td>
<td>No: Yes 64%, No 36% Yes: No 18%, Yes 82%</td>
</tr>
<tr>
<td>2012 (n=172)</td>
<td>10.368 (1)</td>
<td>.001</td>
<td>No: Yes 77%, No 23% Yes: No 6%, Yes 94%</td>
</tr>
</tbody>
</table>
of market-oriented social infrastructure influences some elements of the seed system for all farmers, and that participation in this infrastructure increases the likelihood that farmers will engage in formal exchanges. Interestingly, however, participation in market-oriented social infrastructure also seems to bolster non-formal exchanges and provisioning activities. There are significant differences across all three years in terms of both seed sharing and saving, with union members more likely to save seeds for themselves than non-members and more likely to share seeds with others than non-members. Union members are both more likely to have had previous experience with improved variety seeds and have more access to information about the new seeds than non-members; participation in the social infrastructure facilitates skilling for union members, making them more confident in sharing their knowledge with non-members. Interestingly, in 2012 there is no significant difference between members and non-members in terms of seed sharing, which perhaps reflects the fact that as the number of seed access points expands, skilling is no longer tied to a specific element of the social infrastructure like union membership.
### Table 6-5. Relationships between animateur presence and seed access activities

<table>
<thead>
<tr>
<th>Year (sample size)</th>
<th>Chi square (degrees of freedom)</th>
<th>Significance</th>
<th>Distribution of dependent variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Self</td>
</tr>
<tr>
<td>Relationship between animateur present and access place</td>
<td></td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>2011 (n=333)</td>
<td>10.627 (3)</td>
<td>.014</td>
<td>29%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>39%</td>
</tr>
<tr>
<td>Relationship between animateur present and price paid</td>
<td></td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>2011 (n=333)</td>
<td>.199 (2)</td>
<td>.905</td>
<td>24%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>24%</td>
</tr>
<tr>
<td>Relationship between animateur present and seed sharing</td>
<td></td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>2010 (n=194)</td>
<td>.017 (1)</td>
<td>.895</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>2011 (n=321)</td>
<td>1.762 (1)</td>
<td>.184</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>2012 (n=227)</td>
<td>5.487 (1)</td>
<td>.019</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Relationship between animateur present and seed saving</td>
<td></td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>2010 (n=219)</td>
<td>.573 (1)</td>
<td>.449</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>2011 (n=328)</td>
<td>2.434 (1)</td>
<td>.119</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>2012 (n=218)</td>
<td>3.592 (1)</td>
<td>.058</td>
<td>No</td>
</tr>
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<td></td>
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<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>

The presence of an animateur (farmer-technician) in a farmer’s village is another element of social infrastructure that can be hypothesized to have varying impacts on exchange and provisioning activities. Animateurs are representatives of farmer organizations, and in all of the research sites are the primary sellers of mini-packets. In this way, their presence could facilitate a transition toward formal exchanges. The results presented in Table 6-5 suggest that the presence of an animateur does influence the places that farmers access seeds – there is a decrease in purchases at input shops and an increase in sales in the marketplace by farmers in villages with an animateur. This is likely because animateurs can sell mini-packets in small village markets,
which are more accessible to farmers in that village. There is again no difference in the price paid – formal cash exchanges constitute the majority of seed exchanges for all farmers. In terms of seed saving and sharing, the results in Table 6-5 reflect an interesting shift over time. In terms of seed sharing, the majority of all farmers across all years share seeds, and in 2010 and 2011 there are no significant differences in sharing rates based on the presence of an animateur in a farmer’s village. In 2012, however, farmers in a village with an animateur shared significantly more than farmers in villages without an animateur, which perhaps reflects a skilling process that is facilitated by an animateur in terms of the realities of saving improved variety seeds. Seed saving is largely the same for farmers who live in the same village as an animateur and those who do not. However, the there is a consistent pattern of more farmers in villages without animateurs saving seeds than farmers in villages with animateurs, and this difference approaches significance in 2012. This trend possibly reflects the theme of reliability that emerged in the qualitative analysis above. Farmers with consistent access to social infrastructure, like having an animateur in their village selling mini-packets each year, might shift away from a provisioning orientation that sees seed saving as the most reliable means of seed access and toward an exchange orientation that relies on seed access through market exchanges.

The descriptions of gendered differences within the seed system that are analyzed above suggest that non-formal exchanges and provisioning will be more likely to provide access to improved variety seeds for women than will formal or informal monetary exchanges. It is not necessarily clear if the inverse is true, that men are more likely to access improved variety seeds through formal and informal market exchanges, based on either gendered economic priorities and capabilities, or predilection for market-oriented behavior. The analysis presented in Table 6-6 explores whether there are significant differences between men and women in terms of both exchange activities and provisioning activities. One hypothesis tested here, based on the analysis in Tables 6-4 and 6-5, is that the actual gendered difference that is most predictive of seed access
activities is incorporation into market-oriented social infrastructure (via union membership).

Union membership is gendered not by sex, but by the shift it requires of members from a communal and provisioning orientation to a disposition that sees seeds as a commodity to be formally produced and accessed.

Table 6-6. Relationships between gender and seed access activities

<table>
<thead>
<tr>
<th>Year (sample size)</th>
<th>Chi square (degrees of freedom)</th>
<th>Significance</th>
<th>Distribution of dependent variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relationship between gender and access place</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011 (n=333)</td>
<td>11.364 (3)</td>
<td>.010</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>30%</td>
</tr>
<tr>
<td>Relationship between gender and price paid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011 (n=333)</td>
<td>53.957 (2)</td>
<td>.000</td>
<td>Female</td>
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<td></td>
<td></td>
<td></td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30%</td>
</tr>
<tr>
<td>Relationship between gender and seed sharing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010 (n=194)</td>
<td>.041 (1)</td>
<td>.840</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>2011 (n=321)</td>
<td>.705 (1)</td>
<td>.401</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>2012 (n=227)</td>
<td>.654 (1)</td>
<td>.419</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Relationship between gender and seed saving</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010 (n=219)</td>
<td>.367 (1)</td>
<td>.545</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>2011 (n=328)</td>
<td>1.900 (1)</td>
<td>.168</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>2012 (n=218)</td>
<td>.002 (1)</td>
<td>.967</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
</tr>
</tbody>
</table>

The results presented in Table 6-6 suggest that there are in fact significant differences between men and women in terms of exchange activities. A higher proportion of women than men access seeds through provisioning or exchanges that occur in non-formal settings, while a higher proportion of men than women access seeds in markets and input shops. In analyzing the
relationship between gender and access place, I consider field trials to be “self” access, since a person chooses to conduct the trials and one result of that is the possibility to access seeds for personal use. I consider the price paid for seeds accessed through field trials to be non-monetary, because testers must commit to managing their field and providing results to ICRISAT – the seeds for trials are not gifts but implicated in a type of non-formal exchange of labor for seed. The results for the relationship between gender and price paid are also significant, and show that most women in the sample access seeds through provisioning or non-monetary exchanges. These results in part reflect the fact that female testers were purposively added to the sample because women were underrepresented among buyers. The results in Table 6-6, when taken with the analysis in Table 6-4, suggest that for women, participation in the social infrastructure of field trials facilitates access to seeds through an element in the seed system that is quite temporally specific. Field trials will not continue forever, and in fact are already being phased out as the PPB projects in the research areas transition to supporting seed commercialization. However, the sale of mini-packets is unlikely to facilitate access to seeds for women to the same degree as field trials, especially given the cash and information limitations mentioned by many female farmers. Interestingly, there are no significant differences across any year between men and women in terms of seed provisioning activities, with the majority of both genders engaging in both seed saving and seed sharing. Rates of seed saving are particularly high for 2012, likely reflecting the fact that poor rains in 2011 made seed saving difficult and also led to lower availability of improved variety seeds in 2012 (due to low rates of seed production in 2011). With a better rainy season in 2012, the desire to buffer against seed deficits likely increased seed saving rates even among farmers who prefer to buy anew each year.
**Relationship between natural environment and seed access activities**

The two key elements of the natural environment that influence what type of seed access activities farmers undertake are rainfall and varietal traits, described here not as distinct varieties, but as the unique traits that farmers see as desirable given their own environments. As discussed above, rainfall influences the varietal traits that are desirable, and the combined assessment of the risk and reliability associated with different types of exchanges to access different types of seeds then guides farmers’ decision making about how to access seeds. In some cases, farmers attribute a willingness to buy seeds to the observed lack of rain, and the necessity of improved varieties. Many talked about the reliability that comes from formal sales of mini-packets rather than informal purchasing in the market: now ‘people go to the market and get seeds for themselves…what we are doing, having mini-packets for farmers, that’s really good. It allows them to get them, not seeds in the market.’ There is a general conflation, which will be discussed further below, of formal exchanges with improved variety seeds, whereas informal exchanges are related implicitly to creolized seeds. Rainfall then pushes farmers toward the combined decision of formal exchange/improved variety seed or informal exchange/creolized seed. Another impact of rainfall on seed access noted by many farmers is the decreasing possibility for non-formal exchanges given the pressures of low rainfall and other elements of the natural environment. ‘In the past, when you needed seeds, you asked, in the field, and you got them…now you are obliged to look elsewhere. In the market or to buy them. (What caused this change?) She said that people now have trouble feeding themselves. In the past, yields were higher, there weren’t problems with rain, the soil was fertile. Now it’s not like that.’

Within the exchange-based seed system, farmers note increasing pressure toward formal sales, in order to respond to the risks posed by low rainfall and soil degradation. Many other farmers, however, noted that changes in the natural environment are related to a shift not from
seed saving to formal exchanges, but from a seed system predominantly based on provisioning through gifts to one based on exchanges of various types. In the past, ‘people had an abundance, there were not problems of drought, the rain fell. So they had a lot of production. So people, when you needed seeds, you went to a farmer, you asked and he gave to you. For free. But now, there are those who do exchanges.’ Reflections on the past generally refer only to landraces, since improved varieties were not in circulation until very recently. However, some farmers explicitly note that the contemporary shift toward seed exchange includes all types of seeds: ‘now it’s not gifts but exchanges. Be they local, be they improved varieties. She said that the times have changed, and people also have changed. She said that it’s also an effect of there not being enough production.’ The sharing elements of the seed system are influenced by the possibility of exchange, as well as by decreasing yields. Rainfall also impacts seed saving in multiple ways, depending on the individual farmer and the growing season. For some, because ‘it doesn’t rain a lot, and since [the improved variety] is fast, that’s why he saved a part.’ In other cases, low rainfall makes saving impossible: ‘he lost everything, he doesn’t have seeds for next year.’ Overall analysis here reinforces the theme that rainfall is the most profound risk faced by farmers in Sahelian West Africa, and provides the backdrop against which types of seed and seed access decisions are made.

In addition to rainfall, genetic traits influence farmers’ choice of seed type and so type of seed access activity that is possible. Interest in maturation cycle, yield, and genetic purity were all consistently mentioned by farmers as the traits they prefer and seek out. The desire for a short cycle pushes many farmers toward formal exchanges: ‘it’s a seed that is fast. Even if it doesn’t rain a lot, you can have something to eat. That’s what I explained to them, and then they paid.’ Decreases in yield with creolized seeds seem to push farmers away from saved seeds and toward seeds accessed in some other way. ‘It’s better to buy. Because it you want to produce the same variety, you have to find it again often, because it loses the yield if you keep growing it.’
Comparisons between local and improved varieties also push people away from provisioning and toward exchanges. In the past, ‘there were local varieties…but with time that has changed, because those varieties don’t give much. So they started buying in the market. But with the changes, modernization, they started buying in the shop.’ In addition to a desire to access seeds with increased yield, a few farmers mentioned that yield increases can support the non-formal seed system by providing excess output to be shared: ‘he will do everything to diffuse these seeds, give to everyone, those who ask, he will give, to meet their needs.’ Farmers also expressed an interest in genetic purity in order to maximize the benefits of specific traits, like yield, and implicitly, the reliability of those benefits: ‘he might buy this variety again in packets, to increase and plant in a field that’s isolated from local pearl millet. So that he can see the advantage and importance. And to end mixing.’ A preference for genetic purity leads some farmers to no longer give or exchange second-generation seeds, and instead to share information about where to access certified improved variety seeds. Other farmers have combined seed sharing activities with information sharing, since the cross-pollination aspects of using second-generation improved variety seeds are different than with landraces. One farmer in Niger explained that ‘he gives to his relatives, but he also gives them details, in terms of growing these seeds . He tells them, he’s already done one season with these seeds, so the second season, after the second season, you really have to eat what you’ve produced and buy base seeds. Because…the variety will lose its character a little.’

In general, there is a conflation between type of seed and type of access activity. To access landraces, ‘it’s easy. You can have them by giving, you can exchange, you can sell them also. But for improved varieties, you have to buy them, in the market.’ However, the relationship between type of seed and seed provisioning is more ambiguous. Some farmers see only landraces as able to be saved, while others have adapted to the realities of improved varieties by saving for two or three years before repurchasing. Again, the link between provisioning and
exchange-based seed systems is non-formal exchange, which is conditioned by the type of seed being exchanged. Landraces are now exchanged in equal weight, because informal and formal markets value grain in terms of weight, not volume. Improved varieties, as previously mentioned, can often be exchanged for landraces, using a weighted system that trades twice as much landrace seed for improved variety seed. Taken together, we can start to see the relationships between the natural environment, including varietal traits, and seed access activities that are nested within the social context. These relationships will be explored in depth in Chapter 7, and provide the foundation for understanding the nature of embeddedness in Sahelian seed systems.

**Statistical analysis of the relationship between natural environment and type of access activity**

Because rainfall emerged as one key feature of the natural environment that affects farmers’ interest and ability to engage in exchange-oriented seed systems, I present results in Table 6-7 of statistical analysis of the relationship between rainfall, and the place seed was accessed and the price paid for seed. As discussed above, access place and price are two indicators of the type of access activity described by farmers and quantified in the sample, and provide a snapshot into the range of exchange occurring in Sahelian West Africa as market-oriented seed system development creates the social infrastructure necessary for formal exchanges of improved varieties. The analysis presented in Table 6-7 tests the hypothesis implicit in the market-oriented development approach, that increased rainfall will lead to increased formal exchanges, because farmers in higher rainfall areas will have more production, more surpluses, and so more incentive and ability to purchase seeds. It also tests the converse hypothesis, which emerged from the analysis above, that farmers in lower rainfall areas are more
likely to access seeds through formal exchanges because of the buffer that seed sales and improved varieties can provide against the risk of variable rainfall.

Table 6-7. Relationship between rainfall and type of access activity

<table>
<thead>
<tr>
<th>Year (sample size)</th>
<th>Parameter estimate</th>
<th>Std. error</th>
<th>Significance</th>
<th>Distribution of dependent variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall and access place</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011 (n=332)</td>
<td>-.003</td>
<td>.000</td>
<td>.000</td>
<td>Self 33% Home/field 18% Market/shop 49%</td>
</tr>
<tr>
<td>Rainfall and price paid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011 (n=332)</td>
<td>-.001</td>
<td>.000</td>
<td>.004</td>
<td>Self 24% Non-monetary 19% Monetary 56%</td>
</tr>
</tbody>
</table>

Link function: Logit

The results presented in Table 6-7 confirm the second hypothesis presented above, that rainfall is significantly and negatively related to the likelihood that an individual will engage in informal or formal exchanges for seeds. These results are consistent with the analysis presented above, about the ways in which rainfall constitutes a risk against which to buffer, and in the earlier analysis of social context, which suggests that formal exchanges are seen to provide reliable access to seeds. Recalling the analysis presented in Table 6-2, where rainfall was found to be significantly and positively related to the likelihood that a farmer would not save improved variety seeds, and would not repurchase seeds, the results presented in Table 6-7 further underscores the themes from the qualitative analysis, that exchange-based seed systems (as measured by seed access decisions) are more consistently used by farmers in areas where rainfall acts as a clear risk against which to buffer, pushing farmers away from provisioning activities and toward exchange activities for seed access.
Relationship between social context and type of seed

Several elements of the social context affect the type of seed that farmers are interested in using. Characteristics of the agricultural system, gender dynamics, access to social infrastructure, and awareness of risk and desire for reliability all condition not only the seed access decisions made by farmers, but also the type of seed they prefer. The nature of land management influences farmers’ seed decisions because of the influence of cross-pollination and pest pressures. Land is allocated at the village level and managed by individuals, and there is no formal mechanism to deal with decisions made by a neighbor that will affect one’s own production decisions. Some seed producers, who rely on the genetic purity of their crop to guarantee official certification and a price premium, have taken to requesting that their neighbors also plant the same variety to avoid cross-pollination: ‘he’s my neighbor. I produce Kapelga seeds. So I said to him, that he needed to go and buy them.’ The natural characteristics of the plants, in combination with the social organization of land, potentially mandates that contiguous fields must be planted with the same variety, in effect limiting farmers’ choices if they have neighbors who make strong demands. Another important element of production is the ability to access inputs, including fertilizer. As previously discussed, many farmers’ experiences have taught them that ‘improved varieties are varieties that really need fertilizer.’ Without the cash or proximity to access fertilizer, many farmers prefer to grow landraces since ‘without using something, you have to use fertilizer or they’re not even as good as the local.’

The relationship between gender and type of seed is marked more by an absence of discussion than specific articulations by individuals about how there might be differences between men and women, or among different members of a household or community in terms of seed choice. The analysis presented in prior sections suggests that engagement with various types of social infrastructure, including union membership and participation in field trials, makes
individuals more likely to use improved varieties because of the first-hand skilling process to which they have access. However, in reviewing my field notes, I noted consistent surprise that women who had participated in field trials and demonstration plots for multiple years still did not seem to know the names or specific traits of individual improved varieties. This might be due in part to the smokescreen that women’s inclusion in field trials provides – a woman’s name is recorded as being the participant, but her husband or children often manage the field, and her husband might keep the output. An implicit goal of PPB is to provide a skilling process that will then allow (and encourage) farmers to make decisions about the use of improved varieties, and yet it is not clear that the PPB process necessarily provides the tools to clearly distinguish among different types of seeds or varieties, beyond the fact that improved varieties are ‘new’ and landraces or long-saved seeds are ‘old.’ The new/old distinction can be seen as a kind of second-hand, social skilling, rather than first-hand experiential skilling that allows farmer to identify traits and varieties that have them. For a woman in particular, ‘when her husband did tests,’ she could select, and ‘that’s what she used in her field. So she’s used the seeds for a very long time.’ The decision to save from her husband’s field is based on observation and a less-specific typology of seed types than could emerge from a first-hand skilling process.

Relationships between elements of market-oriented social infrastructure, created to diffuse certified improved varieties, and impacts on the type of seed that farmers use are hoped and assumed to exist in market-oriented seed system development approaches. Understanding these relationships sheds light on the skilling process and lays the foundation of further analysis of the values associated with seed access and use decisions. Seed sales have begun to define types of seeds for some farmers: ‘for local varieties, when you want to plant, you bring a quantity to exchange with the variety that you want. And she said that for improved varieties, you pay.’ For other farmers, the place a seed was accessed might define the type of seed it is. For landraces, ‘they are with relatives, always with relatives or friends.’ Improved varieties, on the
other hand, are bought ‘with the shop, and in a packet, with information, they explain all of the characteristics.’ One question brought up by plant breeding colleagues is the economic theory that goods with no price will be seen as less valuable than those with a price – hence, selling mini-packets as a way to expose farmers to seeds rather than giving seeds away. For those farmers with enough resources to consistently engage in an exchange-based seed system, mini-packets are affordable and often draw them in. For other farmers without access to cash, however, seed aid has in some places provided one-time access to improved varieties, which are then integrated as creolized seeds into a provisioning seed system. One farmer in Niger described the varieties in mini-packets: ‘it’s the same variety that was brought as aid. So now they have eaten it, but reserved a small part to plant. They planted it and they saw that it gave, so there it is, luckily this year there were seeds to plant.’ A final influence of the social context on seed types is the increasing skilling that makes many farmers see landraces as ‘just for food, not for seeds.’ This perception affects exchanges as well, since if a farmer ‘won’t plant [improved varieties], because they’re just for eating,’ he might be less likely to exchange improved varieties for local varieties in years when seeds are scarce.

Another small example of how social infrastructure conditions perceptions of seed types has to do with cross-pollination and creolization. When I asked farmers if they understood cross-pollination and the phenotypic changes that would be apparent in second-generation seeds, many replied that they were familiar with that phenomenon with their landraces. Others, however, said that they had heard on the radio ‘about the change, that there is wind that transports pollen.’ From casual conversation with farmer organization representatives, who often create and sponsor this type of educational announcement, it seems that most of the education about cross-pollination suggests that ‘the seeds will be mixed the second time,’ so that saving improved variety seeds immediately creates seeds that have been mixed or changed. This is true from a genetic standpoint, but stands at odds with farmers’ own descriptions of creolization as more a tipping
point or degree of change, beyond which a variety is no longer identifiable or seeds do not produce adequate levels of certain traits. Confusion among cross-pollination, hybrid seeds and GMOs is in part fueled by unclear radio announcements and varying agendas of the organizations creating them. This is just one example of the ways that the market-oriented social infrastructure, despite being grounded in the social setting, does not always reflect the realities or priorities of many farmers in the area in which organizations are active.

Finally, the recognition of risk and desire for reliability that is integral to the social context of Sahelian seed systems affects farmers’ interest in different types of seeds. Food needs and experience with demands of one’s natural environment affect many farmers’ seed use decisions. For example, because ‘a chief of the family is someone who’s always looking for short cycles, to address the hungry season,’ a household head might be more likely to choose improved variety seed specifically because of the short cycle trait. Food needs also influence how likely it is that farmers will plant and gain experience with creolized seed: ‘he doesn’t know if what he has will make it until next year. If it does, he will replant, but if not, he will rebuy.’ Another common response to risk is diversification, and many farmers choose improved variety seed because access conditions allow for more informed choice. ‘With the shops, you have lots of information and a range of varieties. So you can make a choice.’ Improved varieties are also preferred for their reliability, which is signified by sealed packets and treated seeds. As farmers engage in skilling with the formal exchange of improved varieties, they increasingly identify improved varieties as ‘something guaranteed. You know, it brings confidence, the way that they are well guarded.’

The skilling process with improved varieties and formal exchanges seems to be currently creating new social knowledge that defines improved varieties based on presentation rather than genetic traits or phenotypes, which could limit alternative types of improved variety seed exchanges and production in the future. For example, many women buy mini-packets and rely on
literate children to identify the variety: ‘it’s all written on the packet, they can come and say, here are the characteristics, here’s the name of the variety.’ However, there is also much comparative experiential learning happening. In terms of comparing pure improved varieties to creolized saved seeds, many farmers report buying mini-packets for the next season, ‘to plant and compare with what he produced this year.’ Field trials and field days associated with PPB projects provide both social and experiential skilling, which can support informal and non-formal exchanges by increasing farmers’ ability to identify seed and varieties by phenotype, not just based on presentation or place of sale. One woman in Mali described how ‘she’s seen changes, because with the 32-variety trials, they weigh them after harvest, and there are lots of people who make demands. And there are people who choose a variety and ask for seeds of that variety.’ Not all skilling leads to increased use of improved variety or creolized seed, however. Some farmers who have engaged in the skilling process choose to use landraces, ‘not because the varieties aren’t good, but because he’s used to their local varieties. So he left them, and he will continue with the locals.’

**Statistical analysis of the relationship between social context and type of seed**

Based on the above analysis, gender and engagement with aspects of the social infrastructure influence the type of variety that farmers describe and then choose to use. One indicator of seed type is whether farmers distinguish the variety by name or by characteristics, and I test for relationships between gender and union membership, and type of varietal identification. Table 6-8 presents the results of these analyses.
Table 6-8. Relationship between gender or union membership, and varietal identification

<table>
<thead>
<tr>
<th>Year</th>
<th>Chi square (degrees of freedom)</th>
<th>Significance</th>
<th>Distribution of dependent variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relationship between gender and varietal identification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011 (n=350)</td>
<td>16.052 (2)</td>
<td>.000</td>
<td>None Characteristics Name</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Female 31% 32% 37%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male 20% 21% 60%</td>
</tr>
<tr>
<td>Relationship between union membership and varietal identification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011 (n=343)</td>
<td>15.997 (2)</td>
<td>.000</td>
<td>None Characteristics Name</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No 18% 35% 47%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes 29% 17% 54%</td>
</tr>
</tbody>
</table>

The analysis provided in Table 6-8 suggests that there are significant relationships between gender and varietal identification, as well as between union membership and varietal identification. A majority of men identify improved varieties by name, whereas just over one third of women identify improved varieties by name. The identification of improved varieties by their characteristics is more common for women than for men, as well as having no means of identifying improved varieties beyond their ‘newness.’ In terms of union membership, more union members than non-union members identify improved varieties by name. Interestingly, however, a larger proportion of non-union members identify improved varieties based on characteristics than union members. This could be due to the social learning that non-union members do with union members by observing demonstration fields and new varieties planted near the road – they might not receive detailed information that includes the name of the variety, but they have ample opportunity to observe characteristics. Union members are almost twice as likely to have no specific varietal identification as to use varietal characteristics. In other words, if a member does not identify a variety by name, they are more likely to have no specific knowledge than to have knowledge of the variety’s characteristics. This is likely due to the fact that many women are members of the union through participation in women’s groups that conduct field trials, but as previously discussed, field trials allocated to women are often conducted and managed by men or children rather than by women themselves. This leads to a
lack of both social and experiential learning for women and a lower-than-expected knowledge base for union members.

Chapter summary

The qualitative, quantitative and visual analysis presented in this chapter serves two purposes in answering the overall research questions posed by this project. I take a largely phenomenological approach to identifying elements of the natural environment and social context that influence farmers’ experiences of seed systems, and the qualitative analysis provides a detailed description of the relationships between the context and individual activities within the seed systems. The qualitative data and visual representations presented here also provide the foundation for analyzing how and why farmers choose to or not to incorporate improved variety seeds and market transactions into their individual seed access decisions. The quantitative analysis of the statistical relationships between various elements of the natural environment and social context, and seed access decisions along two dimensions, test the patterns that emerge in qualitative analysis and provide information about which patterns are related to which individuals and which settings. The statistical analysis begins to identify parameters of different types of seed systems that might be emerging parallel to, and at times connected to, one another, as theorized in Chapters 1 and 2. Finally, the use of maps to visualize qualitative and quantitative data provides analysis using village as the unit of analysis. Mapping different elements of the natural environment, the social infrastructure, and the spatial proximity and continuity of these elements helps to connect individual-level patterns to larger scales. Identifying spatial relationships at the scale of the research site also informs analysis presented in Chapters 6 and 7, which seeks to characterize seed systems by integrating individual, village and site-level data and analysis.
Chapter 7 Seed systems and seed economies in the Sahel

In this chapter, I analyze farmers’ descriptions of motivations for instituting provisioning seed systems and substantive seed economies using Polanyi (1944; 1957b) and Bourdieu’s (1979; 2005) theories of relationships among context, social dispositions and individual actions. I further characterize individual farmers’ decision making about engaging with seed systems by using Marxian (1978) categories of economic value and theories of social value (Schumpeter, 1909; Jordan, 2008) of the output to describe the third dimension of seed systems depicted in Figure 2-1 and discussed in Chapter 3. Figure 7-1 depicts my understanding of the relationships among different levels of influence, motivation and action as articulated in the theoretical framework put forth in Chapter 3 and utilized in this chapter. Throughout the analysis I include visual representations spatial and scalar dimensions of different types of seed systems. Farmers’ hand-drawn maps of seed systems oriented around use-value suggest a much shorter supply chain than those being instituted by market-oriented development projects, while maps of seed saving, sharing and sales that I generate from my primary data depict the varied spatial extents of provisioning activities and economic-oriented seed access actions. Combining qualitative and visual data allows me to draw connections between individual habitus and instituted seed systems by situating farmers’ expressions of the values associated with seed access decisions (values that are conditioned by the social and natural context).
Recognizing that seed systems are made up of individuals, institutions and structures that condition and create seed access, I use the relationships depicted in Figure 7-1, among context, habitus, individual action and instituted systems, to analyze farmers’ descriptions of their individual and social judgments of the value of the output of specific types of seeds. Bourdieu’s (1984; 2005) general theory of habitus as the presence of the social world manifest in every individual action generates the overarching category of social habitus, within which economic habitus and, in the case of peasant seed systems, agricultural habitus, are embedded. Habitus, as disposition toward meeting human needs through actions that reflect social history and natural context, generates the organizing principles that guide the institution of systems (Polanyi, 1957b). As individuals make decisions about provisioning and exchange actions taken to meet their material needs, the organizing principles that derive from social habitus (and all that is embedded...
within it) are interpreted and articulated as individual valuations of the outcome of specific activities. The organizing principles and the value judgments they support guide consistent patterns of action that contribute to the institution of social and economic systems, which in turn become part of the social history of a given place and influence future decision making.

In the context of Sahelian seed systems and based on the analysis in Chapter 6, characteristics of social history and the natural environment influence social, economic and agricultural habitus, and the negotiated balance among social and economic habitus in particular leads to a range of organizing principles for seed systems. Habitus as it relates to seeds is shifting as societal experiences with the new types of sorghum and pearl millet seeds, as well as with the newly established seed markets, increase. However, experience and the skilling that can come with it are not uniform across the population, leading to differences in dispositions and individual assessments of the value of the output of improved variety seeds. The analysis provided here suggests that provisioning seed systems, as well as various configurations of substantive seed economies, currently exist in relation to and in conversation with one another in Sahelian West Africa. Rather than defining seed systems as formal versus informal, as is often done in the seed systems literature overviewed in Chapter 2, it is more appropriate to understand several possible seed systems instituted by different expressions of habitus and individual valuation.

**Provisioning seed systems in the Sahel**

Based on my own observations in rural Sahelian West Africa and analysis of farmers’ descriptions of seed systems and the social context within which they are set, seed provisioning emerges as an element of the social life that is foundational to agricultural and seed systems, rather than deriving from them. Building on Chayanov (1986), I see peasant seed provisioning as integral to the peasant farm as an organizational, rather than entrepreneurial, entity. Peasant
farming can take a variety of forms depending on the social context and historical moment, and
the social organization of seed provisioning reflects a given type of peasant agriculture and the
social imperatives that shape it. The analysis presented here builds on arguments by van der
Ploeg (2010) that provisioning is a contemporary manifestation of what has historically been
considered subsistence. Subsistence emphasized an individual or household-level approach to
reproduction of seeds, and evidence of that history can be seen in the analysis presented in
Chapter 6 about the importance of seed saving, as well as in the agricultural habitus described in
this section. However, seed provisioning in contemporary Sahelian seed systems is often
discussed at a village or local scale, implicitly and explicitly relational to the substantive seed
economies that also exist or are being instituted at similar scales. I analyze farmers’ expressions
of the social, agricultural and economic habitus that institutes provisioning seed systems to
illustrate the social value associated with seed saving and seed sharing through gifting in
contemporary social and natural contexts of Sahelian West Africa. I also depict the social
institutions that support and are supported by seed provisioning activities through visual data of
farmers’ seed maps and GIS maps of seed saving activities.

Social habitus in provisioning seed systems

Seed provisioning at the individual or household level takes the form of seed saving, and
at the community or social level, people share seeds with one another to both ensure access to
seeds and to enact more general social mores toward helping family, neighbors, and those in
need. Family obligation is often mentioned by farmers in terms of sharing more generally: ‘if
you have a brother who doesn’t have anything to eat, and you have something, you give to him.’
For seeds as well, when there are those who ask for seeds, ‘you can give them, if it’s our parents.’
Seeds are valuable in a way that makes sharing them an act of care or a gift contribution. For
example, ‘around here [Burkina Faso], when our children get married, we look for the best heads, and we put their grain in a bowl, and we give the bowl, like that.’ Brothers, parents and children are all identifiers used to talk about relatives in general, and the inclusive way that people in the Sahel discuss family belies a fundamental social orientation toward helping your own extended household. The line between family and neighbor is often blurred in rural areas, due to extensive connections through marriage and also, I think, because of the demanding natural setting that requires a level of interdependence that makes community or village the primary scale at which well-being and basic needs can be addressed. As farmers discuss seed provisioning through saving and sharing, they extend the ethic of helping family to others within their immediate social setting: ‘since they are neighbors, in the field, they asked if they could buy with him. He said since there is a system of neighbors, he would give to them.’ Village-level organizations (groupements) also engender ‘solidarity, certainly [with] members of his groupement, so he will tell them, since they would like to try the good variety, he will send them a quantity.’

The social habitus that emphasizes family and communal care over individual economizing action often landrace seeds in a separate category from seeds new or improved varieties. ‘The local varieties are hereditary,’ literally, in that they are saved and reused each year, and socially, in ‘that they are with relatives, always with relatives and friends.’ The heritage and history associated with seeds of sorghum and pearl millet landraces has important implications for the maintenance or degradation of agrobiodiversity in changing natural conditions and with the introduction of improved varieties. On the one hand, farmers express a practical need to change with the times: ‘in the past, they had varieties that they left, because the cycle was very long. And the rain wasn’t enough. They had another variety, like kende [sorghum variety], they left that also…if you don’t change, you won’t progress.’ However, recognizing the material improvements associated with adopting new varieties does not necessarily create an either-or decision about their use. Many farmers discussed how ‘they won’t
leave their local varieties, but little by little the improved varieties will be more than local varieties.’ The social habitus that identifies seeds as heritage means that agrobiodiversity can be supported in provisioning seed systems, at least at the phenotypic level (managing gene flow remains an open question without alternative seed production institutions). Pressures from the natural setting, like drought and pest problems, interact with the social habitus toward conserving landraces, and are also expressed in farmers’ agricultural habitus as it relates to seed decisions and seed saving activities.

**Agricultural habitus in provisioning seed systems**

The agricultural habitus expressed by Sahelian farmers with a disposition toward seed provisioning reflects the tensions among pressures from the natural environment that push certain seed decisions, social imperatives to share seeds with family, and ongoing evaluations of the possible uses for the outputs of different types of seeds of sorghum and pearl millet. As has been extensively discussed, the social habitus toward seed saving and seed sharing derives in part from social history and context. In contemporary seed systems, some farmers see seed saving as ‘a way of being prudent,’ while others suggest that those who save ‘seeds don’t know. It’s their tradition, they want to always save local pearl millet. They are conservative, they are scared.’ Provisioning seed systems are instituted by individuals with the former disposition, who see seed saving as a buffer against the risks inherent in the natural (and potentially social) settings within which farmers make decisions. ‘If you don’t have seeds, after it rains, if you have to look for seeds, that will make you late. So if you have seeds, when it’s time, you can plant. That’s why she saves seeds.’

The provisioning agricultural habitus expresses at least recent Sahelian history of drought and scarcity, which both supports seed saving and takes a pragmatic view of seed use. Newly
available improved varieties are incorporated into provisioning seed systems at times as a complement to landraces, which, as mentioned above, can support agrobiodiversity conservation. On the other hand, the Sahelian agricultural habitus is eminently practical. Many farmers expressed that ‘since it doesn’t rain, they will leave late varieties to continue with early varieties.’ Seed decisions are in general conditioned by personal experience and evaluation, reinforcing Stone’s (2007) argument that adoption of new seeds requires first-hand skilling and observation. Building on the temporal aspect of skilling, I argue that in order for a new variety to be adopted within a provisioning seed system, farmers must have the time and space for skilling to occur. The habitus associated with provisioning prioritizes familiarity and reliability over newness. One farmer in Mali explained to me that he tried and then stopped working with improved varieties, ‘not because the varieties aren’t good, but because he’s used to their local varieties. So he left [improved varieties] and he will continue with the locals.’ Others make a similar point about finding improved variety seeds as opposed to seeds of landraces within the provisioning seed system: ‘improved varieties are difficult to have. The local varieties, since they’re our varieties, we get them amongst ourselves.’

**Economic habitus in provisioning seed systems**

Economic habitus might seem to have no role in a provisioning seed system instituted based on social and agricultural history and structures. However, the definition of economic activity I offer in Chapter 3, that economic activity is predicated on exchange between two individuals while provisioning activity includes individual and interpersonal decisions without exchange of material goods, suggests that most human activity to meet material needs involves social interactions. If social habitus that supports interactions among individual and communities to meet material needs is integral to all seed sharing activities, then economic habitus is implicitly
or explicitly present in decisions to gift versus exchange seeds. As described above, the social and agricultural habitus that institutes seed provisioning systems in the Sahel orients toward reliability, experience, and social priorities that contrast directly with individual utility-maximizing economic imperatives experienced in other venues. Economic habitus in provisioning seed systems is therefore expressed through seed gifting rather than seed exchange, and evaluations of if and how to engage in seed provisioning interactions are made based on the social value of seeds, rather than on reasonable or rational economic grounds.

Perhaps the strongest expression of economic habitus in provisioning seed systems is the injunction against selling seeds in the Sahel, which has been well-documented by practitioners of agricultural development in the region (Smale et al., 2008; Siart, 2008; Ndjeunga, 2002). People in all three countries talk about how in the past, ‘seeds were gifts, seeds weren’t sold.’ The shift to formal, monetary exchange is modern, in both the temporal sense and in rationale. ‘He said that during his childhood, he saw that the elders didn’t sell seeds. They asked. But today, what he has seen, if you don’t pay for seeds, you can’t have them.’ In response to modern pressures to move away from seed provisioning, some farmers report an ongoing insistence for seed gifting, an expression of economic habitus that puts seeds outside of individual utility-maximizing economic logic, thereby instituting a provisioning seed system. ‘There are people who refuse to exchange. They give as gifts. You don’t have seeds this year, but maybe then it will be him in need, so he will go to you. So it’s not really something to exchange or sell.’ These descriptions suggest that provisioning seed systems are based on an underlying logic that incorporates the social imperatives toward family and communal care into a type of reciprocity that is calculated much like Bourdieu’s (1979) descriptions of honor as an organizing principle in Kabyle social and economic systems.

A disposition to share seeds derives both from recognition of their value in the Sahelian setting, and from the social habitus to share something new (much like Bourdieu’s (1979)
description of gift economies). In non-separable peasant households (de Janvry et al., 1991), seeds are a unique good to share, since assuming that a gift of seeds does not decrease the giver’s seed and grain stock below the amount needed to meet their own needs, there is nothing lost by spreading a useful variety. If there are not standardized grain markets for the output, there is no profit to be made from not sharing a better variety and having a higher yield and more surplus than other farmers as a result. Instead, as one farmer explained, paying forward seed gifts spreads community well-being: ‘she said that she often gives to people and others ask, does she do exchanges with local pearl millet. She says no, she will give a part to them, so that they person can go and replant. And in the case that they get a good harvest, they can give.’ The lines between seed gifting to institute a provisioning seed economy and non-formal seed exchange within a substantive seed economy will be discussed further in following sections. For now, it is important to note that many farmers draw a clear distinction between the social expectation of self and community seed provisioning, and the shift to exchange (see also Coulibaly et al, 2008): ‘She said that in the past, in the village, people shared seeds. If you needed seeds, you just asked and they gave to you. But now, it’s by exchange. Measures. You bring a certain quantity, you bring it and exchange for the variety you need. In measures.’

Seed gifting is also determined by a simple availability calculation of how much a household can spare: ‘when you ask people, if they are having difficulties, they can’t give.’ The relationship between the natural environment and the stresses it places on harvests, and seed saving and gifting, suggests that increasingly variable rainfall could lead to less sharing and weakening of provisioning seed systems in the Sahel. After the harvest, ‘you have to calculate first, and sometimes, with the quantity of seeds that she had then, she couldn’t give, because there weren’t enough.’ In addition to the economic habitus that prioritizes conservation of resources, seed sharing is also described as a way to spread well-being through the introduction of useful varieties. For some, it’s as simple as ‘the process of agriculture. If you have people who like the
variety, you give to them.’ Others see sharing as a process of diffusion: ‘she has seeds. If someone asks, she will give to them. So she herself, she wishes that the variety would be diffused.’

Even if the economic habitus expressed in provisioning seed systems places seeds outside the realm of economic activity, decisions about seed provisioning are evaluated based on considerations that are reasonable in the particular social and natural context. In terms of seed saving, many people report buying improved variety seeds in order to save and reproduce them for at least two or three years, a modified approach to provisioning that, as discussed in Chapter 6, reflects farmers skilling with the characteristics of improved varieties. Skilling is also important for sharing new seeds. A few farmers expressed a hesitation with sharing something new, since ‘if you give to people, and they have problems, that will be your responsibility.’ Conversely, many farmers describe the responsibility incumbent upon the receiver of seeds in a provisioning seed system. One man in Niger explained how he makes seed sharing decisions based on ‘the comportment of the person who asks for seeds. If it’s really someone who’s serious and really wants to plant, he will give. If it’s someone who just wants seeds to ignore them, he won’t give.’ The social status of seeds means that calculations about sharing reflect expectations that they will be used in socially appropriate and meaningful ways.

Value in provisioning seed systems

In the expressions of agricultural and economic habitus in provisioning seed systems, there is an implicit distinction between sharing seeds and sharing food. Seed sharing seems to carry an expectation that the seeds will be used as seeds, and not as grain/food, and there is a concern that if seed gifts are made too early in the season, before the rain, ‘if it’s a time of hardship, if someone asks to give them the variety, if you give, they might consume it. It won’t
make it to the rainy season.’ The social understanding of seeds as being distinct from grain, at least when gifts are being made, offers one example of how the value of seeds is clearly demarcated even in provisioning seed systems. From where does that value derive, however, if not from an implicit economic relationship to other goods and, eventually, to cash money?

Building on the analysis above, I argue that expressions of social, agricultural and economic habitus related to seeds identify the value of the production or output. Disposition toward social goals like sufficiency and stability then institutes and is in turn reinforced through seed provisioning activities predicated on the social value of seeds.

The social and economic habitus expressed in descriptions of provisioning seed systems highlight the social value that seeds have in Sahelian West African society. From descriptions of using seeds as wedding gifts to their foundational role in ensuring household and village-level food security, seeds are integral to expressions of social well-being and care. As many farmers explained, ‘our life is to have something to eat, something for the family. The goal for many is to become self-sufficient. He no longer buys grain in the market. So what he grows, that allows him to feed himself.’ With this orientation, seeds are valued for their ability to reproduce, increase and spread without exclusion. This value exists in the output of both landraces and improved varieties, but many farmers express appreciation for the value inherent in improved varieties over landraces. ‘Now there are always more people to feed. Without the improved varieties, you wouldn’t find anyone in the village, they would have all left. Thankfully, with improved varieties…you can really find something. Have a good yield, stock it, and have reserves to make it to the next season.’ The value expressed in provisioning seed systems is akin to the Marxian use-value as described in Chapter 3 and identified below as integral to certain substantive seed economies. The differences between the social value expressed in provisioning seed systems and economic use-value rest in the habitus that defines the social value of seed, and
in the types of social, rather than economic, institutions that facilitate and are incorporated into provisioning seed systems.

**Institutions in provisioning seed systems**

The family and communal care ethic constitutive of the social habitus associated with provisioning seed systems creates the social infrastructure that has been historically necessary for agricultural communities to persist and grow. The foundational goal of that social infrastructure was first subsistence with local seeds and now, increasingly, provisioning of both local and improved seeds as an alternative to exchange-based seed systems (van der Ploeg, 2010). The agricultural habitus expressed through seed saving activities also reflects historical experiences with subsistence organization of seed systems. Contemporary provisioning seed systems are instituted more akin to Polanyi’s (1977) notion of householding, which he argues can only occur at a fairly advanced form of social, agricultural and economic organization. Taken as an identifier of scale, householding suggests that provisioning activities can be instituted by individuals and households that prioritize their own well-being over that of other social scales. The original meaning of householding, however, as described by Polanyi (1977), relates to caring for one’s own, without clear demarcation of scale. The social habitus expressed in Sahelian West Africa in general reflects an orientation toward householding, which institutes a provisioning seed system that includes both seed saving and seed gifting.

In addition to the social infrastructure constitutive of provisioning seed systems, farmers describe how other types of social infrastructure relate to contemporary provisioning seed systems. PPB projects operate in a space somewhere in between provisioning and economic seed systems, and one of the motivations for the seed systems project analyzed in this dissertation was the recognition that field trials supported the incorporating of improved variety and creolized
seeds into provisioning seed systems: ‘[The farmer organization] brings seeds, the new varieties, she saves seeds and plant them in the field.’ As researchers became aware of the large demand to participate in field trials in order to access improved variety seeds, they developed the mini-packets strategy to diffuse those seeds through market-oriented social infrastructure. This approach, however, has shifted seed diffusion into various types of substantive seed economies. When asked about the types of support they would like in order to incorporate improved varieties into provisioning seed systems, some farmers have suggested that they want researchers to ‘help them to be able to save seeds, so that they don’t deteriorate. Because if you have to…next year go search for them again, that’s a little complicated.’ Provisioning-oriented social infrastructure is needed at the household and village level to compliment the scale of the seed system.

**Visualizing provisioning seed systems**

Provisioning seed systems that incorporate improved variety seeds are emerging in Sahelian West Africa at the same time as market-oriented seed system projects are being emphasized. Figures 7-2, 7-3 and 7-4, described in detail below, depict the two different scales of seed provisioning, seed saving and seed sharing, as identified in farmers’ descriptions of householding via provisioning. Figure 7-2 is a map created by me with data from the full sample described in Table 5-2, and depicts every village in my sample in the Dioila area, and those in which at least one household saved improved variety seeds during at least one year of data collection. Figure 7-3 is a map drawn during a group meeting in Masso, Burkina Faso, and shows how householding can occur on a village level. Finally, Figure 7-4 is a map drawn during a village meeting in Elkolta, Niger, on which is listed landraces and their movements among villages, as well as access points for improved varieties.
During individual interviews and group meetings about the organization of seed systems for landraces, virtually everyone explained that seed saving is the primary way that farmers access seeds from year to year. Saving of landrace seeds occurs at an individual and household level. It is less clear how saving of improved varieties will be incorporated into individual and household provisioning systems as farmers continue the skilling process with the new seeds. Based on descriptions of local seed systems, however, I think it is appropriate to explore the extent to which those households in which at least one member is gaining experience with improved variety seeds are continuing to save what become creolized seeds. Figure 7-2 depicts every village in my sample (in which I conducted at least one interview), and every village within my sample in which a farmer reported that someone in their household had saved improved variety seeds of sorghum or pearl millet during each year from 2010 to 2012. A steady rate of seed saving was found in analysis presented in Chapter 6, and here we see the distribution of seed
saving across villages. The spatial reach of seed saving activities is important given the analysis presented here that provisioning seed systems are instituted in part by seed saving, and in part by seed sharing, often of those saved seeds. When combined with the maps in Figures 7-3 and 7-4, we can visualize the relative decentralization of provisioning seed systems.

Figure 7-3. Village map of intra-village seed provisioning in Masso, Burkina Faso, 2010

The map presented in Figure 7-3 was drawn by the animateur in Masso, Burkina Faso, as part of the group meetings I held in several villages each of the two years that I conducted field work. I asked questions about the scale and spatial organization of seed systems in the area – did people access seeds as individuals, as households, as a village? The story that the group told as the animateur drew the map is that the store in the bottom left-hand corner has seeds at the beginning of the growing season. They described it as either a seed bank, where individuals could leave their seeds during the dry season and recuperate them (via donkey cart, as shown here) before the rainy season, or at a shop run by someone local. If one person went to get seeds, he would bring them back to the village and call other people together (the group seen in the upper center of the map) to tell them about the seeds and give them some. If his wife asked for some seeds, he’d give her a little bit to try in her field (at the top of the page). Then the farmer would plant them in his field, at the right. At the end of the season, he’d bring some seeds back
to the village and take them back to the store for next year. If he had some that met the
requirements, he’d also take some to the farmer union (in the bottom left).

This map and description of a contemporary provisioning seed system depicts how
improved variety seeds that are accessed through a seed economy can then enter and circulate
within a village-level provisioning seed system. The initial infusion of seeds comes from outside
of the seed system, but the seed is then circulated within a village for at least one year, and, if
there is a seed bank, for multiple years. This system is described as well in Chapter 6 as a way
for farmers to incorporate creolized seeds into their seed systems, by saving and reusing seeds for
a few years before refreshing them. A provisioning seed system like the one depicted here
operates at the village level and is supported by village-level social infrastructure like seed banks
and kinship ties. When it incorporates improved varieties, the provisioning seed system then
connects with social infrastructure instituted by seed economies but is not integral to the existence
of those seed economies or the institutions that are a part of them.

Figure 7-4. Village map of inter-village seed provisioning in Elkolta, Niger, 2010

The map presented in Figure 7-4 was drawn by a women’s group in Elkolta, Niger, and
depicts the diffuse inter-village provisioning seed system that exists for landraces, in contrast to
the centralized seed economy for improved varieties. The village, Elkolta, is in the center of the map. At roughly the four cardinal direction points are the names of all of the villages that come to Elkolta to buy mini-packets of improved variety seeds. In the upper right and lower left quadrants of the map are the names of the landraces of pearl millet that come from each direction. As the women discussed which type of seeds came from where, they talked in directional terms rather than about specific villages, and mentioned that those in the lower left come from areas that are closer to seasonal water. The type of seed and their traits are associated with the landscape more than specific villages. When I asked the women how they access those seeds, they said that they will pass the fields and take a bit, or will ask someone who comes to Elkolta for the weekly market to bring them a bit to try. The centralization of the market-based seed economy facilitates can also facilitate provisioning seed systems that are instituted on a broader (in terms of the area of potential interactions) spatial plane than the seed economy of the area.

**Substantive seed economies**

The distinction between provisioning seed systems and substantive seed economies is clear when comparing the former with a market-based seed system in which certification, input markets, prices and output markets are standardized and institutionalized. In Sahelian West Africa, as in many other parts of the developing world, however, this contrast is largely irrelevant, and one wonders about the usefulness of differentiating among seed systems that seem interconnected and comparable in many ways. What, for example, is the difference between seed sharing via gifting and exchanges of seed for grain or seed for labor? In context, do these actions over time create patterns that lead to distinct seed systems, or do they add up to a complex, not easily definable set of economic and non-economic social institutions? In this section, I analyze the social, agricultural and economic habitus that are expressed in substantive seed economies,
and identify distinct value of the agricultural production that are validated different types of substantive seed economies. Over time, separate substantive seed economies are beginning to be instituted by ongoing seed access decisions based on these distinct values.

The primary difference between provisioning seed systems and any type of substantive seed economy is that interactions among individuals in seed economies in order to meet material needs are always exchanges of some kind. Many farmers, as discussed above, highlight the shift from seeds having social value, in that they were shared without the expectation of exchange or return, to seeds being something for which one must exchange time, grain or money. From this distinction I return again to the definitions of economics and value that I offer in Chapter 3, and argue that economic activity is characterized by interactions among individuals based on exchange in order to meet material needs. Reasonable decisions about the type of variety and the type of access activity involved in seed access decisions depends on the value of the agricultural production that comes from the seeds. Use-value, exchange-value and commodity-value, as defined in classical Marxian terms, are conditioned by the social and natural context, as well as by the existence of economic institutions that recognize different types of economic value. How the relative values of the two goods being exchanged are established and incorporated into exchange activities depends on the combination of habitus that institutes the specific seed economy.

Social habitus in substantive seed economies

The expression of family care and obligation to provide that is expressed in provisioning seed systems also leads many farmers to make economic seed access decisions. In rural areas, for many farmers, especially men, there is a disposition ‘to feed the family, since I’m the head of the family.’ Seed provisioning via saving is one way to do this each year, but seed saving is more
challenging when there are immediate food needs, and people see both seed gifting and economic seed exchanges as other ways to access seeds then they prioritize grain-as-food over grain-as-seed. A similar calculation is at play when making decisions about seed type as it relates to food tastes and preferences. Some improved varieties are less suited to certain local dishes than are landraces, and decisions about which variety to use demonstrate a conflict between different elements of the social habitus. As one man described, ‘[local varieties] are a little better to eat, but since [improved varieties] give a lot, when you get a lot, you’re going to make a lot also…you will have a lot of good things, even if what you have to eat is a little less good.’ In addition to the most basic social disposition of providing for one’s family, other elements of social habitus push farmers to engage with seed economies in order to access seeds, the output of which can then be used for other social ends (through the modicum of economic activity). In particular, a few people I interviewed made the connection between the social imperative to take a second or third wife, which is common across Muslim West Africa, and the decision to spend money on improved variety seeds in order to have surplus to sell. One woman explained that by using improved varieties that have a good yield, ‘with the profit, she will exchange for money, and with that money…she will try to help her husband to find a second spouse.’

Another element of the social habitus that support the institution of substantive seed economies includes disposition toward community well-being via social and experiential skilling. Many farmers who have had first-hand experience with improved varieties because of their engagement with PPB projects or their proximity to seed sales describe that they have gone ‘to neighboring villages, because they are friends, and told them about these varieties.’ When asked how to better support the diffusion of improved varieties, farmers with experience emphasized the temporal aspect of social learning: ‘when people have them, other will start to see them’ and use them. Spaces of economic exchange can then provide reliable institutional settings within which farmers can shift from social learning to seed access decisions that allow for experiential skilling.
As was described in Chapter 6 as well, there is a clear social habitus toward first-hand experiential learning in the Sahel, and many farmers highlight their desire for comparisons and observations in order to make seed decisions. As one man explained, ‘he bought [an improved variety] to test, in his field. If it gives well, he will take it as his variety. He will use it on a large scale.’

There are several implications of this expression of the desire for a skilling process. First of all, the practicality of the agricultural habitus described in provisioning seed systems could lead to the replacement of landraces by improved varieties if the latter perform well, threatening agrobiodiversity. However, even those operating within a substantive seed economy oriented toward choosing the ‘best’ variety often express that ‘they haven’t totally left the local varieties. Because they do two fields, one field of local varieties and another of the new varieties.’ Seeds retain their social heritage meaning and landraces are maintained accordingly. A second implication of the habitus toward skilling with the goal of scaling up, as expressed above, relates to the scale at which economic and provisioning activities are pursued. Given the social habitus toward seed saving, even if farmers prioritize the skilling process and so purchase small amounts of seed, it does not necessarily follow that the decision to adopt the variety and plant a larger area will lead to purchases of larger quantities of seeds. Seed economies might provide the ‘seed’ seed with which farmers incorporate improved varieties into provisioning seed systems. Finally, the habitus that evolves with the skilling process with improved varieties is at times expressed in a disposition toward standardization: ‘what he’s thinking about, awareness, of others who are more conservative, who want to save local seeds, to share with them the same ideas so that they will plant at the same time, each in their own field, to see the importance of these improved seeds.’ This habitus combines social experiences of the need for coordination on a larger scale than the household, and an agricultural habitus that is shifting to incorporate the physiological traits of cross-pollination in improved varieties.
Agricultural habitus in substantive seed economies

The agricultural habitus expressed in relation to seed economies reflects similar tensions among pressures of the natural environment and social setting to those articulated in provisioning seed systems, and responds to these tensions with a disposition toward explicit calculation of priorities, risks and trade-offs. One of my favorite days of interviewing occurred in Burkina Faso in 2011, when in the course of two consecutive (but separate) interviews two men expressed the decision-making distinctions emerging with more varietal choices. When asked about his priorities in seed decision making, the first man explained that ‘with white people, it’s the stalks, the roots, the leaves, and up to the grain. But here, it’s the grain that they look at.’ During the next interview, asked the same question, another man responded, ‘men and women aren’t the same. If it’s the men, they use the stalks for animals. They look at everything.’ The first quote expresses a growing awareness that intentional choices can be made about not only grain but also about other parts of the sorghum and pearl millet plants. The second suggests that a calculating agricultural habitus is more observed in men than women, which fits with the analysis presented in Chapter 6 that men are more engaged with market-oriented social infrastructure and seed economies than women.

The risks associated with low rainfall lead to the expression of a practical agricultural habitus that prioritizes drought tolerance over social and other agricultural concerns. At times, the shift to improved varieties (and implicitly, the seed economies in which they are available) is described as inevitable: ‘local varieties aren’t resistant to drought, and when there is just a small lack of rain, they don’t give. That’s what will save the improved varieties.’ As skilling with improved varieties continues, however, farmers increasingly voice a preference for choosing the type of seed most likely to succeed. The social disposition toward observing and comparing means that ‘this year also, he will use [new] varieties, and if they give he will leave his local
varieties to get more.’ The propensity toward diversification as a risk buffer remains, however, as does the social habitus that sees seeds as heritage. Thus the agricultural habitus expressed in seed economies leads people to calculate the relative costs and trade-offs associated with each type of variety. As one woman described, ‘she will plant more improved varieties than local. If she plants two fields of improved varieties, she will plant one field of local varieties.’

A calculating agricultural habitus institutes substantive seed economies based on experiences of choice as valuable and important in the current natural environment of the Sahel. ‘You never know about the rainy season. Sometimes the rain starts early comparatively. So if the rainy season starts early, they plant local varieties. Now, in the middle, or if the rainy season doesn’t go well, they grow improved varieties.’ Because improved varieties are currently largely accessible through various types of economic exchanges, appreciation for the choices provided by seed economies further institutes those seed systems. The agricultural habitus that institutes seed economies reflects historical experiences of the need to buffer against risks of all types. This means, for example, that many farmers first plant landraces that have no economic cost, and then ‘people do a small calculation. When at the moment of the rainy season, if it doesn’t rain a lot…people come to buy. When the rain stops, people run to find early varieties.’ The calculations being made by farmers buying seed fit into substantive seed economies but not necessarily into a market-oriented seed system, where seed sellers would themselves want to calculate specific demand ahead of time in order to make decisions about investing in seed production.

A final aspect of the agricultural habitus expressed within economic seed systems relates to calculation and choice as well. Provisioning agricultural habitus, which orients toward adequate supply of seed, can preclude calculation by not clearly providing choice: ‘before with their local varieties, they didn’t have just one variety. All was mixed. You grew even if you didn’t know different varieties, you knew that in field, there were tall sizes, short sizes, red
glumes, white glumes. Even if you selected, cut panicles, planted them again, there would be mixing.’ Calculating agricultural habitus, which prioritizes choice, can be expressed in seed economies where ‘with mini-packets, the labels are done, you can read and choose what you want. All of the information about the varieties is there.’ Agricultural habitus that prioritizes calculation is closely linked with the economic habitus expressed in seed economies, where choice, risk and potentially profit provide the basis for making seed access and use decisions.

**Economic habitus in substantive seed economies**

The economic habitus expressed by farmers in substantive seed economies interacts with the social and agricultural habitus analyzed above, generally by incorporating returns on investment and profitability into institutional structures and seed access decision making. One man in Niger summed it up perfectly: ‘really, they’ve benefitted from the improved variety seeds. They get a good yield, stock, keep, and then sell the rest to invest in other things.’ The return on investment comes in the form of food (and possibly seed) that is the result of increase production with improved varieties. The profit comes if there is some exchange-value or commodity-value, which will be discussed in detail below. For the most part, the economic habitus is in direct conversation with the social habitus. When there ‘is an increase in yield and increase in income, that allows them to meet their family’s needs.’ Economic habitus at times responds to social imperatives toward communal well-being. The non-formal exchanges described in Chapter 6, where ‘they give one measure of improved varieties for two measures of local varieties,’ is an example of economic activity conditioned by social expectations of care rather than economic orientation toward profit maximization. These types of exchanges incorporate as well the agricultural habitus that calculates how seed exchanges will benefit both the individuals and the community. For example, ‘if you see that someone has difficulties, you can exchange, you can
give them what they need…because if they buy some in the market, and you add seeds, there will be mixing.’

The economic disposition expressed in seed economies tends to be more individualistic than in provisioning economies: ‘she said that she can’t give seeds. Because she can’t save part as seeds, and give them. She has to also eat.’ The integration of agricultural habitus into economic disposition and decisions tends to institute a substantive seed economy framed on buying new seeds each year. This precludes non-formal exchanges, since ‘if she grew them to eat, she won’t exchange them.’ The economic habitus expressed here is influenced by the natural environment as it relates to agricultural habitus, which forces more specific prioritization of individual and household over communal well-being. For this reason, seed economies seem in some ways to compliment changing natural conditions in the Sahel. As one man in Mali explained, ‘in the past, with local varieties, when you needed a variety, you asked a farmer and they gave to you. Because all varieties at that time were good. There was lots of rain, people didn’t need things…but now, they don’t give, you buy them. If you need a variety, you buy it.’

As farmers have experienced substantive seed economies, primarily formal sales of certified improved variety seeds, some express a changing economic habitus that orients toward a market-oriented seed economy, and in turn further institutes that seed economy. The distinguishing feature of this economic habitus is that the predilection for seed saving, which reflects social and agricultural habitus toward stability through provisioning, is considerably diminished. Instead, reliability of markets means ‘that she didn’t save a part to replant this year. But as she said, everything is available, so she can buy and plant. In terms of the harvest, it’s for eating.’ Markets also allow for scaling up in a way that is not necessarily possible with other types of seed exchanges or seed provisioning activities: ‘the mini-packets are for trying, but if you already know the seeds, you can buy them in quantity.’ Insofar as improved varieties are synonymous with market purchases, the seeds being access through market exchanges are also
more reliable than seeds accessed through other seed systems. ‘In the past, you would ask, and you wouldn’t get what you wanted. They would give you something, you would plant it, and it wouldn’t start. But now, what you get, it will start.’

As market-based seed systems are instituted through the skilling processes of certain farmers and farmer organizations, the differences between all other economic habitus and that oriented toward a market-based seed economy emerge all along the seed supply chain. For seed producers, market-oriented social infrastructure like unions is the main outlet for selling certified seeds. ‘Other farmers aren’t used to it…they will buy them like local seeds. There isn’t profit there.’ For those farmers who produce improved varieties as grain with the goal of selling their surplus, ‘if you go to sell the harvest in the market…since people are not familiar with the variety, it’s hard to sell it here.’ A market-based seed system and the economic habitus that institutes it emphasize the monetary value associated with certain types of seeds and production practices (like seed certification) over others. When most farmers-as-consumers are making evaluations based on social priorities and influences, the price they are willing to pay is often lower than what would be set by the market-based system. The mini-packet strategy that provides the foundation for this dissertation project is an attempt to incorporate the social and agricultural habitus that include a disposition to seed saving, and an economic habitus not necessarily oriented toward profit-maximization in exchanges. Many farmers note that the low cost of a mini-packet is place-appropriate in a way that price-setting markets might not be. ‘For example, the businessman, he wouldn’t sell that for 50 CFA [10 cents]. He would see that the quality is really good, and he wouldn’t sell it for 50 CFA.’ Keeping the price affordable will support seed diffusion say many farmers, and ‘that will create the commercialization of seeds.’

Implicit in farmers’ descriptions of the skilling process that slowly shifts economic habitus away from provisioning and stability-oriented decisions, and toward a calculation of economic value in seed access decisions, is the recognition ‘that today, agriculture takes money.'
If you don’t have the means, you won’t succeed. Everything is expensive. And then, natural disasters, they also come here.’ Agricultural habitus and the influence of the natural environment continue to condition the desire for increased production, but the value of the yield is less clearly associated with social goals of stability and sufficiency. Instead, calculations of costs and payoffs invoke a less-defined ‘value.’ As one man explained, ‘it’s not just in terms of the price that you have to look. It’s the value that can give you something, and that’s what’s important. So it wasn’t expensive.’ The value comes from the exponential increase in output associated with improved variety seeds – ‘with one planted grain, you can have one kilogram of grain or more. So it’s not expensive.’ For the most part, the economic habitus associated with market-based seed systems seems to evaluate value on the basis of return to investment: ‘what you get is much more than what you invest in these seeds.’ The specific nature of returns to investment, however, depends on the value of the output as defined by the social, agricultural and economic habitus guiding seed access decisions.

**Value in substantive seed economies**

The theoretical framing put forth in Chapter 3 argues that the value of goods in a particular system is determined by social and economic habitus, which are conditioned by and in turn condition the social and economic systems through which value is codified and perpetuated. Value relates as well to the natural environment within which people are working to meet their material needs, and agrarian societies provide a particularly important setting within which to understand the ways in which social and economic habitus interact with the natural environment to identify and institutionalize the value of agricultural production. As discussed above, when social habitus (which reflects societal interactions with the natural environment) institutes a system for accessing seeds, a provisioning seed system often results, based upon social values of
communal well-being, stability and sufficiency. In contemporary seed systems in many rural areas, some interaction with external economic and social forces has influenced economic and social habitus, shifting decision making about seed access toward the inclusion of different types of economic value of agricultural output. The substantive seed economies that emerge from different combinations of social, agricultural and economic habitus can be based on the use-value, exchange-value or commodity-value of agricultural production. In the following sections, I describe and analyze farmers’ expression of value associated with agricultural production, and connect expressions of value to different aspects of social, agricultural and economic habitus in order to characterize the types of seeds and exchanges incorporated into different substantive seed economies currently emerging in the Sahel.

**Use-value of agricultural production**

Many farmers I interviewed, when asked about their motivations for making certain seed access decisions, expressed making calculations based upon the use-value of the agricultural production that would come from the seeds being used. Use-value is identified by social and agricultural habitus that orients toward meeting food needs, households uses for other parts of the sorghum and pearl millet plants besides grain, and the ways that the grain fits into food tastes and preferences. Use-value is also identified by agricultural and economic habitus that emphasizes reliability in production practices and seed quality, in order to buffer against the unpredictable natural environment and ensure yield levels. Recognizing the use-value in different types of seeds leads farmers to make decisions about engaging in seed exchanges for improved varieties that institute a specific substantive seed economy.

As expressed by farmers operating in both provisioning and economic seed systems, meeting food needs is the primary goal of agricultural production for most people, and because of
their drought tolerance, improved varieties have for this reason a high use-value: ‘he said that it’s a big change, in terms of the yield, it’s really increased their supplies. And it allows them to have cereal on time. To meet their food needs.’ When farmers discuss sharing information about improved varieties with others, it is usually on the basis of the use-value, that these varieties give ‘a good harvest so that they can meet their needs.’ There is also use-value in other parts of the sorghum and pearl millet plants. For example, the stalks are used for different things – ‘for roofs, for shade, for animals.’ The leaves as well are used for animal forage, and many people express appreciation for improved varieties having ‘green leaves, at the moment of harvest.’ One man in Niger described how recognition of the use-value of stalks from improved varieties has led to incorporating that value into simple circulation: ‘after the harvest, the pearl millet stalks, they produce a lot of forage. And people are starting to exchange the stalks, [bundles] of stalks, because the animals like them better.’

In addition to the use-value associated with producing adequate quantities of food, tastes and preferences related to local dishes generate use-value associated with social habitus. Taste, color, size, and ease of preparation are all mentioned by farmers as characteristic the generate use-value, as well as exchange-value (as discussed below). Use-values associated with food are particularly important to and identified by women, who have almost complete responsibility for food preparation. Some women appreciate improved varieties for their versatility in terms of preparation – ‘with improved varieties, all dishes are good. Bouillie [porridge], couscous [finely ground grain], tô [steamed dumplings].’ Versatility in preparation is valued by social and economic habitus, since certain dishes require accompaniments that must be purchased. If improved varieties can be used to make a range of dishes, ‘you can use the grain to make other things that aren’t tô. Because if you do tô, you have to have something for sauce.’ Another use-value as defined by social habitus is the ability to save both grain and prepared food, and many report more use-value in landraces than improved varieties. With some improved varieties,
Men tend to emphasize taste more generally rather than preparation in particular, which makes sense given their role as eaters rather than chefs. Some men report conflicting social and economic habitus in terms of taste: ‘with [improved varieties], they give a very good yield, in comparison to our varieties. But if it’s eaten, as tô, for us [local varieties] are better.’

Expressions of use-value require experiential or social skilling in order for properties of improved varieties to be incorporated into social and agricultural habitus. The same is true for economic habitus oriented toward calculation of costs and risks. Once farmers experience improved varieties’ traits, many quickly ascribe use-value to the short cycle, given the agricultural habitus conditioned by history of low and increasingly irregular rainfall. One man in Mali sums up the use-value of seeds with short cycles: ‘he said that in the past, they had varieties that had very long cycles. If you plant those varieties, you will risk not harvesting. So with the new varieties, you will have the chance to harvest something, regardless of the rainfall.’ The use-value also derives from the social habitus that recognizes the central role of ensuring food security in agricultural decisions. ‘Pearl millet that has a short cycle, and really good yield, allows them to deal with the hungry season, well before the local pearl millet is mature. With that, we can eat.’ The use-value of improved varieties relates to landraces, but the two are not mutually exclusive, and both types of seeds are largely identified as having use-value by social and agricultural habitus that emphasizes stability and sufficiency.

The types of exchanges that farmers use to access these seeds, when use-value is the primary motivation for the exchange, reflects at times the economic habitus associated with landrace seeds and seed saving, and in other cases shifts toward a calculating economic habitus that seeks to make exchange decisions that incorporate the ‘cost’ of use-value within the economic system. Some farmers describe how once they have experience with improved varieties, they will buy seeds in formal exchanges in order ‘to have seeds, and after the harvest,
he saved seeds, and this year he planted them.’ Here, use-value as defined by social and agricultural habitus motives and an economic habitus that makes a one-time investment in order to incorporate valuable varieties into a provisioning seed system. Others, recognizing the use-value in adequate food production, calculate the relative cost of purchasing seeds every year and having enough to eat throughout the year: ‘he said that he ate them. He said that each year he will eat them.’

When the production that comes from certain types of seeds has use-value, and those seeds must be accessed through some type of exchange, a calculating economic habitus must incorporate the cost of seed purchases into an overall evaluation of investment. One way this calculation is expressed is in terms of quality: ‘it’s not the price of the seeds but the quality. When you buy these seeds, really, you get something from them.’ Understanding exchange decisions based upon use-value as an expression of shifting economic habitus further develops the notion, described in Chapter 6, of price versus value as an explanation for accessing seeds through formal exchanges. In addition, the non-formal exchanges based upon use-value reflect an economic habitus conditioned by social habitus oriented toward sharing and communal well-being. As one man in Mali explained, ‘in the past, when you needed seeds, if you asked, you were given. But now there’s a change. We don’t give seeds as gifts now. There are exchanges. If you have five kilos, you bring five kilos.’ Non-formal exchanges based on use-value incorporate economic valuation by shifting from gifting to exchanging seeds, as fits the social habitus oriented toward ensuring access to useful inputs for those with family or village ties. Calculating economic habitus guides exchanges on the basis of parity, again reflecting social habitus that emphasizes sufficiency.
**Exchange-value of agricultural production**

The use-value of agricultural production relates to food needs and tastes, non-food uses of plants, and seed needs. When improved varieties are valued for those reasons, seed access for use-value often leads farmers to engage in formal exchanges. Exchange-value, as described by Marx, derives from or incorporates use-value, by recognizing the social and agricultural habitus that gives agricultural production economic value in a given setting. In Sahelian seed economies, exchange-value is primarily conditioned by social and agricultural habitus, and seed access decisions are then made based on a calculating economic habitus. However, calculating economic habitus that incorporates exchange-value into seed access decisions institutes a shift from social habitus conditioning economic habitus (as described above) to economic calculations that seek some increase in returns-on-investment, within the limits of the social and agricultural setting. Decisions about the type of exchange over time institute a particular substantive seed economy that reflects the intermediate step described by Marx from pre-capitalist economic (and provisioning) systems toward a formal, rational market economy.

The exchange-value of agricultural production as expressed by farmers I interviewed largely builds on use-value associated with food needs and tastes, non-food uses of the plants and seed needs. In order for a certain type of output to acquire exchange-value, however, experiential or social skilling must have occurred for enough individuals that the value is somewhat standardized within a localized exchange system. The importance of skilling for establishing exchange-value is clearly expressed by farmers I interviewed in Burkina Faso, where sorghum is used for locally brewed beer, called dolo. People report different experiences with improved varieties and dolo. For certain improved varieties, ‘when you want to resell them, people will buy Gnossiconi very quickly. The buyers, in the market, when you have it, people like it. Especially the women who prepare dolo.’ With other varieties, people say ‘the yield is good, but
the women who want to use it for dolo, they often say the dolo isn’t good. So that’s why she didn’t grow it this year.’ The skilling process with improved varieties can create or undercut exchange-value. Similarly, social and agricultural habitus endow landraces with exchange-value through history and experience with these varieties, often in direct relation to improved varieties: ‘people only use local pearl millet, so in the market, selling local pearl millet is easier.’

If skilling is necessary for the output of certain types of seeds to have recognized exchange-value in local markets, a kind of standardization of expectations, there is also a skilling process necessary in order for producers looking to sell different varieties and products to understand exchange-value as set from the outside. As agricultural economies expand beyond the local level and buyers come from cities to rural areas to buy in bulk, farmers report a shift from sales based on volume to sales based on weight. This shift in systems external to the local markets endows certain varieties with higher exchange-values: ‘selling [improved varieties], you get more money than local varieties, because the grains are heavy.’ In addition, some farmers have expressed surprise at the other types of agricultural outputs that could have exchange-value. One woman in Mali described to me how ‘she wants to be a seed producer, because she has seen – she didn’t know that seeds could bring something. She only sold sorghum as cereal. But as seeds, she saw them [for sale] with [the animateur].’ Exchange-value can result from a skilling process that incorporates use-value into a price that includes extra return on investment.

Exchange-value can also derive, as described by the woman above, from commodity-value set by institutions and actors outside of the local or regional seed economy. This type of exchange-value is captured in Hart’s (2006) description of informal markets and informal exchanges, which incorporate the commodity-value of formal markets into an exchange-value conditioned by the social and natural context.

As mentioned above, the incorporation of exchange-value into a substantive seed economy creates institutional arrangements that reflect social, agricultural and economic habitus.
However, the motivation for seed access decisions based on exchange-value of the output is expressed by economic habitus that makes calculations on the basis of some gain or increase in return on investment. This gain-calculating economic habitus relates in part to the social habitus that prioritizes household care and well-being: ‘he would like a good yield, after food, so that if there are accidents, they can sell. Sell for sickness, small needs for the family.’ There are two important shifts occurring and expressed in this economic habitus. First, there is a shift from provisioning seed systems to substantive seed economies in the primacy given by economic and social habitus to household and individual needs over kinship, village or communal well-being. Second, contemporary Sahelian societies have much interaction with market-based systems at the local and extra-local level for many goods. As skilling with market-based exchange systems increases, those individuals who have an overall positive experience with the reliability and quality that can come from formal market-based exchanges experience a shift in social habitus that orients toward stability in economic exchange rather than stability in provisioning activity. In other words, social habitus cedes to economic habitus the ability to make calculations about social concerns. It is this shift that is much championed by certain trends in international agricultural development, which emphasizes the economic dynamism of smallholder entrepreneur farmers and works to build full market-based systems in which those farmers can maximize their economic potential.

**Commodity-value of agricultural production**

In the process described by Marx, Polanyi and many others, formal market economies are instituted by economic and social habitus that identify profit and utility-maximization as the guiding principles for exchange activity. In order for economic habitus to make calculations about the most profitable exchanges, goods must have a standardized price that reflects value
determined in the market place. Commodity-value might or might not reflect use-value; recall Harvey’s (2006a) description of contemporary futures and derivatives markets as examples of how commodity-value can derive from abstract concepts related to the movement of capital rather than from material reality. When commodity-value is posited in economic systems moving toward increasingly more formal exchanges, it tends to build on exchange-value and therefore require both a skilling process in order to be validated and a more explicit orientation toward institution building than is necessary in other types of economic systems. As farmers I interviewed describe, commodity-value of sorghum and pearl millet grain and seed has not widely been experience or accepted in Sahelian West Africa; in short, those goods do not necessarily have commodity-value for many local farmers. However, many seed system development projects link formal market sales of certified seeds to commodity-value of the output (by assuming that farmers will invest in seeds and be able to realize profit enough to continue to reinvest). The discrepancies in value associated with the outputs of improved variety seeds lead to uneven processes of institution building and skilling for farmers in the region.

The main goal of market-based seed system development is to generate commodity-value for improved variety seeds, in part because of the extra investment necessary to produce and certify the seeds according to standards set by national and international laws and regulations. Certification insures standardization and reliability, adding value for which farmers should be willing to pay, since the certified seeds in most cases produce higher yields and surplus that can be sold for a profit. If there are not strong output markets that immediately recognize the commodity-value of the grain produced, farmers make calculations based upon exchange-value in their specific context. Many report that ‘commercializing [improved varieties] isn’t easy. People prefer a local variety…the preparation of these varieties, in the mini-packets, the women say it’s not good. And since for him it’s for commercialization, he sold it with difficulty somewhere else. That’s why he’s not going to plant it anymore.’ If there is not exchange-value for improved
varieties based on local context, it is possible that there are commodity markets, where
acontextual standards set the value. In Mali, for example, some farmers report buyers coming
from the city and paying based on weight. Improved varieties therefore have commodity-value,
because ‘the grains are heavy. If you want to sell, with these grains you will have a lot of
money.’ Similarly, some seed producers describe their shift toward production and consumption
decisions based on the commodity-value of seeds: ‘those who are used to producing seeds, when
you produce you send them all [to the union]…we say that next year the seeds will come. So we
eat it all, and we send the rest.’

Making exchange calculations based on commodity-value requires an economic habitus
oriented toward utility-maximization, and also experience with institutional arrangements that
reinforce commodity-value. In the context of many developing countries, where provisioning and
economic institutions are not based on commodity-value, the institutions are not necessarily
generated organically but instead originate outside of the economic and social systems. Many
farmers who have some experience with seed production describe their appreciation for
organizations and institutions that guarantee seed purchases. ‘The sale is well done…at the shop,
they weigh, they take your name, and put them in a sack. Then you can come and get your
money.’ Initial skilling with formal seed markets could shift local economic habitus toward a
market orientation that seeks to build commodity-value. One farmer in Niger mentioned that
‘there was a program that encourages them to have a stock of seeds, to put them in packets and
sell as seeds.’ Training from NGOs and government organizations associated with market-
oriented seed development projects works toward instilling and supporting a utility-oriented
economic habitus. Many farmers, however, note that if not for institutional partnerships that
insure a market for their production of improved varieties, ‘people find that they are not as good
as other [varieties]. So you can’t sell them.’ Instead, seed sales require ‘a partnership elsewhere,’
as one man in Niger put it.
The institutions that are built upon different types of economic value will be discussed in detail below. For now, it is important to note that the commodity-value of seeds being identified in Sahelian West Africa is largely the result of outside institutional arrangements, rather than a shift in peasant economic habitus. Seed producers who choose to produce seeds and sell them in commodity-like markets do so ‘because there is already lots of demand with the union.’ The unions and farmer organizations are in turn supported by international development programs hoping to build local capacity to sustain and expand formal seed markets, among other types of market-oriented institutions. Seed producers identify the incompleteness of the formal seed system and seed value chains at this point. Some point to the fact that when local farmers are also seed producers and sellers, there is confusion between the social and economic habitus that institutes other types and spaces of seed systems, and the commodity-value orientation of formal seed sales. People think that ‘since I produce seeds, and then I resell them, they think that they are my own seeds that I’m selling. And they want to have them as a gift. So, if sales were in a shop, they would know that they aren’t gifts.’ Other seed producers point out that in years where the union or organization does not buy all of their production, ‘you can’t even get the average price [that you paid to produce], you have to sell not like certified seeds.’ Rather than buffering against risk by creating standardized prices and market demands, making seed production decisions based on commodity-value remains a risky proposition in part because of the lack of institutional framework necessary to fully build a market-oriented seed system. This institutions lack in turn reflects the predominant social and economic habitus of Sahelian West Africa, which does not see seeds as a commodifiable good.
Institutions in substantive seed economies

The institutions that are created and in turn maintain and expand substantive seed economies are varied in terms of their social and spatial orientation, but all share a common organizing principle of facilitating exchange. As described in Chapter 3 and analyzed above, substantive economies are defined by the exchange activities that institute them, and those exchange activities are in turn guided by a range of social and economic habitus that defines and then acts upon the value of the good being exchanged. In Sahelian West Africa, the institutions associated with substantive seed economies include family and kinship networks, PPB projects, farmer organizations, and local marketplaces as a site for formal seed sales. These institutions facilitate economic activity based on all three types of values, and in this section, I characterize the institutions and the value of agricultural production, particularly seed production, that are reinforced and enacted through them. When the institutional mechanism is generated from within the community or local area, the value orientation of the economic institutions tends to reflect the value orientation of those farmers engaged with it. However, when institutions, like those associated with market-oriented seed system development, are created from outside the setting within which they function, the value placed on seeds does not always align with the value upon which farmers make seed access decisions. This mismatch calls into question the durability of these economic institutions in the absence of outside support.

As skilling occurs for individual farmers with improved variety seeds, the economic cost of purchasing them has been incorporated into the social habitus that prioritizes seed sharing and communal well-being through diffusion. There are at times points of overlap between seed economies and provisioning seed systems – ‘in my area I am the first to buy improved varieties. So my neighbors asked me if I can give them a little to try.’ As described in Chapter 6 in terms of non-formal exchanges, and above in the way that use-value and exchange-value can institute
substantive seed economies, much of the seed diffusion in seed economies occurs through exchanges with family and neighbors. Currently in Sahelian West Africa, improved varieties originate almost entirely from extra-local institutions like seed producers unions and development projects. These seed sources, often part of a parallel seed economy, also support the creation of seed economies based on exchange through social connections. As one woman in Mali explained, ‘[the union] has to stock seeds so that more people can use them. They will plant, and then someone else can ask to try them, and seeds will be diffused. Mostly by exchange.’ Seed exchanges can be based on use-value or exchange-value, depending on the social and economic habitus of the individuals, and in turn have the potential to create non-formal seed economies that do not rely on cash.

Part of the current context of seed systems in the research sites for this project is the presence of PPB activities, which include field trials and demonstration plots. As described in sections above, individual participation in PPB activities can support provisioning seed systems by providing a seed source from which farmers can save and share seeds. For others, PPB experience allows a farmer to ‘choose the variety that you prefer,’ and then potentially to engage with the seed economy to access that type of seed. One man stated that ‘since I started doing the tests, I no longer plant local varieties.’ If improved varieties are prioritized because of a first-hand skilling process that includes knowledge of the genetic degradation that come from seed saving, a calculating economic habitus will often push a farmer toward seed access through exchange activities, likely informal or formal seed sales. Similarly, the social skilling that occurs through observation and conversation also often pushes farmers toward seed access points within seed economies. A woman in Niger explained that while travelling, ‘they had seen a field school, in another village, where they really saw plants growing that were producing. They asked them, where did you get this variety, and they said in the input shop in Serkin. They told them about the price, and that access is really easy. That’s what pushes people to try seeds and see them.’
Experiential and social skilling through PPB activities support seed sales as initial access points, thereby instituting at least an episodic seed economy based on formal seed sales.

Non-formal seed exchanges, defined as economic activity based on the use-value and exchange-value of seeds, can be facilitated by already existing social institutions like family and kinship networks, as well as by new social and economic institutions. As described in Chapter 4, an integral part of the push to establish market-based seed systems in the Sahel is the creation and expansion of farmer organizations and unions. As social infrastructure, farmer organizations can create a space for social learning and seed exchanges by supporting PPB field trials and agricultural training. As economic institutions, farmer organizations provide a stable market for seed producers to sell their seeds, and then invest the extra money to create a final product that can be sold at a value-added price, often by a representative of the farmer organization in a local marketplace. In describing their appreciation for seed sales by farmer organization representatives in local marketplaces, many farmers make the connection between the spatial organization of market-oriented institutions and their relevance to local seed economies. In the past, a farmer might have ‘heard seeds talked about, but he had never come across them here.’ Instead, in order to access improved varieties and sometimes even landraces, ‘you had to go to town to find them, pay the cost of transport.’ Now, however, with the institution of localized points of sale, ‘if you need seeds, you don’t have to travel.’

Increasing the possible points of market access for improved variety seeds through the placement of farmer organization representatives in already existing local marketplaces has facilitated the expansion of seed economies oriented around use-value as well as exchange-value by decreasing the cost of seed access and increasing individuals’ ability to observe seed sales. In order to further support the diffusion of improved variety seeds, many farmers suggest expanding even further the points of sale: ‘if we could put a shop in the center of their village, that would facilitate others to quickly access seeds of improved varieties. Because there are people who
maybe aren’t familiar with [town] and how to access seeds.’ One result of increased seed access points through seed sales is the increasingly standardized and individualized nature of seed exchanges. Market-based institutions, even when implemented by local agents, are predicated on standard prices and products that create reliability as to both the existence and properties of the good being accessed. Farmers highlight the fact that now that there is ‘a representative here, everyone can get seeds for themselves,’ rather than asking others for help in some way. One man in Niger explained that ‘access to these seeds is easy because people are informed, and there’s a village nearby, so they go there on the market day, and they’re easy to find there. And the price is really affordable.’ The localized market-oriented institutions being created by farmer organizations complement the non-formal exchange economic systems that are common for many other agricultural products in Sahelian West Africa, and so farmers with a habitus toward calculating relative social and economic costs and benefits are likely to at least partially engage in these seed economies.

As seed sales by farmer organization representatives expand and are instituted through a network of points of sale in local market places, a contrast is beginning to emerge between the use-value and exchange-value of the seeds to the farmers purchasing them and the commodity-value that drives the overall goals of market-based seed system development. Farmers appreciate the mini-packet strategy in part because they have a value-added associated with their packaging, and in part because of the appropriateness of the price and quantity to their means. However, the current price of certified improved variety seeds does not reflect the monetary cost associated with their production, and for the most part, seed sales are being subsidized by development projects via funding support to the farmer organizations selling the mini-packets. Scaling up purchases of improved variety seed will be unlikely for farmers unless they see a market for the output, a market which, given the social and agricultural habitus that retains a strong orientation toward landraces for food preferences and sufficiency rather than surplus, is unlikely to quickly
emerge. One man in Burkina Faso explained ‘that if one buys and produces a lot [of improved varieties], then there is not a place to sell it…if you who bring the seeds, if they produce and you can come buy it, then he will produce a lot.’ In other words, not only do economic institutions need to be created to support the maintenance of adequate supply, they also need to commit to filling in for demand that might not exist at all or at high enough levels to justify investment in seeds for certain types of production.

Seed producers report a similar problem, ‘because if you produce seeds, if there are not buyers for these seeds, it’s a loss. To produce seeds, to use inputs, you do everything, but in the end, you can only sell five, six, seven sacks…there’s no interest there.’ When there is no demand, ‘in the end, they sold what they produced as grain because people aren’t aware of these seeds.’ The skilling process for many farmers in contemporary Sahelian seed systems has incorporated awareness of improved varieties into their social, agricultural and economic habitus, but seed access and use decisions are still governed by social value or use-value orientation, which prioritizes reliability over profit. When seed sales are unreliable, like for example being unavailable ‘after the first rain…that’s what makes people plant local pearl millet.’ Others make decisions to engage with seed economies and the institutions within them on a limited basis, which potentially creates an overall demand that is too low to justify the costs of supplying seeds at all. Farmers and seed producers aware of this reality have suggested the establishment of supplementary institutions like credit for seed purchases that can be paid back at the end of the season. For the most part, however, farmers in the Sahel increasingly express a contemporary habitus that incorporates provisioning and economic seed access decisions into a dynamic calculation that supports diffusion in a variety of ways. A man in Niger sums it up well: ‘now there is really a chance, in terms of access to seeds. We can find them here in the shop. If someone doesn’t go to the shop, you can find them also with a relative who grew them last year, to get them and replant. There is diffusion.’
Visualizing substantive seed economies

Though a full characterization of substantive seed economies will be offered in Chapter 9 by synthesizing the qualitative, quantitative and visual data presented throughout Chapters 5 through 7, I offer here visual representations of several organizational types of substantive seed economies. Figures 7-5 through 7-8 present seed maps drawn during group meetings as well as maps created by me using GIS software. All of the maps depict substantive seed economies for improved variety seeds, and are characterized by the type of exchanges depicted on the maps.

Figure 7-5. Formal and informal sales of improved variety seeds in Lekuy, Burkina Faso, 2010

Figure 7-5 depicts the substantive seed economy as experienced by farmers in Lekuy, Burkina Faso (seen in the center of the map). The arrows represent the directions that people come and/or go to access improved variety seeds, and villages with seed sales, both formal and informal, are seen on the left. This map effectively depicts the textbook seed value chain being instituted by market-oriented seed system development projects, with added twist of the potential for informal seed sales from seed producers. The value chain flows from the national agricultural

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research station in the upper right hand corner, where new, improved varieties are developed, to the farmer organization headquarters in the regional city, Dédougou, where improved variety seeds are sent for certification and packaging. Mini-packets are then brought to Lekuy by the local farmer organization representative who lives in the village, and individuals from the villages at the top and bottom of the map come to buy seeds in Lekuy. In addition to formal sales of certified and packaged seeds, farmers also included formal and informal sales of seeds that are produced and packaged by outside organizations, and sold in the villages on the left of the map. Those sales are both formal and informal, as there are seed producers in those villages as well who sell uncertified improved varieties straight from their fields.

Figure 7-6. Formal seed sales of improved varieties in Masso, Burkina Faso, 2012

Figure 7-6 was drawn in Masso, Burkina Faso, in 2011. This is the same village that created a map depicting the seed provisioning system in 2010 (pictured above in Figure 7-3). The seed value chain shown in Figure 7-6 clearly depicts the institutions that comprise a substantive seed economy oriented toward formal exchanges and the commodity-value associated with
certified improved variety seeds. The village is shown in the bottom left, and it is noted that in the village are seed producers. Those seed producers send their seeds to the union, at the top of the map, where seeds are certified and packaged. The seeds are then sent back to the village via direct sales to farmers who are members of the union, or indirectly through the distribution of mini-packets to the union representative in the nearby market town, who in turn sells mini-packets to any farmer who comes to buy. Each sales step increases the price slightly, reflecting the value-added that is assumed to accrue throughout the standardized and differentiated supply chain. This map provides a clear, if implicit, contrast to the provisioning seed systems depicted above, where the institutions and relationships facilitating seed sharing were all localized in nature and based on social interaction rather than profit generation.

Figure 7-7. Formal seed sales of improved varieties in Dédougou region, Burkina Faso, 2012

Figure 7-7 was generated using data from my sample of every village to which mini-packets were sold in 2010, 2011, and 2012. The maps depict the point of sale and the home village of the person who purchased the seed. The maps also show every village that was
included in my sample because at least one person in the village accessed improved variety seeds in some way. By depicting the extent of seed sales relative to total seed use at a village level, we can observe the seed sales are for the most part conditioned by proximity to market-oriented infrastructure and institutions, which supports farmers’ descriptions of seed economy institutions analyzed above. In Chapter 9, I will visualize and directly compare the institutional make-up and extent of seed spread in different substantive seed economies. For now, it important to note that seed diffusion often extends beyond first-order seed sales, even in sites where market-based seed systems are being actively instituted.

Figure 7-8. Diffusion through formal seed sales and non-formal exchange of improved varieties in Warzou, Niger, 2010

Figure 7-5 above depicts the seed value chain largely as envisioned by market-based seed system development projects and policies, with secondary seed sales remaining within the framework of formal sales of certified improved varieties. Figure 7-8 depicts a different type of
seed system, one described by farmers in the analysis of economic habitus in substantive seed economies presented in this chapter. The village in the center, Warzou, is shown to be the hub for non-formal exchanges and seed sharing activities for individuals from villages in the area who have social ties to someone in Warzou. Improved varieties enter Warzou from Serkin Haoussa, shown at the bottom of the map, the local capital town where the farmer organization is based, and where there is both a weekly marketplace and an input shop. The diffusion of improved varieties begins through formal exchanges, since implicit in the definition of the type of seed is the type of access activity used to diffuse the seeds. However, secondary seed spread occurs over a much wider range with informal and non-formal seed exchanges, as demonstrated by the map in Figure 7-8.

**Summary**

The analysis presented in this chapter explores the social, agricultural and economic habitus expressed in and engaged in instituting different seed systems in Sahelian West Africa. Contemporary seed systems are incorporating the existence of improved varieties and formal market sales in a variety of ways, and I distinguish between provisioning seed systems and substantive seed economies, as well as among value orientations in distinct seed economies, based upon the habitus that guides the organization and decision-making within the particular seed system. Provisioning seed systems are instituted primarily by social habitus that emphasizes individual and communal well-being through stability and sufficiency of food production. The economic habitus expressed in provisioning seed systems distinguishes seeds as a good that is outside the realm of exchange activity. Substantive seed economies are characterized by negotiations between social and economic habitus, and are characterized based upon the economic value of agricultural output expressed in exchange decisions. Economic habitus
oriented toward use-value organizes exchange on the basis of parity (foundational to social habitus), while economic habitus oriented toward exchange-value seeks a reasonable return-on-investment that is both tempered and enabled by a social habitus toward communal sharing and well-being. The formal seed economy, comprised of seed markets, formal exchanges and certified seeds, is predicated upon the commodity-value of both grain and seeds as agricultural outputs. The economic habitus expressed in a formal seed economy is individualized and does not allow social habitus to condition or shift economic institutions and interactions.
Chapter 8 Structural equation modeling of seed economy growth trajectories

The foundational theories being described, expanded and tested in this research project relate to contrasting conceptions of the establishment and perpetuation of various types of economic systems. Modern approaches to international development have consistently put forth a model for agricultural change that assumes that technological and capitalist market economic systems are consistently preferable and superior to other types of economic organization and priorities. Characterization of substantive, reasonable economies suggest, in contrast, that market economies are only one possible type of economic organization that fit into a broader understanding of activities taken to meet material needs as patterned by social and natural settings. The analysis presented in Chapters 5 demonstrates a range of contextual characteristics that influence seed systems in contemporary Sahelian West Africa, and provides basic univariate and bivariate statistical analysis of the relationships between the natural and social settings, and various individual actions that are indicative of and serve to institute seed economies. Chapter 7 then presents analysis of the complex decision-making and institution creation that lead to distinct seed systems. The themes that emerge from the qualitative analysis suggest that several seed systems are emerging to co-exist in the Sahel, a finding that contrasts with the assumed superiority (and so exclusivity) of market-oriented agricultural development.

This chapter analyzes changing seed systems in Sahelian West Africa using a structural equation modeling (SEM) approach to latent growth curve analysis, in order to characterize the changes occurring over time in individuals’ seed access decisions (Bollen and Curran, 2006). Heeding Duncan’s (1975) warning about making theory construction, model building and statistical inference explicit and separate steps in the analytical process, in Chapter 2, I have developed a model of dimensions of seed systems based on existing literature. In Chapter 6, I then identified appropriate indicators of these dimensions of seed systems within the Sahelian
context, and created a panel data set (as described in Chapter 5) of farmers for whom I have repeated measures of indicators over time. In this chapter, I build and test measurement, path and structural models to characterize the trajectories of individual seed access decisions over time, and the relationships among contextual characteristics and individuals’ trajectories. I first present an overview of SEM and the latent curve modeling (LCM) approach within it, making the argument that the research questions presented in this project suggest latent growth curves as an appropriate statistical approach for hypothesis testing. Model forms, specifications and results are then presented and interpreted using SEM conventions and practical explanations of the statistical outputs. The results presented in this chapter will be then be combined in Chapter 9 with the analysis of complex seed access decisions presented in Chapter 7, to provide a mixed-methods analysis and categorization of provisioning seed systems and substantive seed economies in Sahelian West Africa.

**Principles of SEM and LCM**

SEM builds on the analytical framework of generalized linear modeling to understand relationships between variables based on analysis of variance, covariance and correlation matrices (Hays and Winkler, 1971; Kline, 2011). Using matrix algebra allows for analysis that effectively combines correlation-regression and analysis of variance (ANOVA) approaches, which opens up the types of variables and parameters, and relationships among them, that can be analyzed (Kline, 2011). In particular, the statistical approach of SEM allows for the incorporation of latent factors (unobserved, theorized constructs that are related to empirically observed indicators in the data) into both factor analysis and the estimation of predictive (structural) models (Brown, 2006). In short, the SEM approach characterizes relationships among all types of variables (interval, ordinal, and dichotomous; observed and latent) by constructing and analyzing a covariance matrix.
for two variables, and then provides predicted values for each variable using probability estimations based on the empirically constructed matrices (Bollen and Curran, 2006). Anderson and Gerbing (1988) suggest that SEM should in fact be thought of as a two-part process, with confirmatory factor analysis first used to assess the relationship between observed indicators and theorized factors, and structural modeling then performed by adding exogenous variables to test hypothesized relationships between predictor variables and changes in the latent factors, as measured by changes in observed dependent indicators. McDonald and Ho (2002) break down the process even further, arguing for distinct phases of measurement model estimation, path analysis, and specification of the structural model. In the sections that follow, I will present the analysis and interpretation of my data using the distinctions suggested by McDonald and Ho (2002), to make explicit the decisions and assumptions inherent in each step of the model building process as it relates to the contextual knowledge and prior thematic analysis presented in previous chapters.

SEM approaches to complex modeling allow the analyst to specify a broader range of parameters than would otherwise be possible using regression-based analysis techniques. Parameters are any value within the hypothesized structure that can be estimated using the statistical techniques at hand; in SEM, mean values and variances can be estimated or fixed (depending on the theoretical assumptions being tested) for all observed and latent variables. Covariances among variables and among unobserved residual error terms can also be specified and estimated. Because of the flexibility of the SEM approach to complex modeling, recent extensions of SEM have incorporated analysis of latent growth curves (Bollen and Curran, 2006). Growth curves are foundational to the study of change, using longitudinal panel data that consists of repeated measures of the phenomenon of interest for the same individuals over time. The basic principle of growth curve analysis is to estimate a mathematical equation that represents the underlying trajectory on which discrete repeated outcome measures fall (Duncan et al., 2006).
The most simplistic version of this can be imagined as a scatter plot of outcomes over time for a given individual, with a line of best fit estimated to relate time and the value or level of the outcome using the standard $y=mx + b$ equation for describing a line (outcome=rate of change*time + starting point).

More sophisticated understandings of growth trajectories build on the idea of latent growth curves to theorize intercepts and slopes as latent factors that can be incorporated into measurement and predictive models like any other type of latent factor, allowing for a greater range of relationships and interactions than those possible in linear algebraic estimates of rates of change (Duncan et al., 2006). Incorporating latent growth curve analysis into SEM brings the strengths of the SEM framework to LCM, allowing the variances and covariances of the intercept and slope factors to be parameters within path analysis and structural models (Bollen and Curran, 2006). In other words, LCM in the SEM framework can separate and make explicit the rate of change for the population trajectory, and differences among individual trajectories (McArdle, 2009). Model estimates of mean intercept and mean slope confirm or deny the present of growth curves, while estimates of variance and covariance measure the degree to which each individual in the population is likely to move along the same trajectory of change. If variance and covariance estimates suggest that this is not the case, then LCM in the SEM framework allows for multiple group analysis (much like multi-level modeling) of between-group differences of within-group change (Bollen and Curran, 2006). In this dissertation project, I test the assumption that individuals will move toward integration into a market-based seed economy when given access to seed markets, and then explore the possibility of differences between different sub-groups within the population in terms of market-oriented seed access decision making.

To use the SEM approach with non-interval dependent variables and small sample sizes, three aspects of the analytical process must be addressed. An estimator appropriate to the type of data being analyzed must be used, the limitations of sample size must be considered, and relevant
fit statistics identified in order to evaluate models. The SEM analysis presented in this chapter was undertaken using MPlus software, version 6. MPlus is the most versatile SEM software for incorporating ordinal and dichotomous independent and dependent indicators, through the use of the weighted least squares robust mean and variance (WLSMV) estimator (Muthén and Muthén, 2010; Bollen and Curran, 2006). In brief, standard correlation-regression is based on the assumption of normal distributions of continuous data, and the corresponding function for estimating the parameters of relationships among continuous variables is the maximum likelihood function (Kline, 2011). For ordinal and dichotomous variables, however, a different type of estimator is needed, and the MPlus software includes the WLSMV estimator for use when categorical observed indicators can be theorized to represent an underlying continuous latent response variable (Kline, 2011). Flora and Curran (2004) describe how the latent response variable is estimated using polychoric correlation estimates for polytomous observed indicators.

The robust (including mean and variance influences) WLSMV is also less susceptible to spurious relationships resulting from small sample sizes (Flora and Curran, 2004). Small sample sizes present a range of challenges in SEM, as analysis of a relatively small number of cases can influence the reliability of the model structure and parameter estimates, as well as model fit indices. Schreiber et al. (2006) suggest a general rule of thumb that the sample size should be ten times the number of estimated parameters, to provide sufficient data to estimate multiple variance and covariance matrices. Others (Bollen and Curran, 2006; Kline, 2011) suggest that sample sizes below 100 must be analyzed using simple models only, which could limit the amount of meaningful information provided by the analysis. In addition to considering sample size in model complexity, sample size should also be incorporated into decisions about fit indices. Bollen (1990) suggests that sample size can influence fit indices directly, either because of the oversensitivity of overall measures of fit, like the chi-square statistic, to sampling fluctuations, or indirectly through the incorporation of sampling distribution into fit indices. In general, baseline
fit indices like the chi-square and Tucker-Lewis Index (TLI) tend to over-reject models in small sample analyses (Yu, 2002; Bollen and Curran, 2006).

Determining which fit statistics to use to evaluate and choose among various models is an important step in the SEM process. Sample size, type of data and estimator used, and analytical purpose are all elements to consider in choosing appropriate fit statistics. Baseline fit indices like the chi-square test of significance and the TLI compare the specified model to a baseline model that is more restrictive (has fewer parameters being estimated) than the model specified in the analysis. In addition to over-rejecting models in small samples, the chi-square fit statistic is estimated differently depending on the model estimator (ML versus WLSMV, for example) used, and cannot be used for chi-square difference testing to compare models to one another when the WLSMV estimator is used. Stand-alone fit statistics like the root-mean-square error of approximation (RMSEA) incorporate sample size into their calculation, making them more accurate across sample sizes. The Bayesian information criteria (BIC) is another stand-alone fit statistic that is calculated using the chi-square (or adjusted chi-square with WLSMV) fit statistic and incorporating sample size (Bollen and Curran, 2006). Raftery (1995) explains how the BIC is based on log-likelihood analysis of parameter estimates, making it appropriate and sensitive for categorical variables. Stand-alone fit indices are useful for comparing models when an estimator other than ML is used, and when models are not nested (Bollen and Curran, 2006). Levels of fit statistics necessary for a model to be considered a generally good fit are as follows: chi-square statistic should be not significant, TLI>.9, RMSEA<.05, and BIC should be negative (Yu, 2002; Bollen and Curran, 2006; Schreiber et al., 2006).
Theory construction and data organization for LCM of Sahelian seed economies

Schutz (1967) describes the two-part process of interpretive sociology as “the construction of the ideal type and the application of this type as an interpretive scheme to real concrete actions” (228). By this he means that the confirmation of ideal types through previously observed and analyzed situations is related to but distinct from using the same ideal types to predict future actions. Duncan (1975) makes the same point in his description of the three steps of theory construction, model building and statistical inference in SEM. Reviewing the contemporary agricultural development and seed systems literature in Chapter 2, I developed a conceptual framework that in Chapter 6 provided a heuristic for initial qualitative and quantitative analysis of dimensions of seed systems and relevant indicators of these dimensions in the Sahel. This project asks research questions about how dimensions of seed systems in Sahelian West Africa are characterized and how those dimensions are changing with the establishment of formal seed markets. Further questions ask how elements of the social and natural contexts relate to seed systems, and if seed systems differ by gender or crop type.

Based on the theories generated out of the literature and initial analysis offered in Chapter 6, I present in this section a list of possible indicators of changes in seed systems, and develop a full theoretical model of the complex interactions among observed actions, the underlying factors they represent, and exogenous influences of the social and natural contexts on individuals’ trajectories. Table 8-1 lists the full range of dependent and independent indicators of seed economies and the latent constructs theorized in the LCM of changes in related dimensions of the seed system. Figure 8-1 then presents the full theoretical model that incorporates all of the variables presented in Table 8-1. In order to test the research questions developed in this project, I utilized the sampling methodology presented in Chapter 5 to build a longitudinal panel data set of farmers who initially purchased mini-packets of improved variety seeds in formal markets in
Sahelian West Africa. Tables 8-2 and 8-3 present descriptive statistics of the panel data set characterized by demographic and social infrastructure indicators, and differentiated by gender.

In the explanation that follows, I describe how the indicators and the theoretical model were developed for an LCM analysis within the SEM framework, and then discuss key characteristics of the sample represented in the panel data set.
Table 8-1. All variables in full theoretical model with measurement scales

<table>
<thead>
<tr>
<th>Indicators (dependent observed variables)</th>
<th>Measurement scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>u1 Place of seed access</td>
<td>0-traditional 1-informal 2-formal</td>
</tr>
<tr>
<td>u2 Price of seed</td>
<td>0-traditional 1-informal 2-formal</td>
</tr>
<tr>
<td>u3 Person with whom seed was accessed</td>
<td>0-traditional 1-informal 2-formal</td>
</tr>
<tr>
<td>u4 Type of seed certification</td>
<td>0-traditional 1-creolized 2-improved</td>
</tr>
<tr>
<td>u5 Years seeds have been saved and re-used</td>
<td>0-traditional 1-creolized 2-improved</td>
</tr>
<tr>
<td>u6 Type of seed packaging</td>
<td>0-traditional 1-creolized 2-improved</td>
</tr>
<tr>
<td>u7 Identification of variety by individual</td>
<td>0-traditional 1-creolized 2-improved</td>
</tr>
<tr>
<td>u8 Economic value of food produced</td>
<td>0-none 1-non-commodified 2-commodified</td>
</tr>
<tr>
<td>u9 Economic value of fodder produced</td>
<td>0-none 1-non-commodified 2-commodified</td>
</tr>
<tr>
<td>u10 Economic value of seed produced</td>
<td>0-none 1-non-commodified 2-commodified</td>
</tr>
<tr>
<td>u11 Seed saving (of improved variety seeds)</td>
<td>0-no use 1-saving 2-no saving</td>
</tr>
<tr>
<td>u12 Seed sharing (of improved variety seeds)</td>
<td>0-no use 1-sharing 2-no sharing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factors (dependent latent variables)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>e Formality of exchange</td>
<td>Underlying continuous distribution</td>
</tr>
<tr>
<td>s Improvedness of seed</td>
<td>Underlying continuous distribution</td>
</tr>
<tr>
<td>v Commodity of production</td>
<td>Underlying continuous distribution</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Latent curve factors (dependent latent variables)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>α Intercept of related latent curve</td>
<td>Underlying continuous distribution</td>
</tr>
<tr>
<td>β Slope of related latent curve</td>
<td>Underlying continuous distribution</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time-invariant covariates (independent observed variables)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>x5 Age</td>
<td>Interval (years)</td>
</tr>
<tr>
<td>x6 Individual experience with PPB</td>
<td>Interval (years)</td>
</tr>
<tr>
<td>x7 Individual experience with improved varieties</td>
<td>Interval (years)</td>
</tr>
<tr>
<td>x9 Initial information source about improved varieties</td>
<td>0-other farmer 1-animateur 2-agrodealer 3-radio</td>
</tr>
<tr>
<td>x10 Individual reason for first trying improved varieties</td>
<td>0-to learn/see 1-prior experience 2-yield 3-cycle</td>
</tr>
<tr>
<td>x11 Animateur in village</td>
<td>0-no 1-yes</td>
</tr>
<tr>
<td>x12 Distance to animateur</td>
<td>Interval (km)</td>
</tr>
<tr>
<td>x13 Agrodealer in village</td>
<td>0-no 1-yes</td>
</tr>
<tr>
<td>x14 Distance to agrodealer</td>
<td>Interval (km)</td>
</tr>
<tr>
<td>x15 Distance to weekly market</td>
<td>Interval (km)</td>
</tr>
<tr>
<td>x16 Tester in village</td>
<td>0-no 1-yes</td>
</tr>
<tr>
<td>x17 Distance to tester</td>
<td>Interval (km)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time-variant covariates (independent observed variables)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>w1 Household size</td>
<td>Interval (number of people who eat together)</td>
</tr>
<tr>
<td>w2 Individual ownership of agricultural machines</td>
<td>0-no 1-yes</td>
</tr>
<tr>
<td>w3 Individual ownership of oxen</td>
<td>Interval (number of oxen)</td>
</tr>
<tr>
<td>w4 Area cultivated for all crops</td>
<td>Interval (ha)</td>
</tr>
<tr>
<td>w5 Area cultivated for cereal of interest (sorghum/pearl millet)</td>
<td>Interval (ha)</td>
</tr>
<tr>
<td>w6 Area cultivated with improved varieties of cereal of interest</td>
<td>Interval (ha)</td>
</tr>
<tr>
<td>w7 Annual rainfall</td>
<td>Interval (mm)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grouping variables</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>d1 Country</td>
<td>1-Mali 2-Burkina Faso 3-Niger</td>
</tr>
<tr>
<td>d2 Gender</td>
<td>0-female 1-male</td>
</tr>
<tr>
<td>d3 Crop</td>
<td>0-pearl millet 1-sorghum</td>
</tr>
<tr>
<td>d8 Individual union membership</td>
<td>0-no 1-yes</td>
</tr>
</tbody>
</table>
The full variable list presented in Table 8-1 supports as well the analysis presented in Chapter 6, wherein indicators of dimensions of seed economies in Sahelian West Africa were derived from thematic analysis of qualitative data about how individuals’ experience seed access decisions and contemporary changes to seed access options with the establishment of formal markets and seed sales. The indicators of different dimensions of the seed system are observed endogenous (dependent) variables, and are all ordered categorical, scaled so that an increase in category (from 0 to 1 and 1 to 2) indicates an increase in market-orientation of the action. In SEM, ordered categorical variables are treated as if they are approximations of an underlying continuous latent response variable (Bollen and Curran, 2006). This assumption is appropriate to the indicators of seed access decisions presented in Table 8-1, since, for example, the formality of the place of access will be conditioned by individual habitus and social context, creating a continuous spectrum of underlying motivation (see Espeland and Stevens, 2008, for discussion of the social dimensions of quantification).

The latent factors, both of the separate seed system dimensions and of the related latent curves, are also theorized to be continuous variables. Finally, the exogenous (independent) variables are all observed and are measured on either continuous or unordered categorical scales. The exogenous variables are classified as: time-invariant, meaning that they originate outside of the temporal frame analyzed here; time-variant, meaning that they are measured at the same time point as the endogenous indicators and have the potential to change over time; and grouping variables, which are dummy variables used to test between-group differences in the LCMs for each dimension of the seed system. The description provided here references Bollen and Curran (2006) for explanation of variables in SEM and LCM, and for the possible combinations of variables scales. The variables presented in Table 8-1 are all incorporated into a full theoretical model, presented in Figure 8-1, of the relationships among changes in different dimensions of seed systems in Sahelian West Africa.
Figure 8-1. Full theoretical LCM of changes in dimensions of seed system

Figure 8-1 depicts the full model of the relationships among contextual indicators and changes in dimensions of the seed system, as well as relationships among the latent curves that describe changes within each dimension of the seed system. This model is far too complex for any reasonable available data set, even the one I had planned to generate through this research project. I present it here simply to show the most complex and complete theorized model that derives from prior theory and analysis of qualitative data, in order to visualize the hypothesized relationships among all of the variables presented in Table 8-1. I also use Figure 8-1 to explain how SEM and LCM visually depict measurement, path, and structural models, and the parameters they test.
Figure 8-1 uses standard SEM notation (see Schreiber et al., 2006) to portray a complete structural model of changes in dimensions of seed systems. Variables in rectangles are observed, while variables in circles are latent or unobserved. On the left-hand side of the figure are time-invariant exogenous variables along with grouping dummy variables. In structural analysis, only one dummy variable is included at a time to test between-group differences. On the right-hand side of the figure are time-variant exogenous variables, measures of which are repeated at each time point at which endogenous indicators are measured. The latent factors $\alpha$ and $\beta$ represent the intercept and slope of the growth curve for each dimension of the seed system. The latent factors for each dimension of the seed system are characterized by several indicators (the small rectangles on the right side of the figure), and the value of these latent factors is theorized to change based on the underlying trajectory. For example, the latent factor $e$ measures the formality of seed exchange, which is characterized by several indicators. The degree of formality of an individual’s decisions is hypothesized to change (and to move toward formality, based on market-oriented development theories) over time, and this change will be characterized by the underlying growth curve. Single direction arrows signify directional (though not necessarily causal) paths between variables. Finally, the small circles related to each latent factor represent residual errors, which covary with the residual errors of all other factors at a given level of the model and provide the mechanism for measuring relationships among changes in different dimensions of the seed system. The figures presented throughout this chapter will use the basic notation described by Schreiber et al. (2006) and used to explain the full theoretical model above.

Once the relevant indicators and full model structure presented in Table 8-1 and Figure 8-1 were developed out of initial analysis of prior theory and qualitative data, I created a panel data set of individuals for whom I had three years of data. As described in detail in Chapter 5, the original sampling methodology planned for four waves of data gathering, so that the first year, where the only population frame available was those individuals who purchased mini-packets,
would provide a starting point from which to snowball to seed receivers. In this way, waves 2, 3, and 4 would have created a three-wave panel data set with enough variation in all variables to allow for LCM analysis of ordinal indicators. However, due to political instability and changing research possibilities, I was unable to collect a fourth wave of data, and wave 3 was collected only in Mali and Burkina Faso. These limitations mean that the panel data set used for the LCM analysis presented in this chapter is smaller than originally intended, limiting the robustness of the model conclusions and making the analysis susceptible to fluctuations of indicators within the sample. Tables 8-2 and 8-3 present demographic characteristics, and characteristics of relationships to social infrastructure, differentiated by gender, for the panel data set analyzed in this chapter. I separate demographic and social infrastructure characteristics of individuals in the panel data set in order to make explicit the distinctions between individual characteristics and elements of the social context that are theorized to influence seed access actions.

Table 8-2. Individual demographics (means) of panel data set by gender (n=75)

<table>
<thead>
<tr>
<th></th>
<th>Age (yr.)</th>
<th>People in household</th>
<th>Owns ag. tools (%)</th>
<th>No. of oxen</th>
<th>Cultivated area all(^1) (ha)</th>
<th>Cultivated area cereal(^2) (ha)</th>
<th>Cultivated area IV(^3) cereal (ha)</th>
<th>Yrs. with PPB</th>
<th>Yrs. with MVs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mali n=34</td>
<td>45</td>
<td>17**</td>
<td>53*</td>
<td>1***</td>
<td>9.7</td>
<td>4.1</td>
<td>.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Niger n=28</td>
<td>49</td>
<td>20**</td>
<td>10*</td>
<td>0***</td>
<td>3.3</td>
<td>2.3</td>
<td>.5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mali n=4</td>
<td>49</td>
<td>20**</td>
<td>10*</td>
<td>0***</td>
<td>3.3</td>
<td>2.3</td>
<td>.5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Niger n=9</td>
<td>49</td>
<td>20**</td>
<td>10*</td>
<td>0***</td>
<td>3.3</td>
<td>2.3</td>
<td>.5</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

1 Areas reported during first wave of data collection in 2010
2 Sorghum in Mali, pearl millet in Niger
3 IV=improved varieties
* Differences in distributions significant at the .05 level (Fisher’s exact test)
** Differences in means significant at the .01 level (independent t-test)
*** Differences in means significant at the .001 level (independent t-test)
### Table 8-3. Individual relationships to social infrastructure (means) of panel data set by gender (n=75)

<table>
<thead>
<tr>
<th></th>
<th>Union member (%)</th>
<th>Animateur in village (%)</th>
<th>Agrodealer(^1) in village (%)</th>
<th>Tester(^2) in village (%)</th>
<th>Distance to weekly market (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td>Mali n=34</td>
<td>Niger n=28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>35</td>
<td>21</td>
<td>32</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(10)**</td>
<td>(30)**</td>
<td>(8)</td>
<td></td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td>Mali n=4</td>
<td>Niger n=9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>92</td>
<td>23</td>
<td>0</td>
<td>75</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(6)**</td>
<td>(8)**</td>
<td>(11)</td>
<td></td>
</tr>
</tbody>
</table>

1. Agrodealers present only in Mali
2. Testers included only in Mali
** Differences in means significant at the .01 level (independent t-test)
*** Differences in means significant at the .001 level (independent t-test)

Tables 8-2 and 8-3 present key characteristics of the panel data set differentiated by gender and note significant differences in specific indicators between men and women, in order to further characterize the population from which the sample was drawn (those who first purchased seeds in 2010). Table 8-2 suggests that men in the sample come from significantly smaller households than women, and are significantly more likely to own agricultural mechanical tools (defined as plows, seeders, weeders) and own significantly more oxen than women. The gendered differences in access to agricultural implements reflect themes in agricultural development literature that highlight unequal access to means of production based on gender.

Understanding why women who purchased seeds come from larger households than men who did so is less clear, but could be related to more diffuse economic responsibilities in larger households, which would allow women to retain more of their cash income for personal use (since there are potentially more adults to contribute). In terms of social infrastructure, the results presented in Table 8-3 show that men who purchased seeds and do not live in a village with an animateur live significantly further from an animateur than do women who purchased seeds, supporting the notion that men’s mobility is less restricted in Sahelian West Africa than is women’s, allowing for further travel to access seeds. Where agrodealers are present in Mali,
women who purchased seeds live significantly closer to them than do men, though there is high collinearity between agrodealer sites and weekly market sites, making it difficult to separate the effect of an agrodealer’s presence from that of a weekly market.

The descriptive statistics presented in Tables 8-2 and 8-3 characterize the panel data set based on key exogenous variables used in subsequent analyses. In order to build and test the specific LCM models presented in this chapter, I began by assessing which endogenous and exogenous variables listed in Table 8-1 were possible to include, based on univariate and multivariate kurtosis. Bollen and Curran (2006) highlight the importance of testing not only for univariate but also multivariate kurtosis in latent factor analysis, which can be a particular problem in small samples and with categorical indicators. Given the those two constraints in my panel data set, as well as the invariability in the first wave of data (because only three waves, rather than four, could be collected), many of the endogenous indicators of changes in dimensions of the seed system exhibited high degrees of univariate kurtosis. Based on this initial test, I eliminated all but u1 (place seed was purchased), u8 (value of food produced), u10 (value of seed produced), u11 (seed saving decision) and u12 (seed sharing decision). The first three variables, when incorporated into initial measurement models, proved to have high degrees of multivariate kurtosis, meaning basically that there was uneven distribution across categories, across years. In the end, only indicators u11, seed saving decision, and u12, seed sharing decision, demonstrated sufficiently stable distributions for an LCM analysis. The distributions of these two variables over each measurement year are presented in Table 8-4.
The distributions of u11 and u12 presented in Table 8-4 demonstrate the variation in seed saving and seed sharing decisions made within the sample over time, but do not provide an understanding of whether individuals make the same decision consistently about seed saving or seed sharing across the years 2010 to 2012. Using the variables described in Table 8-4, the following sections present first the unconditional (no predictor variables) measurement and path analysis LCMs for seed saving, seed sharing, and a theorized output-value latent factor defined by both seed saving and seed sharing. One important note here is that the observed indicator seed sharing, as coded in Tables 8-1 and 8-4, has a middle category (‘sharing’) that includes both non-formal exchanges of seeds and seed gifting. Original interview questions did not distinguish between sharing seeds through exchange versus gifting, as it was not until initial qualitative analysis that I realized the clear distinction drawn between sharing in provisioning systems (gifting) and sharing in economic systems (through exchange). Because ordinal indicators are theorized to have an underlying continuous curve in LCM, distinctions in the type of sharing (based on underlying propensity for or against provisioning) will emerge in the longitudinal analysis.

**Unconditional parameterized models of seed saving and seed sharing latent curves**

The SEM approach is comprised of three steps: measurement modeling, path analysis, and structural testing (McDonald and Ho, 2002). Measurement modeling in LCM insures that the
indicators being used to describe the latent factors have consistent relationships to the latent factors over time (since each individual indicator is ostensibly measuring the same phenomenon at different time periods). In other words, measurement modeling tests invariance in the relationship between indicators and latent factors over time. For categorical variables, this means testing the invariance in thresholds across indicators, since thresholds are used to define the underlying continuous latent response variable theorized to be approximated by the categorical measure (Bollen and Curran, 2006).

If a model with threshold invariance fits the data sufficiently well, path analysis of the unconditional model then estimates relationships among the latent factors and the indicators, as well as variances and covariances of the latent factors. In the case of LCM, the parameters of interest are the means and variances of the latent intercept and latent slope factors. Model estimates of the means define the probable value of the starting point (intercept) and rate of change (slope) in the sample and population that it represents. If the model estimates for variances are significant, this suggests that there are significant differences among individuals in terms of their starting point (intercept) and rate of change (slope). Finally, an estimate of statistically significant covariance between the latent factors suggests that there is a significant relationship between an individual’s starting point, and their subsequent rate of change, which then argues for the appropriateness of theorizing a latent curve model to explain patterns over time. Figure 8-2 below depicts the measurement and path analysis models used to characterize changes in seed saving and seed sharing in the panel data sample and the population from which it came.
Figure 8-2 presents the LCM for seed saving and seed sharing using the common notation described earlier in this chapter. The observed indicators, either u11 or u12, are represented by boxes on the right-hand side of the model, and are influenced by the theorized latent growth factors, α (intercept) and β (slope). The subscripts on the dependent indicators represent the time period at which the indicator was measured. In this analysis, data on farmers’ seed saving and seed sharing activities for growing seasons 2010, 2011 and 2012 were collected at the end of each year’s growing season, so that the interval between each repeated measure is equal. The path coefficients that measure the relationship between the latent slope factor and the repeated indicators are thus a linear, interval scale, starting with zero as is the standard convention in LCM (Bollen and Curran, 2006). The path coefficients measuring the relationship between the latent intercept factor and the repeated indicators are set to 1 to represent an equal influence of an individual’s starting level of interest in seed saving or in seed sharing on each year’s decision making. Setting the path coefficients between the latent intercept and slope factors in the model specification allows for LCM analysis to test the means, variances and covariance of the latent factor in order to assess whether the data presents sufficient variability to suggest that a growth curve is indeed an appropriate characterization of patterns of difference within the sample.
Seed saving model testing and parameter estimates

The LCMs of seed saving trajectories of individuals in Mali and Niger who purchased improved variety seeds are tested in Table 8-5, and discussion of the parameterization is presented. The BIC is used to determine the best-fitting model, and parameter estimates for the best fitting model are presented in Table 8-6 and then interpreted in the context of this research project. The results of the unconditional LCM for seed saving will be incorporated into the conditional LCM presented later in this chapter, to identify exogenous variables that influence the parameters of interest and their estimates.

Table 8-5. Overall fit measures for parameterized models of seed saving trajectories (n=75)

<table>
<thead>
<tr>
<th>Model parameterizations</th>
<th>$\chi^2$ (adj.) $^1$</th>
<th>df</th>
<th>Sig.</th>
<th>TLI</th>
<th>RMSEA</th>
<th>BIC $^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed thresholds</td>
<td>193.864</td>
<td>3</td>
<td>.000</td>
<td>-4.546</td>
<td>.921</td>
<td>180.912</td>
</tr>
<tr>
<td>Time-invariant thresholds</td>
<td>1.935</td>
<td>1</td>
<td>.164</td>
<td>.918</td>
<td>.112</td>
<td>-2.382</td>
</tr>
<tr>
<td>Time-invariant thresholds and variance $\alpha$ fixed at 1</td>
<td>36.903</td>
<td>2</td>
<td>.000</td>
<td>-.521</td>
<td>.482</td>
<td>28.268</td>
</tr>
<tr>
<td>Time-invariant thresholds and variance $\alpha$ fixed at 0</td>
<td>13.525</td>
<td>2</td>
<td>.001</td>
<td>.498</td>
<td>.277</td>
<td>4.890</td>
</tr>
<tr>
<td>Time-invariant thresholds and $\beta$ variance fixed at 1</td>
<td>8.314</td>
<td>2</td>
<td>.016</td>
<td>.725</td>
<td>.205</td>
<td>-.321</td>
</tr>
</tbody>
</table>

$^1$Adjusted by MPlus with WLSMV estimator
$^2$BIC= $\chi^2$ – df (ln (N))
$^3$All models start with the factor intercept mean fixed to 0

As previously mentioned, the first step in specifying a structural equation model is to verify measurement invariance, which in the case of categorical variables means testing threshold invariance of the repeated indicators over time (McDonald and Ho, 2002; Bollen and Curran, 2006). For seed saving, which is measured on a three-category scale defined as 0, 1, 2, this means that the first model to test is the most restrictive, with the thresholds being fixed (within the computer software) to be equal to those used in the data set. Statistically, this means testing whether there is a consistent normal distribution of the data perfectly defined by the category thresholds used in coding (Bollen and Curran, 2006). As seen in all of the fit statistics presented
in the first row of Table 8-5, fixing the thresholds of the repeated indicators over time produced a model that in no way represents the data in the sample. When we then set the thresholds to be time-invariant, all of the fit statistics suggest that there is a decent fit (the BIC is -2.382), so analysis can move forward with the categorical indicators scaled as they are. Given the limitations of the data (having only three waves of repeated measures, and only three-category indicators), I cannot test a measurement model with free (time-variant) thresholds across repeated indicators. However, the model with time-invariant thresholds fits sufficiently well by all model fit measures and so I conclude that there it is reasonable to move forward with this parameterization.

The measurement modeling used to confirm threshold invariance and presented in Table 8-5 included several model parameterizations related to possible significant variance and covariance relationships evident in the data. All models have the mean of the intercept factor fixed at 0, a necessary specification due to the limited number of indicators but also one that fits with the theoretical model being tested. I am interested in whether there are non-zero rates of change in individuals’ seed saving activities as they have access to and interact with seed markets. Where they start at the outset in terms of propensity to save seeds (the estimate represented by the mean of the intercept factor) is not a central concern. Instead, what is of interest is the mean slope (and whether it is significantly different from zero) in the population, and the variance of the intercept and the slope factors. Fixing the variance of the intercept factor to 1 creates a model that specifies widely varying starting points for each individual, while setting the variance of the slope factor to 1 creates a model that specifies widely varying rates of change among all individuals. Models with a range of theoretically possible specifications were tested, and the four presented in Table 8-5 were both the most interesting and the best fitting. In the end, a model with time-invariant thresholds, the mean of the intercept factor fixed to 0, the mean of
the slope factor freely estimated, and the variances of the intercept and slope factors freely estimated fits best. The model estimates of the free parameters are presented in Table 8-6.

Table 8-6. Model parameter estimates for unconditional LCM of seed saving trajectories (n=75)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Parameter estimates for model with time-invariant thresholds$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (p-value)$^2$</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0 (-)</td>
</tr>
<tr>
<td>$\beta$</td>
<td>-.694 (.000)</td>
</tr>
<tr>
<td>$\alpha$ with $\beta$</td>
<td></td>
</tr>
</tbody>
</table>

$^1$Chosen as best-fitting model using fit statistics in Table
$^2$Indicating that estimate is significantly different than 0

Table 8-6 presents the parameter estimates from the best-fitting model selected from results presented in Table 8-5, to characterize the seed saving trajectories of individuals in the population. The mean of the intercept factor is set to zero, and the mean of the slope factor is estimated to be slightly negative and significantly different than zero. The significant mean slope estimate suggests that a latent curve is present in the data, and that movement occurs toward the lower category of the observed indicators, which in this case is saving or no use of improved varieties. The variance of the slope factor suggests that there are not significant differences among individuals in their rates of change. The negative variance estimated for the intercept factor is concerning, as negative variance is empirically impossible and so can represent a range of possible problems, from underidentification to sampling issues to misspecification of the model (Kolenikov and Bollen, 2010). Because the model converged and is not underidentified (as estimates would not be provided by MPlus if that was the case), and because of the small sample size, I move forward with the reasonable assumption that the negative variance is attributable to sampling fluctuations that will be more fully accounted for in the conditional
model, where covariates account for some of the variance captured in the intercept factor in the unconditional model (for discussion of negative variance estimations, see also Wothke, 1993).

The overall picture painted by the best-fitting LCM of seed saving decisions over time suggests that farmers in Sahelian West Africa all start from a similar point in terms of propensity to save seeds, and that they will all move on a similar trajectory toward traditional activities to access and use improved variety seeds, or no use of them at all. The significant covariance between the intercept and slope factors suggests that those with a ‘higher’ starting point (less propensity to save, since the highest category is no saving) will have a less steep trajectory toward traditional seed saving decisions (they will have a less negative slope). In the final section of this chapter, I present the conditional LCM for seed saving trajectories using the model identified and estimated here, and will compare the final estimates from the conditional model to those derived from the unconditional model presented in Table 8-6.

Seed sharing model testing and parameter estimates

Tables 8-7 and 8-8 presents the results for measurement model and path analysis testing for an unconditional LCM of seed sharing trajectories, and the best-fitting model parameter estimates, in the same stepwise order as the results presented in Tables 8-5 and 8-6 for seed saving trajectory models. The various seed sharing trajectory models, tested with different parameterizations, are presented in Table 8-7. The best-fitting model is identified using the BIC fit statistic, and the model estimates are then presented in Table 8-8 and interpreted in the framework of this project. I will use the unconditional LCM for seed sharing selected and estimated in Tables 8-7 and 8-8 as the basis for the conditional model presented in the final section of this chapter.
Table 8-7. Overall fit measures for parameterized models of seed sharing trajectories (n=75)

<table>
<thead>
<tr>
<th>Model parameterizations</th>
<th>$\chi^2$ (adj)$^3$</th>
<th>df</th>
<th>Sig.</th>
<th>TLI</th>
<th>RMSEA</th>
<th>BIC$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed thresholds</td>
<td>292.746</td>
<td>3</td>
<td>.000</td>
<td>-58-33</td>
<td>1.135</td>
<td>279.794</td>
</tr>
<tr>
<td>Time-invariant thresholds</td>
<td>2.559</td>
<td>1</td>
<td>.120</td>
<td>.059</td>
<td>.144</td>
<td>-1.785</td>
</tr>
<tr>
<td>Time-invariant thresholds and $\alpha$ variance fixed at 1</td>
<td>2.935</td>
<td>2</td>
<td>.230</td>
<td>.718</td>
<td>.079</td>
<td>-5.700</td>
</tr>
<tr>
<td>Time-invariant thresholds and $\beta$ variance fixed at 1</td>
<td>3.556</td>
<td>2</td>
<td>.169</td>
<td>.530</td>
<td>.102</td>
<td>-5.079</td>
</tr>
<tr>
<td>Time-invariant thresholds and $\alpha$ and $\beta$ variance fixed at 1</td>
<td>4.094</td>
<td>3</td>
<td>.252</td>
<td>.780</td>
<td>.070</td>
<td>-8.858</td>
</tr>
</tbody>
</table>

$^1$Adjusted by MPlus with WLSMV estimator

$^2$BIC = $\chi^2$ – df (ln (N))

$^3$All models start with the factor intercept mean fixed to 0

The various models tested for the two-step process of measurement modeling and path analysis for seed sharing trajectories are presented in Table 8-7. Fixing the thresholds of the categorical indicators to perfectly match the 0, 1, 2 scale used in the data results in a very poor fitting model. However, relaxing the assumption to test the time-invariant setting of the thresholds generated a decently fitting model by all measures except the TLI – likely because there is only one degree of freedom in the hypothesized model (Bollen and Curran, 2006).

Moving forward with the statistically acceptable assumption of time-invariant thresholds, I then test a range of model parameterizations to assess which model best fits the data. The mean of the intercept factor is fixed to zero as a necessary precondition for model identification, which fits the focus of the model building and testing that asks questions about differences in individuals’ rates of change, rather than in their starting points. Based on the BIC and all other indicators of model fit, I select the model with the mean of the intercept factor fixed to 0, and the variances of the intercept and slope factors fixed to 1. Estimates of the model parameter values are presented in Table 8-8.
Table 8-8. Model parameter estimates for unconditional LCM of seed saving trajectories (n=75)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Parameter estimates for model with time-invariant thresholds, fixed α and β&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (p-value)&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>α</td>
<td>0 (-)</td>
</tr>
<tr>
<td>β</td>
<td>-.612 (.000)</td>
</tr>
<tr>
<td>α with β</td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup> Chosen as best-fitting model using fit statistics in Table 2
<sup>2</sup> Indicating that estimate is significantly different than 0

The model parameters specified and estimated for the best-fitting unconditional LCM of seed sharing are presented in Table 8-8. The slope factor mean is negative and significant, suggesting that the population moves toward the lower categories of the measured indicators – in this case, farmers are on a trajectory toward sharing or no use of improved variety seeds, and away from use but no sharing. The fact that the best-fitting model includes fixing the slope and intercept factor variances to 1 suggests that there is a wide range of starting points and a wide range of rates of change for individuals’ propensity for seed sharing in the data. The finding that model fit is best with variances fixed to 1 reinforces the appropriateness of the LCM approach to understanding seed sharing changes. Finally, the negative and significant covariance between the slope and intercept factor suggests that those with a higher starting point (less propensity to sharing improved variety seeds) have a steeper negative trajectory toward traditional or no use of improved variety seeds than do those with a lower starting point.

Given analysis presented in Chapter 6, the model parameter estimates presented in Table 8-8 could reflect the strong historical social pressure to share seeds, meaning that farmers who continue to hold that disposition will maintain their sharing activities (and thus have a smaller rate of change, since the decisions are more consistent over time). Those farmers who have
moved toward a more individualized approach to using improved variety seeds are still making decisions within a social milieu that puts pressure on them to share seeds, which could push them toward sharing or even not using improved variety seeds at all, in order to avoid the conflicting personal and social pressures. And because of the wide range of experiences with markets and market-oriented social infrastructure, individual farmers will have a wide-range of starting points just prior to entering the panel data set analyzed here in terms of their propensity to share seeds. The unconditional LCM selected and estimated here will be incorporated into a conditional LCM for seed sharing in the final section of this chapter in order to identify some key relationships between elements of the social setting, and individuals’ propensity to seed sharing and trajectory of change in that propensity.

**Unconditional and conditional models of latent output-value factor latent curves**

The models depicted in Figure 8-2 hypothesize a distinct latent growth curve that describes changes in seed saving and seed sharing activities separately. In Chapter 6, I identified seed saving and seed sharing as specific actions within Sahelian seed systems that could change over time, so that a LCM was an appropriate model to test for each indicator. The analysis presented in Chapter 7, when combined with the conceptual model of different dimensions of the seed system developed in Chapter 2, led to the creation of the full theoretical model presented in Figure 8-1. The full theoretical model depicts the relationships among changes in each dimension of the seed system, with the dimensions theorized as latent constructs measured by several indicators. Given the restrictions of the data set discussed earlier in this chapter, only the indicators u11 (seed saving) and u12 (seed sharing) can be used for LCM analysis because of problems of excess kurtosis and lack of full coverage. Seed saving is identified in Chapter 6 as a provisioning activity, motivated by social goals, and seed sharing as an activity that might or
might not have an economic end in mind, but which happens largely through social institutions. The analysis presented in Chapter 7 further explores the seed access habitus that exists in the Sahel, and argues that decisions about seed access are motivated in part based on the value of the crop production output to the individual. This value can be social (provisioning-based) or economic, and within economic valuation individuals and institutions can make decisions based on use, exchange or commodity-value. Using seed saving and seed sharing decisions as two indicators of an individual’s underlying assessment of the value of their agricultural production, Figure 8-3 presents a modified (in that it has only two indicators) unconditional LCM of changes in individuals’ valuation of their output over time.

Figure 8-3. Unconditional output-value latent curve model

The unconditional LCM of output value presented in Figure 8-3 is an extension of the LCM framework that includes an additional level of hypothesized latent factors whose trajectories are being measured by the latent intercept and slope factors. In the model in Figure 8-3, the latent factor \( v \) (value) represents an individual’s valuation of their output, as measured by seed saving and seed sharing activities. The indicators are scaled (as described in Table 8-1) so that higher categories represent values moving toward full commodity-value, and the latent factor \( v \) is therefore also scaled such that increasing \( v \) represents increasing ‘commoditiness’ of value.
The inclusion of repeated latent factors in the LCM framework does not change the specification or interpretation of the model, but it does increase model complexity by adding parameters to be estimated or specified (Bollen and Curran, 2006). The model in Figure 8-3 depicts how the repeated latent variables are related, through the covariance of their residual errors, a parameter that must be tested for invariance in the path analysis step of estimating the LCM. Because the observed indicators are categorical, testing the threshold parameters rather than the residual error terms of the indicators for invariance over time confirms that the measurement model is stable and fits reasonable well over time.

The parameters to be estimated in the model depicted in Figure 8-3, then, are the means and variances of the latent intercept and slope factors, the covariance of the latent intercept and slope factors, the covariances of the residual errors of the repeated latent factor, v, and the thresholds of the observed indicators, u11 and u12. A range of model parameterizations that increasingly added invariance to more parameters over time were tested in step-wise fashion, in order to select the best fitting model with only the appropriate parameters free to be estimated. Full parameterizations of the models are presented in Table A-1 in Appendix A, and the model fit indices for those models are presented in Table 8-9. I describe below the parameterization of the best-fitting model, and then present model parameter estimates of the best-fitting model in Table 8-10.
### Table 8-9. Overall fit measures for parameterized models of output-value trajectories (n=75)

<table>
<thead>
<tr>
<th>Model parameterizations$^3$</th>
<th>$\chi^2$ (adj.)$^1$</th>
<th>df</th>
<th>Sig.</th>
<th>TLI</th>
<th>RMSEA</th>
<th>BIC$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>42.403</td>
<td>11</td>
<td>.000</td>
<td>.896</td>
<td>.195</td>
<td>-5.089</td>
</tr>
<tr>
<td>Model 2</td>
<td>29.984</td>
<td>7</td>
<td>.000</td>
<td>.880</td>
<td>.209</td>
<td>-.238</td>
</tr>
<tr>
<td>Model 3</td>
<td>33.654</td>
<td>9</td>
<td>.000</td>
<td>.900</td>
<td>.191</td>
<td>-5.203</td>
</tr>
<tr>
<td>Model 4</td>
<td>33.057</td>
<td>11</td>
<td>.001</td>
<td>.927</td>
<td>.164</td>
<td>-14.435</td>
</tr>
<tr>
<td>Model 5</td>
<td>66.949</td>
<td>12</td>
<td>.000</td>
<td>.833</td>
<td>.247</td>
<td>15.139</td>
</tr>
<tr>
<td>Model 6</td>
<td>46.537</td>
<td>12</td>
<td>.000</td>
<td>.895</td>
<td>.196</td>
<td>-5.273</td>
</tr>
<tr>
<td>Model 7</td>
<td>34.210</td>
<td>9</td>
<td>.000</td>
<td>.898</td>
<td>.193</td>
<td>-4.647</td>
</tr>
</tbody>
</table>

$^1$Adjusted by MPlus with WLSMV estimator  
$^2$BIC= $\chi^2$ – df (ln (N))  
$^3$Details of model specifications in Appendix A – all models have time-invariant thresholds for categorical indicators

Using the BIC as well as all other fit statistics, the results in Table 8-9 suggest that Model 4 best fits the sample panel data, and that relationships between seed saving, seed sharing, and an underlying repeated latent factor are described sufficiently well by an LCM. Model 4 fixes indicator thresholds and latent repeat factor residual errors to be time-invariant, and sets the mean of the latent intercept factor to 0. All other parameters are freely estimated. Models 1, 2 and 3 represent parameterizations to test the measurement model, culminating in measurement invariance confirmed as the best fit in Model 4. Models 4 through 7 then provide path analysis to identify the best-fitting specifications for parameter estimations. The results of parameter estimation for Model 4 are presented in Table 8-10 and interpreted below.
Table 8-10. Model parameter estimates for unconditional LCM of output-value trajectories (n=75)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Parameter estimates for Model 4$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (p-value)$^2$</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>$0$ (-)</td>
</tr>
<tr>
<td>$\beta$</td>
<td>$-0.444$ (.001)</td>
</tr>
<tr>
<td>$\alpha$ with $\beta$</td>
<td></td>
</tr>
</tbody>
</table>

$^1$Chosen as best-fitting model using fit statistics in Table

$^2$Indicating that estimate is significantly different than 0

The parameter estimates for the best-fitting LCM of output-value trajectories presented in Table 8-10 suggest that there is a statistically significant (different from 0) negative slope for output-value trajectories in the sample and the population from which it comes, meaning that individuals are increasingly making decisions based on use-value or social value over time. The insignificance of the variance of the latent slope factor suggests that there are not between-individual differences in the rate of change over time, and the close-to-0 variance of the latent intercept factor suggests that there are not significant differences in terms of individuals’ initial valuation of the output of improved variety seeds. The insignificant covariance of the slope and intercept factors suggests that there is no clear relationship between starting point and rate of change, which makes sense given the highly insignificant variance of the slope and intercept factors – individuals all start from similar points in terms of valuing the output from improved variety seeds, and they move over time toward a valuation that is based on use-value or social value. I do not include estimates for the repeated latent factor $v$ because the combination of categorical indicators and having only two indicators for each repeated latent factor means that a numerical estimate of $v$ has little substantive meaning. I also recognize again the limitations of moving forward with a model that includes a significantly negative variance for a latent factor (intercept), but again refer to the caveats discussed above (and also in Wothke, (1993)) and move
forward to test a conditional model that includes covariates whose relationships with the dependent observed indicators might account for the sample fluctuations that give rise to negative variance.

The model selected in Table 8-9 and estimated in Table 8-10 fits the data and suggests that because there is a significantly non-zero latent slope factor, an LCM presents an appropriate foundation for testing and estimating a full structural model. Moving on to the final step, and ultimate goal, of SEM, I use the unconditional LCM of output-value trajectories as the foundation for the creation, specification and testing of a conditional LCM that includes time-variant, time-invariant and grouping covariates. As discussed at the beginning of this chapter, limitations of sample size and the number of waves of data gathered created a situation in which only two dependent observed variables, out of all of those theorized to be relevant in the full theoretical model presented in Figure 8-1, could be used in actual analysis here. Similarly, testing of the covariates determined that many of them were either inappropriately distributed (too skewed) or lacking sufficient data points to be potentially incorporate into the conditional LCM analysis. Because of the small sample size, only continuous covariates were possible to include when also including a dummy variable for between-group analysis (necessary to test the hypotheses of this research project about different trajectories for different groups within the population). Several of the covariates theorized to be time-variant did not in fact change significantly over time, and so were moved to the time-invariant side of the equation. Finally, because the indicators are categorical, it was possible include only one time-variant covariate. Figure 8-4 depicts the conditional LCM of output-value trajectories with all possible covariates.
The conditional LCM of output-value trajectories presented in Figure 8-4 includes all potential covariates, as well as three possible grouping dummy variables. The parameters to be estimated in a conditional model increase, to include the residual error variance of the intercept and slope factors, and the covariance of those errors. These residuals measure the amount of variation in the growth curve factors not accounted for by the covariates included in the model. Of more immediate interest are the path coefficients that estimate the relationship between each individual covariate and the latent growth factors, net of (controlling for) all other covariates. Starting from the full list of covariates presented in Table 8-1, I determined that x5 (age), x6 (years of PPB experience), x12 (distance from animateur), x15 (distance from weekly market) and w1 (household size) are the statistically stable time-invariant covariates to include in analysis of the conditional LCM. Time-variant covariates that can be included are either w4 (total area for all crops), w5 (total area for the crop species of interest) or w6 (total area for MVs of crop species of interest). In addition to exploring the relationships of time-invariant and time-variant covariates with the growth factors, I am interested in testing between-group differences of output-value growth curves, and so I estimated models using one of three grouping variables: d2.
(gender), d3 (crop), and d8 (union membership). Conditional LCMs were specified and evaluated in a stepwise fashion to first determine model fit for each dummy variable, then which time-variant covariate’s inclusion led to the best-fitting model, and finally the maximum number of time-invariant covariates that could be included and the model estimated. Full results of the model specification and testing process are presented in Table A-2 in Appendix A.

Once a best-fitting conditional LCM was specified and tested for each grouping variable, model estimates for path coefficients and factor parameters were estimated. The results of these estimates are presented in Table 8-11 (for gender), Table 8-12 (for crop) and Table 8-13 (for union membership). Interpretation of path coefficients and parameter estimates is provided after the related table for each model, followed by a summary comparison across models.

Table 8-11. Model estimates of relationships between gender, covariates and output-value latent trajectory factors $\alpha$ and $\beta$, and estimates of latent trajectory parameters

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Relationship between predictor variables and growth factors</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\alpha$</td>
<td>$\beta$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Path coefficient$^1$</td>
<td>Sig.</td>
<td>Path coefficient$^1$</td>
</tr>
<tr>
<td>Gender</td>
<td>1.539</td>
<td>.170</td>
<td>-2.308</td>
</tr>
<tr>
<td>Individual experience with PPB</td>
<td>.333</td>
<td>.009</td>
<td>-.305</td>
</tr>
<tr>
<td>Distance to animateur</td>
<td>.153</td>
<td>.012</td>
<td>-.070</td>
</tr>
<tr>
<td>Distance to weekly market</td>
<td>-.144</td>
<td>.030</td>
<td>.062</td>
</tr>
<tr>
<td>Household size</td>
<td>-.003</td>
<td>.836</td>
<td>.011</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Growth factor parameter estimates</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\alpha$</td>
<td>$\beta$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Estimate</td>
<td>Sig.</td>
<td>Estimate</td>
</tr>
<tr>
<td>Intercept$^2$</td>
<td>-</td>
<td></td>
<td>.599</td>
</tr>
<tr>
<td>Variance of residual error</td>
<td>-.377</td>
<td>.099</td>
<td>-.176</td>
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<tr>
<td>Covariance of residual errors</td>
<td>.373</td>
<td>.035</td>
<td>.373</td>
</tr>
</tbody>
</table>

$^1$Path coefficients measure the strength of the relationship controlling for all other covariates in the model

$^2$Intercept functions much like the mean in the unconditional LCM but is evaluated for significant rather than value
The model estimates presented in Table 8-11 describe the differences between men’s and women’s output-value trajectories controlling for other covariates, as well as the relationships among other covariates and growth factors controlling for gender and estimates of growth factor parameters. It is particularly important to assess gender differences net of other covariates, since the panel data statistics presented in Tables 8-2 and 8-3 suggest that there are significant relationships between gender and household size, and between gender and relationships to social infrastructure. The results suggest that there are significant differences between men and women in their latent slope factor. Men have a significantly more negative slope than do women, controlling for all other covariates. When gender is included as a covariate, net of gender there is also a significant relationship between individual experience with PPB and latent slope factor, with more years of PPB experience leading to a more negative slope for output-value trajectories. Significant relationships also exist between individuals’ proximity to social infrastructure and their latent intercept factor. Net of gender and other covariates, more experience with PPB leads to higher (closer to commodity-value orientation) starting points for output-value trajectories. Distance from an animateur is also positively related to more commodity-value orientation, and distance from a weekly market is negatively related to commodity-value orientation.

The path coefficients presented in Table 8-11 suggest that there are between-group differences, differences between men and women, in terms of the slope of their output-value trajectories. Because, as analysis in Tables 8-2 and 8-3 demonstrates, several of the covariates are significantly related to gender, the goal for between-group analysis is to actually test the need for between-group modeling (as is done and confirmed here), and then to test for within-group differences in order to understand interactive effects. My sample size, however, is not large enough to permit this type of multi-level modeling, and so the results presented here simply confirm that there are a range of significant relationships that are conditioned by gender, as well as there being significant differences between men and women in terms of their overall changes.
in valuation of improved variety output over time. The parameter estimates presented as well in Table 8-11 provide a bit more clarity into these between-group differences. The slope-intercept estimated here is for the group with dummy code=0, which in this case is women. Net of other covariates, women do not have a significant rate of change (the intercept estimate is not significantly different than zero). The variance of the residual errors are not significantly different from 0, suggesting that a significant portion of the variance in growth factors is explained by the covariates included in this LCM of output-value trajectories. However, the covariance of the residual errors for the latent growth factors is significant, suggesting that there are explanatory covariates omitted from this model. The results presented in Table 8-11 overall tentatively confirm the hypothesis that there are significant differences between men and women in output-value trajectories as one component of changes in seed access decision making.

Table 8-12. Model estimates of relationships between crop, covariates and output-value latent trajectory factors α and β, and estimates of latent trajectory parameters

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Relationship between predictor variables and growth factors</th>
<th>α</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Path coefficient¹</td>
<td>Sig.</td>
</tr>
<tr>
<td>Crop</td>
<td></td>
<td>.497</td>
<td>.464</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>.006</td>
<td>.278</td>
</tr>
<tr>
<td>Individual experience with PPB</td>
<td></td>
<td>.054</td>
<td>.188</td>
</tr>
<tr>
<td>Distance to animateur</td>
<td></td>
<td>.005</td>
<td>.727</td>
</tr>
<tr>
<td>Distance to weekly market</td>
<td></td>
<td>.021</td>
<td>.228</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Growth factor parameter estimates</th>
<th>α</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>Sig.</td>
<td>Estimate</td>
</tr>
<tr>
<td>Intercept²</td>
<td></td>
<td></td>
<td>-.111</td>
</tr>
<tr>
<td>Variance of residual error</td>
<td>-.476</td>
<td>.012</td>
<td>-.110</td>
</tr>
<tr>
<td>Covariance of residual errors</td>
<td>.339</td>
<td>.047</td>
<td>.339</td>
</tr>
</tbody>
</table>

¹Path coefficients measure the strength of the relationship controlling for all other covariates in the model
²Intercept functions much like the mean in the unconditional LCM but is evaluated for significant rather than value
A second hypothesis put forth in this research project is that seed access trajectories might differ by the crop for which seeds are being accessed. Because pearl millet is an open-pollinated species, in contrast to sorghum as a primarily self-pollinated species, it is possible that farmers using improved variety pearl millet seeds will be more likely than those using improved variety sorghum seeds to have an economic and commodity-value valuation of the output, since it is more imperative to repurchase open-pollinated seeds every year. Table 8-12 tests this hypothesis using a dummy variable to test for between-group differences in the growth curve factors, as well as to test for relationships between covariates and the growth curve, controlling for crop type. We see that there are no significant differences between pearl millet and sorghum systems in terms of individuals’ output-value trajectories, and that controlling for crop type, there are no other significant relationships between covariates and growth curve factors. The growth factor parameter estimates also presented in Table 8-12 suggest that the slope value for those using pearl millet (dummy variable=0) is not significantly different than 0, and this value does not widely vary across the population net of the covariates. The conditional LCM presented in Table 8-12 provides the best fit for the data when crop type is used as a dummy variable, but the significant and negative variance of the intercept residual error suggests that there are either sampling errors or model misspecifications. Given that the inclusion of gender as a dummy variable created a stable model, whose results are presented in Table 8-11, I argue that between-group differences are better modeled by comparing men and women than by comparing pearl millet and sorghum systems. In other words, the wide variance in the overall data that can lead to negative residuals variance is explained by the inclusion of gender as the grouping variable, but cannot be explained by the inclusion of crop (instead of gender) as the grouping variable.

One final hypothesis developed during first-level analysis in Chapter 6 is that proximity to or inclusion in social infrastructure might be significantly related to farmers’ seed access
decisions over time. I include as covariates several measures of proximity to social infrastructure, and to test for significant differences in terms of individuals’ inclusion in social infrastructure, I use union membership as a dummy variable. The resulting model estimates are presented in Table 8-13, and suggest that there are significant differences in the latent slope factor net of other covariates based on union membership.

Table 8-13. Model estimates of relationships between union membership, covariates and output-value latent trajectory factors $\alpha$ and $\beta$, and estimates of latent trajectory parameters

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Relationship between predictor variables and growth factors</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\alpha$</td>
<td>$\beta$</td>
</tr>
<tr>
<td></td>
<td>Path coefficient$^1$</td>
<td>Sig.</td>
</tr>
<tr>
<td>Union</td>
<td>-.241</td>
<td>.080</td>
</tr>
<tr>
<td>Age</td>
<td>.004</td>
<td>.502</td>
</tr>
<tr>
<td>Individual experience with PPB</td>
<td>.070</td>
<td>.040</td>
</tr>
<tr>
<td>Distance to animateur</td>
<td>.024</td>
<td>.091</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>$\alpha$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept$^2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variance of residual error</td>
<td>-.351</td>
<td>.148</td>
</tr>
<tr>
<td>Covariance of residual errors</td>
<td>.222</td>
<td>.029</td>
</tr>
</tbody>
</table>

$^1$Path coefficients measure the strength of the relationship controlling for all other covariates in the model

$^2$Intercept functions much like the mean in the unconditional LCM but is evaluated for significance rather than value

The results presented in Table 8-13 help to characterize multiple relationships between social infrastructure and individuals’ seed system orientation. Output-value trajectories are more positive for individuals who are members of a union than for those who are not. Controlling for union membership, an individual’s latent slope factor becomes less positive as distance to an animateur increases. There are also significant positive relationships between years of PPB experience and output-value starting point (latent intercept factor). All of these relationships
make sense in that union membership generally brings increased training in market engagement and opens market opportunities, so that individuals in the union will likely have a more economic-value orientation. In addition, controlling for union membership we then see that participation in PPB activities pushes up an individual’s starting point for valuation of the output of improved varieties. Finally, closer proximity to social infrastructure like an animateur further causes a less negative slope factor, which makes sense given the opportunity to access both information and inputs that animateurs can provide.

The growth factor parameter estimates in Table 8-13 suggest that those who are not members of the union (dummy variable=0) have a slope that is more negative than for members, and that controlling for all of the covariates, there is not statistically significant variance in the error terms of the slope or intercept factors. Again, the slight negative error variance is not statistically significantly different than 0, and I interpret these parameters to be negative due to sampling fluctuation. This suggests that between-group comparisons are appropriate to understand differences between union members and non-members, since controlling for the other covariates, there is a significant difference in the value of the slope factor. In addition, the covariance of the residual error terms suggest that there is additional fluctuation in the growth factors that is not accounted for by the covariates included in this model, and that could be caused by a common covariate (one with influence on both intercept and slope factors) that has been left out.

**Summary of conditional LCM for output-value trajectories**

Taken in sum, the results and analysis presented in Table 8-11, Table 8-12 and Table 8-13 suggest that the theoretical model developed first in Figure 8-1 and then modified in Figure 8-4 provides a reasonable structure for characterizing seed saving and seed sharing as indicators of
an underlying valuation by farmers of the output of improved variety seeds. This research project developed hypotheses about differences between men and women, and between pearl millet and sorghum systems, in terms of changes over time in all dimensions of seed systems, including output-value. The results presented in Tables 8-11 and 8-12 test these two hypotheses, and find that there are significant differences by gender in terms of output-value trajectories, but that there are not significant differences by crop species. In mixed-data analysis in Chapter 6, I also developed a secondary hypothesis that proximity to various types of social infrastructure might be related to significant differences in seed access decision making, and the results in presented in Table 8-13 test that hypothesis. I find that union membership is significantly related to differences in output-value trajectories, even when controlling for other, related elements of social infrastructure like proximity to an animateur.

All three conditional LCMs with latent response variables generate small negative variance estimates for certain growth parameters, which though insignificant, suggest that there are problems with sampling fluctuations. I therefore put forth the results of the full conditional LCM as reliable within the established framework of SEM (see Bollen and Curran, 2006), but also seek to more fully account for the sampling fluctuations caused by using a small data set with which to estimate models. One way to lessen the effects of small sample size is to simplify the model being tested, and in the following section, I take this approach to estimate conditional LCMs for seed saving and seed sharing, building on the models depicted in Figure 8-2.

**Conditional LCMs for seed saving and seed sharing**

In the following section, I test conditional LCMs for seed saving and seed sharing that incorporate the same covariates and grouping variables as the models depicted in Figure 8-4 and
estimated in Table 8-11, Table 8-12 and Table 8-13. By separating the growth factors for seed saving and seed sharing (rather than hypothesizing an underlying latent response variable as is done in the model depicted in Figure 8-4), I take a modified approach to testing between-group differences in a complex model with latent response variables. I estimate the conditional LCM for seed saving and for seed sharing to test for significant relationships between covariates and growth factor parameters for each indicator, rather than for their hypothesized common cause (latent factor), which allows for comparisons between seed saving and seed sharing trajectories.

**Seed saving conditional LCM testing and estimation**

Figure 8-5 depicts the conditional LCM for seed saving trajectories with all possible covariates and grouping variables.

**Figure 8-5. Conditional seed saving latent curve model**

The stepwise process for specifying and testing various models to arrive at the best-fitting conditional LCM for seed saving trajectories is the same at that described above for the output-value conditional LCM. Full results of the model testing process are presented in Table A-3 in
Appendix A. The best-fitting models for each between-group analysis (gender, crop, and union membership) are presented in Tables 8-14, 8-15 and 8-16. I briefly describe the results of each table below, and then summarize the key findings for characterizing seed saving trajectories.

Table 8-14. Model estimates of relationships between gender, covariates and seed saving latent trajectory factors $\alpha$ and $\beta$, and estimates of latent trajectory parameters

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Relationship between predictor variables and growth factors</th>
<th>(\alpha)</th>
<th></th>
<th>(\beta)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>\text{Gender}</td>
<td></td>
<td>.671</td>
<td>.396</td>
<td>-5.479</td>
<td>.522</td>
</tr>
<tr>
<td>Parameters</td>
<td>\text{Growth factor parameter estimates}</td>
<td>(\alpha)</td>
<td>(\beta)</td>
<td>(\alpha)</td>
<td>(\beta)</td>
</tr>
<tr>
<td></td>
<td>estimate</td>
<td>sig.</td>
<td>estimate</td>
<td>sig.</td>
<td>estimate</td>
</tr>
<tr>
<td>\text{Intercept}</td>
<td>0</td>
<td>-</td>
<td>2.513</td>
<td>.623</td>
<td>.424</td>
</tr>
<tr>
<td>\text{Variance of residual error}</td>
<td>-.469</td>
<td>.384</td>
<td>.424</td>
<td>.578</td>
<td>.219</td>
</tr>
<tr>
<td>\text{Covariance of residual errors}</td>
<td>.219</td>
<td>.566</td>
<td>.219</td>
<td>.566</td>
<td></td>
</tr>
</tbody>
</table>

\(1\) Path coefficients measure the strength of the relationship controlling for all other covariates in the model
\(2\) Intercept functions much like the mean in the unconditional LCM but is evaluated for significant rather than value

The results presented in Table 8-14 demonstrate that when using gender as the grouping variable, the best-fitting conditional LCM for seed saving trajectories includes gender as the only time-invariant covariate and all three time-variant covariates (which do not directly influence the growth factors and so their estimates are not presented here). There are no significant differences between men and women in terms of seed saving starting points or changes over time, and seed saving decisions are constant (there is no statistically significant rate of change). In other words, there is not an underlying growth curve present, which supports the bivariate findings in Chapter 6, that the majority of farmers save seeds, regardless of their other seed access activities. The variance of the residual errors of intercept and slope factors are not statistically significantly different from 0, suggesting that gender and time-variant covariates account for sampling fluctuations consistently across all individuals.
Table 8-15. Model estimates of relationships between crop, covariates and seed saving latent trajectory factors $\alpha$ and $\beta$, and estimates of latent trajectory parameters

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Relationship between predictor variables and growth factors</th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\alpha$</td>
<td></td>
<td>$\beta$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Path coeffi</td>
<td>Sig.</td>
<td>Path coeffi</td>
<td>Sig.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop</td>
<td></td>
<td>3.082</td>
<td>.630</td>
<td>-3.622</td>
<td>.626</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>.010</td>
<td>.650</td>
<td>.003</td>
<td>.905</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual experience with PPB</td>
<td></td>
<td>.071</td>
<td>.435</td>
<td>.028</td>
<td>.836</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance to animateur</td>
<td></td>
<td>-.046</td>
<td>.609</td>
<td>.029</td>
<td>.794</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance to weekly market</td>
<td></td>
<td>-.031</td>
<td>.828</td>
<td>.043</td>
<td>.767</td>
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<td></td>
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<table>
<thead>
<tr>
<th>Parameters</th>
<th>Growth factor parameter estimates</th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\alpha$</td>
<td></td>
<td>$\beta$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Estimate</td>
<td>Sig.</td>
<td>Estimate</td>
<td>Sig.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept$^2$</td>
<td></td>
<td>0</td>
<td>-</td>
<td>.694</td>
<td>.849</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variance of residual error</td>
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<td>.146</td>
<td>-.664</td>
<td>.639</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covariance of residual errors</td>
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<td>1.191</td>
<td>.328</td>
<td>1.191</td>
<td>.328</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^1$Path coefficients measure the strength of the relationship controlling for all other covariates in the model

$^2$Intercept functions much like the mean in the unconditional LCM but is evaluated for significant rather than value

The results presented in Table 8-15 demonstrate similar results to Table 8-14, though in this case, the best-fitting model when using crop species as the grouping variable included several time-invariant covariates. Across all path coefficients and growth factor parameter estimates, we find no significant differences in seed saving activities between those using improved variety seeds of pearl millet and those using sorghum. These findings contradict the hypothesis that those using improved variety pearl millet seeds will be less likely to continue to save their seeds over time, due to genetic deterioration, and will move on a trajectory toward seeing seeds-as-inputs as having economic rather than provisioning value.
Table 8-16. Model estimates of relationships between union membership, covariates and seed saving latent trajectory factors $\alpha$ and $\beta$, and estimates of latent trajectory parameters

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Relationship between predictor variables, and random intercept and random slope</th>
<th>$\alpha$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Path coefficient(^1)</td>
<td>Sig.</td>
</tr>
<tr>
<td>Union</td>
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<td>-1.727</td>
<td>.815</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>.002</td>
<td>.828</td>
</tr>
<tr>
<td>Individual experience with PPB</td>
<td></td>
<td>.188</td>
<td>.592</td>
</tr>
<tr>
<td>Distance to animateur</td>
<td></td>
<td>-.027</td>
<td>.806</td>
</tr>
<tr>
<td>Distance to weekly market</td>
<td></td>
<td>.043</td>
<td>.218</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Model parameter estimates</th>
<th>$\alpha$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Estimate</td>
<td>Sig.</td>
</tr>
<tr>
<td>Intercept(^2)</td>
<td></td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Variance of residual error</td>
<td></td>
<td>-1.187</td>
<td>.137</td>
</tr>
<tr>
<td>Covariance of residual errors</td>
<td></td>
<td>.867</td>
<td>.489</td>
</tr>
</tbody>
</table>

\(^1\)Path coefficients measure the strength of the relationship controlling for all other covariates in the model

\(^2\)Intercept functions much like the mean in the unconditional LCM but is evaluated for significant rather than value.

The results presented in Table 8-16 reinforce once again that there are not significant differences between groups of individuals in terms of their seed saving activities over time. When union membership is used as the grouping variable, there are no significant model parameter estimates, either of path coefficients or of growth parameter estimates. These findings again reject the hypothesis that engagement with social infrastructure will move people away from traditional, provisioning oriented activities and toward an economic valuation of seeds as inputs.

Taken together, the results presented in Table 8-14, Table 8-15 and Table 8-16 suggest that there are no statistically significant differences between men and women, between pearl millet and sorghum growers, or between union members and non-members in terms of their seed...
saving trajectories over time. The conditional LCM for seed saving, regardless of which
covariates are included, demonstrates that there is not in fact a slope factor that is statistically
significantly different from 0. In other words, there is no significant rate of change over time.
Individuals, regardless of their personal characteristics and their relationship to social
infrastructure, save seeds at about the same rates across groups and over time. These findings
contrast somewhat with the conditional LCM of output-value trajectories, and following the
exploration of seed sharing conditional LCMs, comparisons of all three conditional LCMs will
make explicit how to understand the difference conclusions drawn from each model.

**Seed sharing conditional LCM testing and estimation**

Figure 8-6 depicts the conditional LCM for seed sharing trajectories, with all possible
covariates and grouping variables.

Figure 8-6. Conditional seed sharing latent curve model

The stepwise process for specifying and testing various models to arrive at the best-fitting
conditional LCM for seed sharing trajectories is the same at that described above for the output-
value conditional LCM. Full results of the model testing process are presented in Table A-4 in
Appendix A. The best-fitting models for each between-group analysis (gender, crop, and union membership) are presented in Tables 8-17, 8-18 and 8-19. I briefly describe the results of each table below, and then summarize the key findings for characterizing seed sharing trajectories.

Table 8-17. Model estimates of relationships between gender, covariates and seed sharing latent trajectory factors $\alpha$ and $\beta$, and estimates of latent trajectory parameters

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Relationship between predictor variables, and random intercept and random slope</th>
<th>$\alpha$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Path coefficient $^1$</td>
<td>Sig.</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td>.456</td>
<td>.259</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>.009</td>
<td>.333</td>
</tr>
<tr>
<td>Individual experience with PPB</td>
<td></td>
<td>-.031</td>
<td>.711</td>
</tr>
<tr>
<td>Distance to animateur</td>
<td></td>
<td>.016</td>
<td>.550</td>
</tr>
<tr>
<td>Distance to weekly market</td>
<td></td>
<td>.038</td>
<td>.094</td>
</tr>
<tr>
<td>Household size</td>
<td></td>
<td>.013</td>
<td>.181</td>
</tr>
</tbody>
</table>

Much like the results for the seed saving conditional LCMs presented in the section above, the conditional LCM for seed sharing trajectories with gender as the grouping variable demonstrates very few significant model parameter estimates. There are no significant differences between men and women in terms of their seed sharing activities. The only significant path coefficient shows a significant positive relationship between distance to weekly market and likelihood of not sharing seeds (when controlling for gender), which makes sense.
given the extra cost and effort required for both men and women to purchase seeds when markets are further from their home. The covariance of the residual error terms of the growth factors is highly significant, which makes sense given the parameterization of the selected model, which specifies residual error variances to 1, but could also signify that a key covariate that would help explain more variance in the intercept and slope factors is not included in the model.

Table 8-18. Model estimates of relationships between crop, covariates and seed sharing latent trajectory factors $\alpha$ and $\beta$, and estimates of latent trajectory parameters

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Relationship between predictor variables, and random intercept and random slope</th>
<th>$\alpha$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Path coefficient$^1$</td>
<td>Sig.</td>
<td>Path coefficient$^1$</td>
</tr>
<tr>
<td>Crop</td>
<td>.087</td>
<td>.137</td>
<td>-.298</td>
</tr>
<tr>
<td>Age</td>
<td>.008</td>
<td>.376</td>
<td>.000</td>
</tr>
<tr>
<td>Individual experience with PPB</td>
<td>-.047</td>
<td>.576</td>
<td>.020</td>
</tr>
<tr>
<td>Distance to animateur</td>
<td>.016</td>
<td>.547</td>
<td>-.025</td>
</tr>
<tr>
<td>Distance to weekly market</td>
<td>.035</td>
<td>.098</td>
<td>-.060</td>
</tr>
<tr>
<td>Household size</td>
<td>.012</td>
<td>.215</td>
<td>.002</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Model parameter estimates</th>
<th>$\alpha$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>Sig.</td>
<td>Estimate</td>
</tr>
<tr>
<td>Intercept$^2$</td>
<td>0</td>
<td>-</td>
<td>-.140</td>
</tr>
<tr>
<td>Variance of residual error</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Covariance of residual errors</td>
<td>-.638</td>
<td>.000</td>
<td>-.638</td>
</tr>
</tbody>
</table>

$^1$Path coefficients measure the strength of the relationship controlling for all other covariates in the model
$^2$Intercept functions much like the mean in the unconditional LCM but is evaluated for significant rather than value

Table 8-18 present the results of the conditional LCM for seed sharing trajectories when crop species is the grouping variable included. The model estimations demonstrate that there are significant differences between seed sharing trajectories in pearl millet and sorghum systems, with the path coefficient for the relationship between crop species and slope factor suggesting that
those using sorghum seeds have a significantly more negative slope than those using pearl millet seeds (net of other covariates). In other words, those in sorghum systems move more quickly toward seed sharing or no use of improved variety seeds. Controlling for all covariates, the slope factor intercept for pearl millet users is not statistically significantly different than 0. The covariance of the residual errors of the growth factors is highly significant, again suggesting a missing covariate in the conditional LCM.

Table 8-19. Model estimates of relationships between union membership, covariates and seed sharing latent trajectory factors $\alpha$ and $\beta$, and estimates of latent trajectory parameters

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Relationship between predictor variables, and random intercept and random slope</th>
<th>$\alpha$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Path coefficient$^1$</td>
<td>Sig.</td>
<td>Path coefficient$^1$</td>
</tr>
<tr>
<td>Union</td>
<td>-.075</td>
<td>.317</td>
<td>.243</td>
</tr>
<tr>
<td>Age</td>
<td>.008</td>
<td>.387</td>
<td>.001</td>
</tr>
<tr>
<td>Individual experience with PPB</td>
<td>-.042</td>
<td>.613</td>
<td>.008</td>
</tr>
<tr>
<td>Distance to animateur</td>
<td>.017</td>
<td>.528</td>
<td>-.026</td>
</tr>
<tr>
<td>Distance to weekly market</td>
<td>.036</td>
<td>.084</td>
<td>-.066</td>
</tr>
<tr>
<td>Household size</td>
<td>.012</td>
<td>.214</td>
<td>.002</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Model parameter estimates</th>
<th>$\alpha$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>Sig.</td>
<td>Estimate</td>
</tr>
<tr>
<td>Intercept$^2$</td>
<td>0</td>
<td>-</td>
<td>-.412</td>
</tr>
<tr>
<td>Variance of residual error</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Covariance of residual errors</td>
<td>-.649</td>
<td>.000</td>
<td>-.649</td>
</tr>
</tbody>
</table>

$^1$Path coefficients measure the strength of the relationship controlling for all other covariates in the model

$^2$Intercept functions much like the mean in the unconditional LCM but is evaluated for significant rather than value

The results presented in Table 8-19 demonstrate that, net of the covariates, there are no significant differences between union members and non-members in terms of seed sharing activities over time (though the effect of union membership on the slope growth factor is
approaching significance). Controlling for union membership and all other covariates, there is a significant relationship between distance to the weekly market and the slope factor of the seed sharing trajectory, with those further from the market moving toward seed sharing activities. This contradicts the finding when gender is held constant, but given the range of other covariates, the meaning of this contrast is difficult to untangle. Finally, the model estimate of the slope factor intercept is not statistically different from 0, suggesting that seed sharing rates for union non-members are consistent and not changing over time. The covariance between the residual errors of the growth factors is highly significant, suggesting that there are important covariates left out of this conditional LCM model.

Overall comparisons among the conditional LCMs for seed sharing trajectories presented in this section suggest that seed sharing is largely consistent over time, though there are significant differences between seed sharing in pearl millet and sorghum systems, net of other covariates. The highly significant covariance of growth factor residual error suggests that covariates are missing from any one model. In addition, the contrast between the significance of the relationships between grouping variables and slope factor, and the non-significant zero value for the slope factor intercept for dummy variable=0 in all three conditional LCMs suggests either that a latent growth curve is not an appropriate model structure to understand rates of change in seed saving and seed sharing over time, or that there are more complex interactive effects among covariates that for technical reasons cannot all be included here. The model fit indices indicate acceptable representation by the models in Figures 8-4 and 8-5 for the panel data set, which is consistent with fit indices for the unconditional LCMs presented in Tables 8-5 and 8-7. Therefore, I suggest that the rates of change over time for seed saving activities and seed sharing activities are influenced by between-group and within-group covariates that are captured individually in the results presented in Tables 8-14 through 8-19, but which cannot be adequately incorporated into a more complex model given data limitations.
Summary

The initial research questions asked in this project focus on changes experienced by farmers in terms of the seed systems with which they interact and the seed access decisions they make. In order to understand how best to measure dimensions of Sahelian seed systems and individuals’ seed access actions within them, I used an initial mixed-analysis approach in Chapter 6 to derive indicators of the dimensions of seed systems. Hypotheses of the seed systems project coordinated by ICRISAT and of my own research project suggested that there could be significant differences between men and women, and between pearl millet and sorghum seed users, in terms of changes to seed systems and seed access actions. Initial analysis in Chapter 6 provided an additional hypothesis, that engagement with social infrastructure could have a significant influence on seed access decisions and change in seed systems. To test these hypotheses, in this chapter I utilized an SEM approach to latent growth curve analysis to model and test longitudinal changes in specific seed access actions and the dimensions of the seed system of which they are indicators.

The results presented in this chapter suggest that LCMs are appropriate models of change for seed saving and seed sharing trajectories, as well as for change in the theorized latent construct of output-value, for which seed saving and seed sharing are measurable indicators. Final, conditional model selection suggests that when modeling seed saving and seed sharing trajectories separately, there appears to be little change over time and little variation between groups, either based on gender, crop species or union membership. However, these models show a high degree of variation in terms of the relationship between other covariates, net of the grouping variable. For seed sharing, the conditional LCM fits best when residual variances of the growth factors are set to 1, suggesting that the incorporation of more covariates or complex relationships could create patterned relationships and differences in growth factors. One way to
add complexity is to theorize an underlying latent repeated variable, as is done in Figure 8-4 with the inclusion of the latent variable that measures valuation of the output of improved varieties. The conditional LCMs of output-value trajectories suggest that there significant difference between men and women, and between union members and non-members, in terms of changes over time in their valuation of the output of improved varieties.

Understanding the inclusion of a latent variable measuring output-valuation, and what it means for output-value to change significantly over time, requires re-engagement with the analysis of qualitative data presented in Chapter 7. Ideas about the relationships between social context, habitus and individual action help to explain why the output-value trajectory would be influenced by gender, crop species, union membership, and proximity to other types of social infrastructure. Habitus and the organizing principles for systems that it generates also helps to explain how individual farmers’ decisions about seed saving and seed sharing become indicators of valuation that is more or less oriented toward economic value or provisioning social value. By testing for changes in seed saving and seed sharing activities over time, I build here on theories of economic habitus and the underlying orientations of provisioning systems and substantive economies. By analyzing a panel data set and characterizing individuals’ decisions over time, the SEM approach to LCM allows for the identification of sub-groups of individuals that might have different economic habitus at the outset, as well as those sub-groups whose economic habitus might be changing at a different rate than others’. In Chapter 9, I synthesize the analysis of qualitative data presented in Chapter 7, which explores how substantive seed economies are defined, perpetuated and influenced by the social and natural context, with the statistical analysis presented in this chapter.
Chapter 9 Discussion

In this chapter, I synthesize the data and analysis presented in Chapters 5, 6 and 7, to characterize the distinct dispositions held by farmers in Sahelian West Africa that compel them to specific patterns of seed access decision-making. These actions reflect value associated with the output of the seed, and when organized by a consistent underlying principle, value-oriented action institutes a seed system. The underlying principles that organize seed systems, like other systems instituted to meet material needs, are generated by social memory, influence of the natural environment, individual experiences of social differentiation, and orientation toward the economic role that seeds (or some other good) play in the social system. Starting from current approaches to market-oriented sustainable agricultural development and the call for integrated seed systems (see Louwaars and de Boef, 2012), I expand the understanding of integrated seed system development to include more than interactions between the formal and informal systems defined in much of the literature. I identify instead several provisioning seed systems and substantive seed economies, each organized by a distinct foundational principle that defines the value of seeds and guides the social organization of seed access systems. Results of statistical analysis are used to explore the differential impacts on groups of individuals of pursuing the development and integration of specific subsets of seed systems. The action taken to access seeds, as well as the type of seed that can be accessed through a given system, create points of overlap and separation among the systems, and I visualize these relationships through the use of maps of seed use and spread. I argue that Sahelian seed systems are integrating new seed access possibilities into a dynamic seed system instituted by discrete social habitus and value orientations.
Understanding dynamic seed systems through substantive economies and habitus

This dissertation is based upon ongoing responses to the agrarian question, of how peasant agriculture organizes and re-organizes itself to persist in changing macro-economic and political conditions. I draw on the works of Polanyi, Bourdieu and theories of peasant studies to create a multi-level framework, presented in Figure 7-1, of how interactions between the natural environment and social systems across scales create conditions within which individuals make decisions to meet material needs that account for variation of influences and context. When evaluated within the frame of formal, rational economics, the heterogeneity of peasant systems can be characterized as more or less economically efficient, and points of inefficiency identified. This characterization is not necessarily judgmental, but rather uses a heuristic derived from formal economic theory to improve social and economic systems seen to be less than optimal in terms of potential for meeting material needs. International agricultural development efforts have consistently sought out points of weakness in agricultural systems in order to improve efficiency and ultimately, to enhance food security. Initially, technological challenges were identified and the Green Revolution launched in order to improve the technology able to increase efficiency in agricultural systems throughout the developing world. The neoliberal era then took a formal, macro-economic approach to identifying points of inefficiency, focusing on the role of markets and fiscal policy in generating or impeding profit-maximizing economic systems. The current incarnation of international agricultural development, as part of the ‘green capitalism’ global trajectory of the agri-food system (Friedmann, 2005), takes an integrated approach to identifying environmental, technological and economic inefficiencies and addressing them through market-oriented sustainable development.

In many ways, the market-oriented sustainable development approach is more nuanced than previous approaches to agricultural development, as it seeks to incorporate social and natural
context into the standardized formula of price-setting markets generating economic efficiency and therefore material well-being. There is recognition that social characteristics will affect individuals’ ability to participate in markets, and an awareness of the differences across types of goods in terms of the appropriate speed and scale of market creation and integration. However, returning to Polanyi’s (1957b) distinction between formal and substantive economies, the formal economic heuristic described above assumes that economic efficiency is the basic goal of all systems that function to meet material needs. The definition of economic activity that I offer in Chapter 3 instead presents material need as a basic human condition, and systems instituted to meet material needs as organized on specific principles that reflect the social and natural contexts within which the system operates. These systems can be economic (based on exchanges among individuals) or provisioning, and are instituted by patterns of individual actions organized by a distinct foundational principle. Polanyi (1957b), for example, identifies reciprocity, redistribution and efficient exchange as the goals or principles upon which economic systems have historically been based.

Individual actions to meet material needs, whether economic or social, are expressions of social habitus; economic principles are always embedded in, and derive from, social disposition. In other words, “the social world is present in its entirety in every ‘economic’ action” (Bourdieu, 2005: 3). The particular formal economic system as described by Polanyi (1944) is one in which social habitus identifies rational, efficient economic systems as the most desirable way to meet all material needs, eliminating the possibility of systems organized by some other principle that is reasonable, rather than rational, in the given social and natural setting. The scale at which formal economic systems operates is, as Bourdieu (1979) describes, often so different from the scale at which social habitus interacts with and understands the world that a shift toward market capitalism is jarring at best, and devastating at worst. However, habitus is by definition ever-emergent, and systems evolve because individuals incorporate personal experience and social
learning into ongoing understandings of value and foundational principles for organizing action. The skilling process that allows new experience to be incorporated into habitus takes time, and Stone (2004; 2007) makes explicit the need not only for spatial but also temporal-scale complementarity in the institution of new possibilities or imperatives in systems organized to meet material needs in general, and in seed systems in particular.

In analyzing current points of contact and integration across distinct seed systems in Sahelian West Africa, I seek to apply more general theories of alternative economies and social habitus instituting economic systems to agricultural development and peasant studies. Contemporary discussions of peasant agriculture as an organizational form continue to ask the original agrarian question of if and how peasant systems persist in the current market-oriented global economy (McMichael, 1997; Birner and Resnick, 2010; van der Ploeg, 2013). The data analysis presented throughout this dissertation and synthesized below suggests that peasant seed systems are changing to incorporate the formal market-oriented seed economy being instituted through many agricultural development projects, and that peasant seed systems maintain distinct patterns of decision-making on the basis of separate organizing principles. The analysis shows that provisioning seed systems persist and adapt even in the contemporary macro-economic climate that definitively emphasizes market-oriented development. Identifying this pattern, and using statistical tests to understand for whom provisioning seed systems work, contributes to critical understandings of the differentiated effects of the current dominant approaches to international agricultural development. In addition to critique, I also seek to build constructive understandings of the complimentary and independent social and economic systems instituted by Sahelian farmers to contribute to understandings of the ongoing agrarian question in a particular geographic and social location.
Categorizing and contextualizing organizing principles of Sahelian seed systems

Seeds are foundational both to agricultural production, as a primary input and basic material need, and to food security for rural families and communities. Because of the complex role that seeds play in agrarian society, seed systems share the common purpose of providing access to seeds, and are then organized by a specific principle relevant to the habitus being expressed. Social habitus includes but is not limited to economic habitus, a point that is particularly salient as we consider not only economic but also provisioning seed systems, and the organizing principles that underlay them. Habitus identifies the social or economic value of seeds as it relates to specific characteristics of the natural and social setting. Individual seed access decisions across dimensions of the seed system then reflect the habitus instituted in a given seed system. Table 9-1 presents descriptions of the five seed systems identified in analysis presented in Chapters 5 and 6, using theoretical and conceptual categories drawn from literature presented in Chapters 1 and 2.

Table 9-1. Categorization of organizing principles and dimensions of Sahelian seed systems

<table>
<thead>
<tr>
<th>Organizing principle</th>
<th>Type of system</th>
<th>Access actions</th>
<th>Seed types</th>
<th>Value of output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability</td>
<td>Provisioning</td>
<td>Saving</td>
<td>Local</td>
<td>Social value</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Creolized</td>
<td>Social value</td>
</tr>
<tr>
<td>Sufficiency</td>
<td>Provisioning</td>
<td>Gifting</td>
<td>Local</td>
<td>Social value</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Creolized</td>
<td>Social value</td>
</tr>
<tr>
<td>Parity (reciprocity)</td>
<td>Economic</td>
<td>Non-formal exchange</td>
<td>Local</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Informal exchange</td>
<td>Creolized</td>
<td>Social value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Formal exchange</td>
<td>Improved</td>
<td></td>
</tr>
<tr>
<td>Reasonable return</td>
<td>Economic</td>
<td>Non-formal exchange</td>
<td>Local</td>
<td></td>
</tr>
<tr>
<td>(redistribution)</td>
<td></td>
<td>Informal exchange</td>
<td>Creolized</td>
<td>Social value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Formal exchange</td>
<td>Improved</td>
<td></td>
</tr>
<tr>
<td>Utility maximization</td>
<td>Economic</td>
<td>Formal exchange</td>
<td>Improved</td>
<td>Commodity-value</td>
</tr>
<tr>
<td>(efficient exchange)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9-1 offers a categorization of the seed systems currently present in Sahelian West Africa, including the recently established formal seed markets that are part of a broader push for the development of sustainable seed value chains. Seed systems can be categorized as either
provisioning or economic, based upon the definitions of economy and provisioning that I offer in Chapter 3. Provisioning seed systems provide seed access through non-exchange based interactions between individuals and the natural world, in the case of seed saving, or through social interactions between individuals; for example, seed gifts can reflect religious or familial responsibilities. Economic seed systems provide seed access through some type of exchange between individuals; these exchanges reflect the economic value associated with the output or production that comes from the seeds as inputs. Within both types of seed systems are separate configurations of access actions and values that reflect distinct organizing principles and combinations of influence from the social and natural setting.

**Provisioning seed systems**

Provisioning, as described by van der Ploeg (2010), was considered an autarkic action in an idealized past of agricultural independence and self-sufficiency, but for contemporary peasants provisioning systems reflect intentional decisions about how best to organize systems to meet their material needs. Polanyi (1977) makes a similar argument in describing the decision to orient toward self-support or householding as the privilege of farmers and households with enough accumulated knowledge and experience to reliably meet their material needs through provisioning activities. In other words, skilling (Stone, 2004) must occur within variable social and natural settings in order for provisioning systems to be instituted. Because the context of agriculture is heterogeneous and changeable, skilling leads to provisioning seed systems that are organized on principles that can provide buffer against uncertainty and vulnerability (Richards, 1985). Analysis presented in Chapter 6 suggests that rainfall and genetic traits are key features of the natural environment that farmers incorporate into seed system actions, along with
characteristics of the social setting, including agricultural and food preferences, and connection to social infrastructure.

Based on analysis in Chapter 7, I identify in Table 9-1 two separate provisioning seed systems, based on principles of stability and sufficiency. Provisioning seed systems based on stability are instituted by farmer seed saving activities – in other words, through individuals’ interchanges with their natural environment. The social value associated with seeds in the stability-oriented provisioning seed system is influenced primarily by the natural environment, and reflects a habitus that reflects experiences of drought and environmental uncertainty. Provisioning seed systems based on sufficiency are instituted by seed gifts. Seed gifting is a non-exchange based social transaction because only one person receives something material (seeds) from the interaction, and because the value of the seed gift comes from a social setting that prioritizes community-level food security as a means of buffering against uncertainty in the natural and social (including economic) environment. Farmers’ comments about the solidarity associated with seed gifts, as well as the adamant stance taken by some that seeds are not something to be either sold or exchanged, suggest a distinct habitus skilled by social history that connects individual well-being to communal well-being.

An important component of the theoretical framework that connects skilling to shifts in habitus that institute provisioning seed systems is the temporal scale being expressed and incorporated. Skilling take time to fully institute new or adapted systems, and the time frame associated with subsistence systems is often assumed to be short-range and reactive. The analysis of provisioning seed systems as being constructive and intentional reflects related research findings that argue for peasant agriculture having context-appropriate time preferences (see for example, Moseley, 2001). In drought-prone areas, habitus oriented toward stability could take a flat view of time by effectively only assuming the worst and making decisions based on the immediate future. Skilling and householding, however, require the time necessary for farmers to
incorporate experience and knowledge of new types of seeds or new access points into their systems. Table 9-1 identifies both local and creolized (second-generation improved) variety seeds as theoretically accessible through provisioning systems, with the implication that farmers will make calculations about reusing creolized seeds rather than repurchasing improved variety seeds. Results of the seed saving LCM in Chapter 8 similarly suggests (because slope factors are not significantly different from zero) that once farmers have one year of experience saving and then replanting creolized seeds, they will continue to include those seeds in provisioning seed systems. The skilling actually occurs over several years, as farmers save and replant, and then make calculations about the following year based on experience with the new seeds.

Substantive seed economies

The economic seed systems categorized in Table 9-1 reflect Polanyi’s (1957b) description of substantive economies, within which a formal economic system based on profit-maximization and market exchanges for commodity-value of goods is only one possibility. Substantive seed economies involve some type of exchange between individuals, wherein both gain a material good, and where value and cost are determined by the organizing principle of the specific seed economy. The value of the output of seeds in substantive seed economies reflects the Marxian categories of use-value, exchange-value and commodity-value. I begin with the value orientation of substantive seed economies rather than the organizing principles to highlight the heterogeneity in motivations for engaging in economic exchanges to access any type of seed. The value chain approach to agricultural development, and seed system change in particular, assumes that farmers are motivated by utility-maximization and rational, rather than reasonable, calculations about costs and benefits of buying and using improved variety seeds. Get the links in the chain right, reflective of the contextual costs and benefits, and farmers will integrate
themselves into seed value chains, thereby fully instituting a profit-maximizing substantive seed economy (Kaplinsky, 2000). Seed system integration via value chains does not admit the possibility that farmers might see the output of seeds as having use-value or exchange-value, and might therefore orient toward economic systems organized by the principles that prioritize other goals than efficiency.

Parity-oriented substantive seed economies see use-value in the output of seeds. As described in Chapter 7, food, fodder and building materials are valued for many people first because of their integral role in what were historically self-contained systems. In other words, the same habitus that, when influenced primarily by risk and uncertainty, leads to provisioning can also push farmers to engage in some type of economic exchange with the goal of equal exchange so as to ensure communal well-being (because no one is gaining or losing). Parity-oriented substantive seed economies can be seen as the first step in the shift from provisioning toward utility-maximizing economic decision making. However, the Marxian (1978) view of use-value economies facilitating simple circulation suggests that use-value can institute economies that persist rather than define a moment of transition. The organizational principle of parity for use-value exchanges that I see expressed in Sahelian West Africa reflects a social habitus unsure about using seeds as an economic good, in part because of the social mandate to care for the community and the foundational role that seeds play in these communities.

The parity-oriented substantive seed economy is embedded within a social system that discourages exploitation or accumulation, and the habitus that institutes this system incorporates any type of exchange and any type of seed, as long as the exchange produces equal gain. Non-formal exchanges like equal quantities or measures of grain for seed are indicative of use-value, as are informal and formal exchanges wherein farmers see the cost as equal to the value they will receive at the end. This value is not a price, since use-value is an empirical but interpretive measure that is contextualized and so inherently not able to be standardized by money. Instead,
use-value is defined by social habitus and individual experience, and so always evolving. The type of seed that is accessed in parity-oriented substantive seed economies is similarly varied. Farmers’ comparisons of the use-value of yields, high germination rates and reliability of the product, in comparison to the monetary price of improved variety seeds accessed through formal exchanges, belies their own calculations about the relative costs and outputs of using improved variety seeds.

Marx (1978) describes economic systems that validate use-value as instituted by simple circulation, and though historical materialism might have seen them as an ephemeral configuration in the shift toward capitalist agriculture, peasant studies has long argued that parity-oriented economies are reasonable in many agrarian societies. Even less durable than systems based on use-value were, for Marx, those recognizing and built upon exchange-value. Exchange-value signifies a rupture with provisioning and economic activity based solely on material comparability; suddenly, capital can bestow abstract rather than material value, which creates the potential for unlimited accumulation and leads to a formal-rational definition of efficiency. However, experience with returns-on-investment (profit) necessarily institutes not only formal economies but also economic systems, like Hart’s (2006) informal markets, that embed profit generation in social context. In Table 9-1, I identify a substantive seed economy organized on the principle of reasonable return that recognizes potential exchange-value in seeds and remains conditioned by social expectations of non-exploitation and communal care. Farmers descriptions of exchanging two measures of local grain for one measure of improved variety seeds reflects Bourdieu’s (2005: 9) description of economic habitus making ‘reasonable’ calculations based on the social and natural context within which exchange occurs.

Reasonable return-oriented substantive seed economies are instituted by a calculating economic habitus embedded in a social habitus that recognizes benefit both in rewarding value-added economic activity and in tempering the degree to which value can be accumulated by
individuals. The negotiation among different dispositions within habitus expressed in reasonable return-oriented seed economies allows for the potential incorporation of any type of exchange and any type of seed. Certified improved varieties sold to family members at a lower-than-market price, and landraces sold at a higher price in local markets for specific uses, like sorghum beer in Burkina Faso, are both examples of calculations of exchange-value made by individuals in actions that institute an economic system based on reasonable return. Because this substantive seed economy is embedded within a social system that prioritizes communal well-being, the price or terms of exchange must be reasonable not only with regard to the financial or material assets of the two parties, but also reasonable in terms of the potential for accumulation. Exchanges in economic systems based on reasonable return are largely conducted through social institutions like kinship and embedded economic institutions like local marketplace relationships. Both the parity-oriented and reasonable return-oriented substantive seed economies described by farmers reflect Hopkins’ (1957) description of economic embeddedness as “economies whose constituent actions are patterned through their occurrence in non-economic roles” (299).

The language of substantive economics, economic disposition conditioned by social habitus, and reasonable calculations of value remains relevant for the profit-maximizing economic system articulated in classical economic theory. Polanyi (1944) describes the formal economy as a particular substantive economy, wherein social habitus has shifted to prioritize individual accumulation as the best means to meeting material need, making the rational economic calculation of efficiency reasonable and instituting a system organized on the principle of utility or profit-maximization. The utility maximization-oriented substantive seed economy in Sahelian West Africa is largely being instituted, at least initially, by seed value chain development projects and organizations that operate at a broader social scale than the household or village level. As shown in Table 9-1, this system is instituted by formal exchanges of improved variety seeds – other types of exchanges and other types of seeds do not allow for the
full expression of commodity-value because they are not standardized enough to allow value, as reflected in price, to be determined within price-setting markets. In the profit-maximizing seed systems envisioned by the development of seed value chains, farmers would be motivated by individual gain through efficient decision making, in part based on experiences of price-setting markets both for seeds as inputs (where they are consumers) and for grain and seeds as outputs (where they sell their production). For the most part, analysis of farmers’ initial experience with the profit-maximizing seed economy suggest that commodity-value, reflected in prices set by markets for either grain or seeds produced, is not recognized by most economic actors in the region. Farmers report difficulty in selling the grain of improved varieties in local or regional markets, with buyers and wholesalers unfamiliar with the varieties and so making reasonable calculations about their value within Sahelian markets and food systems.

Seeds (as an output of agricultural production) have a commodity-value within the seed value chain, but as explored extensively in this dissertation, the social habitus of many farmers in the Sahel rejects profit-maximizing seed sales because of the foundational role that seeds play in individual and communal well-being. Economic activity based on commodity-value requires a social habitus oriented toward individual accumulation to institute price-setting markets. Hopkins (1957) describes formal market economies as “near the zero end of the ‘embeddedness’ spectrum,” meaning that social habitus has shifted to identify economic calculations of efficiency as the organizing principle for systems to meet all material needs (299). As mentioned in the introduction to this dissertation, many economic theorists have recognized the potential for formal market economies to efficiently meet material needs in ways that might not be socially desirable (by creating high rates of inequality or environmental externalities). The response within classical economics to this challenge has been to embed social systems within economic systems, to provide secondary support or buffer for individuals and communities where social goals of care or access to basic resources are not met by the market system. Analyzing exchange
activity through the lens of substantive economies, however, allows for an understanding of
economic embeddedness that identifies organizing principles for exchange activity that reflect an
economic habitus conditioned by and embedded within experiences of social history and natural
context expressed in the broader social habitus.

Based on Polanyi’s (1944; 1957a; 1957b) extensive writing about substantive economies,
Hopkins (1957) identifies three dimensions of substantive economic analysis: degree of
embeddedness, type of movement and form of integration. I focus here on the first and third of
these, and explore type of movement below using maps to visualize distinct seed systems.
Degree of embeddedness cannot be discretely identified, but rather exists on a spectrum that is
expressed through negotiation between social and economic habitus. In the Sahel, provisioning
seed systems are not economic in that there is no exchange activity, and the economic habitus that
distinguishes seeds as a social good reinforces rather than challenges the social habitus oriented
toward stability or sufficiency. In other words, economic habitus is completely embedded to the
point of being non-distinguishable from more general social habitus. In substantive seed
economies, economic habitus emerges as having an orientation at times at odds with that of social
habitus. The resulting organizing principles of parity and reasonable return reflect the relative
strength of economic habitus in the calculation process that institutes seed economies based on
use-value or exchange-value. In profit-maximizing formal seed economies, the idealized
assessment of embeddedness suggests a complete subsuming of social habitus by economic
habitus (Polanyi, 1944). As Granovetter (1985) argues, however, market economies rarely if ever
attain the purity theorized by classical economic, and instead both economists and sociologists
agree that formal market economies retain a degree of negotiation between social and economic
habitus. The sustainable value chain approach to seed system is an example of how skillling at
local and extra-local levels throughout the neoliberal period, wherein it became clear that natural
context and social history (embodied in social habitus), is currently being incorporated into new iterations of market-oriented development (see Birner and Resnick, 2010).

The substantive seed economies present in Sahelian West Africa and identified in Table 9-1 are instituted by habitus oriented toward organizing principles of parity, reasonable-return and utility-maximization. I induced these categories through thematic coding and analysis of qualitative data (presented in Chapters 6 and 7), and see the organizing principles presented in Table 9-1 as specific to Sahelian seed systems. These organizing principles generate forms of integration of substantive seed economies, and reflect Polanyi’s (1957b) more general categories of reciprocity, redistribution and efficient exchange. Polanyi argues that these forms of integration must be institutionalized beyond repeated interpersonal interactions, and I add as well that the institutions that integrate specific seed systems must be identified and understood in context. In the Sahel, parity-oriented substantive seed economies are integrated through reciprocal institutions like family, kinship and village that generate individual responsibility for communal well-being. Seed economies oriented toward reasonable return are integrated through redistribution via institutions like local markets and informal exchange systems, which govern how much accumulation is possible. Finally, utility-maximizing seed economies are working toward integration through efficient exchange in institutions of price-setting markets, which, as discussed above, are being largely established by external organizations.

Characterizing who institutes and has access to which Sahelian seed systems

The forms of integration, organizing principles and institutions necessary for each distinct seed system reflect a specific habitus that interprets social history and natural environment in concert with individual experience. This is Bourdieu’s (1984) description of habitus as the “objective relationship between two objectivities” (101). In other words, an individual farmer
making decisions about which seed system to use does not reflect upon his or her ultimate motivation for action and the social ramifications of it. Instead, the social and natural history contained in habitus is filtered through individual subjectivity, so that the discrete options about what type of access activity and what type of seed to use are assessed on the basis of individual experience, and decisions made accordingly. Habitus is the objective relationship between the material world and individual experience, and is simultaneously a subjective social phenomenon that generates patterns of action across groups of individuals. Habitus differs across contexts, and also differs within a given setting based on individual characteristics that identify groups. The research questions in this dissertation related to gender differences in seed access actions and appropriate seed systems, as well as differences between sorghum and pearl millet seed systems, identify possible characteristics of an individual or setting that influence habitus and so the type of seed system instituted.

In Chapter 8, I used an SEM approach to latent growth curve analysis to answer research questions related to changes over time in seed systems, and whether groups of individuals experience those changes differently from one another. The measurable observed indicators of actions within different dimensions of the seed system were identified in initial analysis in Chapter 6, and by gathering repeating measures of the same indicator, LCM was chosen to test and model the movement of individual toward certain patterns of seed access actions. As shown in Table 9-1, a single indicator, like type of activity used to access seeds, can be an indicator of several distinct types of seed systems. When multiple indicators are combined and used to measure an underlying latent construct like formality of exchange, the theoretical model then tests for something approximating habitus, in that it tests for a disposition moving toward or away from the organizing principle of utility-maximization. Though data constraints limited testing the full theoretical model presented in Figure 8-1 in Chapter 8, the latent growth curves for seed
saving and seed sharing, as well as the latent factor of output-value, provide insight into questions about changes over time, and whether those changes differ across groups of individuals.

The bivariate analysis presented in Chapter 6 suggested that there were no significant difference between men and women in terms of seed saving or seed sharing, with the majority of both men and women saving and sharing seeds each year. Crop species was found to be significantly related to seed saving, with far higher rates of seed saving for pearl millet than for sorghum. In addition, initial analysis showed the union membership was significantly related to seed saving and seed sharing, with higher percentages of union members saving and sharing seeds each year. The latent growth curves in Chapter 8 then test for differences between groups in rates of change in seed saving and seed sharing decisions over time. Tests of the model in Figure 8-5 find that seed saving, as the discrete action instituting the stability-oriented provisioning seed system, is present and consistent over time, without significant differences between men and women, sorghum and pearl millet, or union members and non-members. The stability-oriented provisioning seed system aligns with habitus present across social difference in the Sahel.

The model in Figure 8-6 in Chapter 8, depicting seed sharing trajectories, is less precise than tests for changes in seed saving, because seed sharing includes gifts and non-formal (non-monetary) exchanges based on either use-value or exchange-value. There is not a one-to-one correlation between seed sharing and a specific seed system. However, seed sharing as an access action approximates descriptions of the informal or local seed systems described in much of the seed system literature, where social interactions of some type, both exchange and non-exchange based, are considered the basis for seed access (see for example Almekinders et al., 1994; Sperling and McGuire, 2010). The most important finding from tests of the model in Figure 8-6 is that the best-fitting model sets the variance of residual errors of the growth factors to 1, meaning that there is intra-individual variation in trajectories toward or away from seed sharing,
but that the covariates included in any of these models are not adequate predictors of those variables. If the seed sharing model captures much of what are considered informal seed systems, there is no evidence to suggest that with the establishment of formal, profit-maximizing seed systems, there is differentiation on the basis of gender or participation in social infrastructure (union membership). However, the residual variance terms do suggest clear subgroups within the population who move toward or away from market-oriented seed systems, so that we can anticipate inequality or differentiation on the basis of some as-yet unknown covariate or demographic characteristic.

Modeling and testing changes in seed saving and seed sharing activities over time provide broad characterizations of types of seed systems being instituted in Sahelian West Africa. In the model of integrated seed system change is offered in Figure 8-4 in Chapter 8, seed saving and seed sharing are considered observed indicators of output-value, since each is an action taken at the end of the growing season and is indicative of the values identified in Figure 9-1 above. Combining even these two measures as indicators of a higher-order latent construct allows for more precise model than the simple latent growth curves for each separate indicator, because it is combinations of actions and motivations that define specific seed systems. Tests of the model in Figure 8-4 show that men are moving toward engagement with the utility maximization-oriented seed economy at a slower rate than women, which seems counterintuitive to the hypotheses put forth by the seed systems project of which this dissertation is a part, as well as to the general literature that suggests that women are more oriented toward provisioning seed systems. However, when combined with analysis in Chapter 6, which shows that men are significantly more likely to buy improved variety seeds than women, non-significant rate of change for women suggests that men have had a period of skilling and so are more likely to display a clear disposition in relation to the formal seed system.
Similar results are found for the relationship between union membership and disposition for the formal seed system. Testing the model in Figure 8-4 shows that union members move less quickly (have a less negative rate of change) away from the formal seed system, though both members and non-members demonstrate consistent engagement with provisioning seed systems through seed saving. Union members, being engaged in social infrastructure, have had access to an experiential and social skilling process, and the less steep trajectory toward informal or provisioning seed systems could reflect a shift in habitus so that economic efficiency is included in and challenges social habitus that orients toward sufficiency or parity. Interestingly, results of the qualitative analysis suggest that farmers who engage with the formal, profit-maximizing seed system are more comfortable continuing to save seeds for their own re-use than with any type of seed sharing or informal seed sales with improved varieties. One possible interpretation of these combined results is that with the emphasis on individual-level calculations and efficiency that is evident in the value chain approach to seed system development, economic habitus remains embedded in a social habitus that increasingly orients toward individual and family, rather than communal, well-being.

**Visualizing connected and integrated Sahelian seed systems**

The overlap between stability-oriented provisioning seed system and profit maximization-oriented seed economy described above is one type of integration that can be seen among the seed systems categorized in Table 8.1. Integration can occur as the result of skilling and shifts in habitus that institute connections between otherwise separate systems but maintain the distinct organizing principles of each. Similar to Polanyi’s distinction between formal and substantive economies, I make a distinction here between integration-by-incorporation, and integration-by-interconnection. At the global and macro-economic levels, economic integration
generally means the incorporation of non-market-oriented economic and social systems into the dominant capitalist economy. In Africa, integration-by-incorporation at the global scale has led to differentiated and inequitable impacts for individuals and communities whose own systems are organized by principles that are reasonable in their context and do not necessarily include utility maximization (Daviron and Gibbon, 2002; Nissanke and Thorbecke, 2008). Recognizing that peasant economic and social systems are organized by distinct and consistent internal logic, another form of integration among systems is emerging that builds upon interconnection and continued distantiation rather than incorporation and capitulation of separate systems (van der Ploeg, 2008).

To visualize the integration described by farmers and analyzed in this dissertation, I created a series of maps for one site in each country. Maps for Dioila, Mali are presented in Figures 9-1, 9-2 and 9-3 the body of this chapter, while those for Dédougou, Burkina Faso and Serkin Haoussa, Niger are presented in Appendix 2. The maps in Figure 9-1 depict seed saving, seed sharing, and seed sales as three distinct seed access actions that can institute a single seed system or set of seed systems. The final map in Figure 9-1 shows all three types of actions, to visualize the relative extent and points of overlap for each seed access action. Analysis of feedback from group mapping exercises confirms the point made by Djurfeldt (2013), that market or economic system integration in Africa happens at the village scale, and so maps depict seed access actions with village as the unit of analysis. The maps in Figure 9-1 combine data from 2010, 2011 and 2012 to depict the full extent of seed spread within the sample for all three years. Figure 9-2 adds social infrastructure as an additional element related to seed system integration to visualize the market-oriented institutions that might facilitate connections among seed systems. Finally, Figure 9-3 then presents two maps that depict the points of overlap among seed systems and related seed spread in 2010 and 2011, and again in 2012 and 2013.
Figure 9-1. Seed spread through seed access actions, Dioila, Mali, 2010-2012
Figure 9-2. Relationships between social infrastructure and seed systems, Dioila, Mali, 2010-2012

Figure 9-3. Connection points of seed systems, Dioila, Mali, 2010-2012
The first 3 maps presented in Figure 9-1 above, as well as in Figures B-1 and B-4 in Appendix B, show the extent of each type of seed access action. Seed saving, seed sharing (which includes gifting and non-formal exchanges) and seed sales are measurable and representable actions taken by farmers to access seeds, and seed saving actions institute the stability-oriented provisioning seed system. Seed sharing and seed sales, as described in Table 9-1, can institute a range of seed systems depending on the organizing principle of the system and the value associated with the output. The final map in Figure 9-1, which shows the points of overlap of distinct seed access actions, helps to clarify the type of seed systems being instituted in relation to improved variety seeds. In almost every village to which seeds are sold, there is saving; farmers who buy improved variety seeds in formal markets and then save them are instituting a parity-oriented seed economy and at the same time, incorporating creolized seeds into the stability-oriented provisioning seed system already used for landraces. Seed sharing is also largely connected to seed saving, reinforcing the point made above: provisioning seed systems and parity-oriented seed economies are connected by a common social habitus that prioritizes communal well-being over personal gain.

Figure 9-2 adds an additional layer to the seed access maps by including social infrastructure that facilitates access to improved variety seeds. Building on Louwaars and de Boef’s (2012) distinction between development-oriented and market-oriented seed value chains, I distinguish between the presence of testers (farmers conducting PPB field trials), and agrodealers and local weekly markets. Animateurs and farmer organization representatives can support either type of value chain, and because these are ICRISAT’s partners in seed system development projects, the potential exists for either type of seed value chain development. The programmatic implications of the ambiguous role played by international public research institutions and local farmer organizations will be discussed in the Conclusion chapter. With the map in Figure 9-2,
however, it is important to note that while seed sales clearly originate from market-oriented social infrastructure, seed saving and sharing is occurring in villages where field trials provide access to creolized seeds (in that they have been saved for at least one year) as well as in villages originally connected to improved variety seeds through market-oriented institutions.

The maps in Figure 9-3 visualize seed spread at the village level in Dioila, Mali, and the connection points among seed systems that facilitate that spread. The first year of sales of mini-packets of improved varieties was 2010, and the map on the left in Figure 9-3 shows the extent to which seeds were spread through sales in 2010 and further through other seed systems in 2011. In almost every village to which seeds were sold, seeds were then saved at the end of 2010, meaning that creolized seeds were incorporated into stability-oriented provisioning seed systems. That saving also generated some seed sharing in 2011, mostly within the same village as seed saving, but there was some additional seed spread through inter-village sharing. Two years later, in 2012, the map on the right in Figure 9-3 shows a decline in seed sales and many villages in which saving of creolized seeds continued from year to year. In 2013, the dominant (in terms of extent) seed system is a stability-oriented provisioning system instituted by seed saving and facilitating the use of creolized (for two or three years) seeds.

**Summary**

Taken together, the seed access actions and their points of overlap presented in Figures 9-1, 9-2 and 9-3 depict a seed system integrated by interconnection rather than incorporation. Comparisons of the extent of seed access actions in 2010-2011 and 2012-2013 suggest that distancing among seed systems continues, but that integration is also occurring, mostly in connections between formal sales of improved variety seeds and next-year seed sharing of creolized seeds. Figure 9-3 present a visual representation of the statistical analysis presented in
Chapter 8 and further elaborated above - the creation of market-oriented social infrastructure and institutions becomes part of the integrated seed system but does not subsume the other organizing principles and values that comprise provisioning seed systems and non-formal substantive seed economies. The seed maps in Figure 9-3 suggest instead a skilling process is occurring for farmers as they make decisions about incorporating both improved variety and creolized seeds, and their experience is incorporated into a habitus that innovates with configurations of seed access actions and exchange decisions. This skilling and innovation could potentially institute seed value chains, if the value captured in relationships along the chain reflected the value identified by economic habitus. The current push for market-oriented sustainable seed value chains, however, will likely exclude those whose personal experience and social history does not prioritize or identify the commodity-value of seeds.
Chapter 10 Conclusion

Seed systems provide a particularly interesting case with which to study the process and impacts of current sustainable market-oriented development approaches in international agricultural development. In many ways, the seed value chains envisioned as a key feature of the second Green Revolution for Africa reflect the general approach to sustainable value chain development and current approaches to ‘green capitalism’ (Scoones and Thompson, 2011; Toenniessen et al., 2008; Friedmann, 2005). To incorporate small scale producers in seed value chains, it is necessary to define separate roles for producers and consumers, so that rent can accrue as economic value is added by producers, and prices can be used to signal economic value to consumers (Kaplinsky, 2000). De Janvry et al. (1991) show that peasant agriculture is often, in economic terms, non-separable; a farmer or farming household makes production and consumptions decisions in tandem, acting in a closed system where the option of separate economic actions is not practically possible. Non-separability is seen in development and peasant economics (Ellis, 1988) as a feature to be recognized but not necessarily incorporated into future economic development. As Lockie and Kitto (2009) argue, however, the producer/consumer dichotomy does not capture the reality of many agricultural households of various sizes, and in both developed and developing country settings. And within agricultural households and systems, seeds are a material representation of non-separability, since barring extreme genetic manipulation, all seeds can be saved and reused indefinitely.

Non-separability and the ability of farmers to reproduce seeds suggest that seed systems, even those instituted through a value chain approach, will likely retain some non-market features and institutions. In classical economic terms, these hybrid seed systems are less efficient or
instituted by incomplete markets. From an economic sociology perspective, seed systems that incorporate market and non-market institutions to create access to seeds display a degree of embeddedness – non-rational motivations continue to be present and directive in maintaining non-market institutions. Agrarian political economy critically analyzes the persistence of peasant agricultural systems (economic, social and productive) to challenge the rational assessment of those systems only on the basis of economic and productive efficiency. Instead, peasant agriculture as an organizational form is theorized to be instituted by principles and values that are internally consistent and reasonable to a given social and natural setting.

This dissertation applies economic sociology and critical agrarian studies theories to the case of seed system development in Sahelian West Africa. In the following sections of this Conclusion, I overview the structure of the dissertation, including literature and theory used, project design and analytical techniques. I then discuss strengths and limitations of the research design and analysis process, and then build upon the discussion by highlighting applications and future research directions. I focus in particular on the programmatic implications of this research, in part because the dissertation project was conceived of and implemented in collaboration with ICRISAT, a public international agricultural research for development institution with an applied imperative for their research. Connecting theoretical and conceptual analysis and outputs to application and process is also consistent with both critical agrarian studies and the epistemological standpoint I take throughout this dissertation project. The ultimate goal of a theory of practice is to engage with ambiguity and interpretation in order to re-orient action in a specific context. The future directions for research outlined at the end of this Conclusion reflect current emerging issues and interests in critical, applied rural sociology and agrarian studies.
Overview of dissertation structure and results

In Chapter 2 of this dissertation, I review the academic literature on modern (post-WWII) international agricultural development, with reference to economic and political theories as they relate to specific approaches to agricultural development. I highlight three periods of emphasis in international agricultural development. The 1950s to 1970s saw an emphasis on transferring agricultural technologies to increase production efficiency, which led to the Green Revolution. The neoliberal era of the 1980s and 1990s shifted to an emphasis on privatization and promotion of economic efficiency in international development that led to the minimization of support for small-holder and developing world agriculture in favor of industrialization. The current, 21st century shift toward market-oriented sustainable development incorporates both technological and market efficiency into a framework that recognizes the externalities associated with each of the previous eras of agricultural development, highlighting in particular the need for diversification and innovation to make markets and market systems place-appropriate. Within the broad context of international agricultural development, I then explore approaches to seed system development, and focus in particular on the lack of clear distinction among different types of seed systems beyond the simplistic formal/informal dichotomy. Building on this observation, in the final section I offer a conceptual framework that identifies three dimensions of seed systems that are addressed by market-oriented seed system development. Seed type reflects the technological aspect of seeds as inputs, exchange type addresses the economic transactions associated with seed access, and valuation of the output expands the contemporary language of sustainable value chain development and integrated seed systems.

Based on the themes and gaps identified in the literature review in Chapter 2, I present and combine in Chapter 3 economic sociology and peasant studies theories of the institution of social and economic systems to meet material needs. Polanyi’s (1944; 1957b) theory of
substantive economy provides the starting point from which to broaden the specific framing of seed systems as formal or informal, and to challenge the more general trend in international agricultural development that assumes markets and economic efficiency create an ideal system through which to meet economic needs. I incorporate Bourdieu’s (1984; 2005) notion of habitus and the interpretive nature of social and economic systems, as patterns of individual action reflect social and natural history and in turn institute and modify existing systems. Both Polanyi and Bourdieu present language that interacts with classical economic theory, which allows for the integration of formal economics and rational economic habitus into broader theories of social and economic systems. They are therefore useful as I seek to challenge the superiority and singularity of market economic assumptions, instead recognizing market-based economies as one of many systems able to meet material needs. Polanyi and Bourdieu’s theories of the development of economic and social systems in general, building as they do on Marxian analysis of value and the advance of capitalist production, are reflected in theories of peasant economies. I incorporate these related strands into a multi-level theory of the interactions among natural environment, social history, individual experience and skilling (as defined by Stone, 2004) processes to analyze contemporary and ongoing changes in Sahelian seed systems.

Chapters 3 and 4 situate the research setting and methodology within the theoretical framework and historical moment presented in the previous chapters. In Chapter 4, I provide detailed information about the natural and social histories, as well as agricultural systems, of the Sahelian region and the countries of Mali, Burkina Faso and Niger. I also overview the institutional context within which seed system development is occurring, and focus in particular on ICRISAT, the public international agricultural research organization with which I collaborated for this research. The research context, which includes as well my own history and positionality in the region, informs much of the methodology presented in Chapter 5. I designed a mixed-methods study to understand seed system change in sites where ICRISAT is working with
national and local partners to institute a formal seed system by developing local seed value chains. Mixed-methods were particularly important because of the dual nature of this study as both dissertation research and impact assessment. I used several analytical approaches, including thematic coding of qualitative data, statistical modeling of changes in individuals’ seed access decision-making over time, and both participatory seed maps and GIS mapping to visualize seed spread and the points of connection among distinct seed systems.

Chapters 5, 6 and 7 present mixed-data analysis to answer research questions about changes in seed systems at the scales of both individuals and villages or communities, and how those changes differ across groups with specific characteristics. Using the conceptual framework developed in Chapter 2 and the multi-level understanding of social and economic systems highlighted in Chapter 3, I present a first-order mixed-data analysis in Chapter 6 that identifies key characteristics of the social and natural environment that farmers identify as influencing seed access decisions. This analysis is largely confirmatory (as described by Small, 2011), in that I triangulate among qualitative, quantitative and visual data to identify indicators of the dimensions of seed systems and general themes in the organization of seed access decision making. My analysis presented in Chapters 6 and 7 is then complementary and tests the appropriateness of theoretical models for the sample and setting described here. Chapter 7 uses in-depth thematic coding to describe and categorize the organizing principles of distinct Sahelian seed systems as instituted by social and economic habitus that ascribes specific value to seeds. Visual data, including maps generated during participatory mapping exercises and using GIS software, is presented to depict distinct sets of seed access decisions that institute seed systems using village as the unit of analysis. In Chapter 8, I analyze a panel data set generated from my data and, using individuals as the unit of analysis, test a theoretical model that hypothesizes that there will be inter-individual differences of intra-individual changes in engagement with seed systems over time. One specific hypothesis being tested is the classical economic assumption that given access
to complete, formal markets, individuals will make economically efficient decisions and move away from non-rational decision-making.

In Chapter 9, I synthesize the theory and analysis presented throughout the dissertation, to categorize the Sahelian seed systems on the basis of organizing principle and value associated with seeds. I find that there are provisioning seed systems and substantive seed economies being instituted and integrated in contemporary Sahelian agrarian communities. Provisioning seed systems are based on organizing principles of stability or sufficiency, and are instituted by a social habitus that prioritizes buffering against environmental risk and supporting communal well-being, through seed saving and seed gifting. Substantive seed economies are based on organizing principles of parity, reasonable return or utility maximization, and are instituted by negotiations between social and economic habitus that ascribes economic use-value, exchange-value or commodity-value to seeds as inputs and outputs. Substantive seed economies based on use-value and exchange-value can include local, creolized and improved variety seeds, and can be instituted through non-formal, informal or formal exchanges. The formal seed economy that is the emphasis of seed value chain development allows for only improved varieties accessed through formal exchanges. Results from Chapter 8 reject the hypotheses that women will be more excluded than men from the development of a formal seed system, and that crop species will affect seed system change. However, statistical analysis does suggest the potential for exclusion based on wide variance in individuals’ movement toward the newly established formal seed system. Maps are then used to depict the seed system integration currently occurring in the Sahel, and the combination of visual and statistical data suggests that integration is occurring through interconnection rather than incorporation.
Strengths and limitations of the project

Based on the review of seed systems literature in Chapter 2, which suggests an oversimplification of the dimensions of seed access decision-making from the point of view of farmers, the development and application of the conceptual framework depicted in Figure 2-1 increases the precision with which the integration of seed systems can be measured and described. The seed systems literature emphasizes the importance of informal seed systems for the diffusion of improved varieties, but because the integration of seed systems is assumed to operate at the scale of the formal seed system (usually regional if not national or international), informal seed systems are also analyzed at a meso-scale that does not capture micro-heterogeneity (Almekinders et al., 1994; Sperling and McGuire, 2010; Louwaars and de Boef, 2012). Many empirical studies situated in specific geographic and social spaces recognize the variation in informal seed systems, in terms of the institutions and access actions that facilitate seed diffusion and use (Lyon, 1999; Badstue et al., 2002; Smale et al., 2008, among many more). However, connections between the heterogeneous field of local seed systems and the discrete conceptual category of informal seed system are lacking in the seed systems literature. I use agrarian political economy to connect a theoretical understanding of how social systems (in this case, seed systems) are organized to meet material need, to contextualized analysis of empirical observations of seed system change in the Sahel. The resulting analysis and findings present a comprehensive framework for understanding rural change at the individual and village level, in relation to broader systemic changes occurring in the seed system.

From a methodological standpoint, I seed mixed-data analysis that integrates thematic coding and statistical modeling as approaching Bourdieu’s (1977) description of a theory of practice, which combines interpretive phenomenology and empirical analysis, and then re-situates results in a specific context. Bourdieu (1979) himself does this in his analysis of peasant
household economies in colonial Algeria, and in the synthesis presented in Chapter 9, I offer an understanding of peasant seed systems as an organizational type, and connect the findings to both broader theory and the specific setting of Sahelian West Africa. The full theoretical model of seed system change using individuals as the unit of analysis, presented in Figure 8-1 in Chapter 8, seeks to test theories of habitus shift and skilling that have very real implications for farming households and communities. As Stone (2007) argues, if seed system development in the market-oriented, value chain model moves forward without concurrent skilling of farmers with both new seeds and new points of access like markets, the consequences can be destabilizing and destructive. Developing models that reflect various trajectories toward or away from the market-oriented seed system can help to mitigate exclusion and provide concrete actions to develop alternative seed systems.

Buttel (2001) argues that a strength of agrarian political economy is the tradition of connecting theory to empirical analysis through critical contributions to make both applied and theoretical arguments. In the context of international agricultural development, and especially in light of assessments of the differentiated impacts of the first Green Revolution, applied critical analysis is an imperative for research wishing to anticipate and limit future exclusion in agricultural development (see Pray, 1981; Evenson and Gollin, 2003, for examples). This dissertation builds on recent calls for mixed methods research and disaggregated data to test multiple aspects of participation and difference in approaches to agricultural development (de Janvry et al., 2010; Djurfeldt, 2013; Doss, 2013). A weakness of much impact assessment or change-oriented research in international development is the lack of comparison between the population of interest and an appropriate counterfactual, which decreases the precision of measurements of change (Winters et al., 2011). One response in the field of impact assessment has been the use of a difference-in-difference approach to measuring change, in which comparisons among individuals are made of individual change over time (de Janvry et al., 2010).
The use of growth curve modeling in this dissertation is a sophisticated difference-in-difference test, and the structural equation modeling approach allows for the control of observed covariates and context-level variables to better test for significant inter-individual differences in intra-individual rates of change, net of common covariates.

As mentioned in Chapters 4 and 7, unforeseen political instability in Mali and the entire Sahelian region curtailed the data gathering process for this dissertation. I had originally developed a research proposal and research questions with the intention of four seasons of field work, which would have generated a stratified panel data set, with four waves of data in one stratum and three waves in another (representing 2010-2013). Because of the uncertainty surrounding safety in the region in fall 2012, I chose to hire local research assistant to collect a third wave of data (representing the 2012 growing season), and to end data collection with that wave. The panel data set used for modeling latent growth curves is therefore smaller than anticipated, and skewness and kurtosis in many of the indicators made it impossible to test the full theoretical model. Even the models that are tested demonstrate indeterminate variance in certain cases, which I attribute to the ‘noise’ associated with small sample sizes and wide variance in many indicators (Kolenikov and Bollen, 2010). Model results are legitimate, but would be refined and made much more robust with a larger sample size and more waves of data. An additional limitation stemming from general sampling complications is that because of the small sample size, the statistical analysis in Chapter 8 demonstrates significant residual variance for the growth factors of the theorized latent variable of output-value. In other words, there might be inter-individual differences in individual movement toward commodity-valuation of seeds, but the covariates that it is possible to include in this model, given sample size, do not account for much of that variation. Without the ability to test a range of covariates, it is impossible to test alternative hypotheses about which groups of individuals are more or less likely to engage with market-oriented seed systems, making it more difficult to identify possible exclusionary impacts.
A final limitation of this dissertation project has to do with the integration of theory across scales, as presented in Chapter 3. Polanyian theory is sometimes categorized as structuralist or institutionalist, a reasonable assessment given his affinity for Marxian analysis and system-level approach to understanding human interactions and institutions (Halperin, 1984; Migone, 2011). Bourdieu is less easily categorized, and I see some of the confusion and uncertainty associated with applying his theory of habitus as stemming from the unclear scale at which he theorizes. Though not a post-modernist, Bourdieu is certainly post-structuralist in that he takes an interpretive rather than instrumental approach to understanding social systems (Bourdieu and Wacquant, 1992; Buttel, 2001). Bourdieu offers a multi-scalar theory that is methodologically challenging but captures the complexity and emergent nature of the social world as experience by individuals. I use mixed methods to capture and reflect my understanding of a theory of practice, and see the use of individuals as the primary unit of analysis as appropriate to both Polanyi and Bourdieu, insofar as they develop theories of how individual actions reflect and institute social systems. However, this analysis runs the risk of remaining overly empirical or phenomenological, or of missing opportunities for critically engaging with structural elements of the social and economic setting within which Sahelian seed systems are set (see Bourdieu, 1977; Granovetter, 1985; Peck, 2005, for critique of scalar issues in economic sociology).

**Applications and future research directions**

The final step of a theory of practice is to re-situate an abstract theory in a specific context that is subjective in that systems and actions are emergent and not explicitly based on objectified theory. In other words, praxis is the development of theory for application and action. I see three specific applications for the theory and analysis presented in this dissertation. The
categorization of Sahelian seed systems presented in Chapter 9 suggests that there are values associated with seeds that do not align with economic efficiency and commodity-value. The seed value chain approach in contemporary international agricultural development professes to be more inclusive than past approaches that overly emphasized technology transfer or market efficiency, mostly by incorporating environmental and social heterogeneity into place-based value chains (Toenniessen et al., 2008; Scoones and Thompson, 2011). However, the incorporation of social value or economic use-value and exchange-value is rarely mentioned in relation to market-oriented seed system development. The results of this dissertation suggest that farmers who identify use-value or exchange-value of improved variety seeds are instituting seed systems that are integrated through interconnection with the formal seed value chain. The programmatic application of these findings is to expand measures of seed diffusion and adoption to include second-generation creolized seeds that are accessed through the formal seed value chain and then reused through saving and gifts. Incorporating these actions into impact measurements would more accurately reflect the true impact of seed value chain development than counting only sales and repeat customers.

The second, conceptual application of identifying alternative values and organizing principles associated with seed systems other than the formal seed value chain relates to the development-oriented goal of integrated seed systems (Louwaars and de Boef, 2012). Kaplinsky (2000) argues that for the value chain approach to truly work for small scale producers, strong governance will be necessary to buffer against the inherently unequalizing forces of capitalism. In settings like Sahelian West Africa, where national-level government institutions are relatively weak, value chain governance would likely occur at the village or local (organized around an administrative town) scale. Given that seed systems other than the formal seed value chain are also instituted and organized at the local levels, and are shown to be integrating through interconnection with the formal seed system, one way to think about the persistence of non-
market based seed systems is as a governance mechanism. This form of governance is not necessarily intentional or coordinated, but instead is a contemporary version of the same social habitus that historically has buffered against environmental risk and institutional uncertainty. The governance of extra-local value chains through local alternative systems draws on analysis from Lawrence (2005), Harvey (2006a) and many others of the scalar mismatch between capitalistic value chains and localized economic and social systems, a phenomenon that has also been documented in Sahelian West Africa (Diakité et al., 2008).

A final, programmatic application of the framework and findings presented in this research is the potential for the organization of approaches to seed system development that do not rely entirely upon the market-oriented value chain approach. Calls for connecting PPB projects to participatory seed diffusion approaches have not clarified the specifics of how to continue the inclusive and place-appropriate development new varieties and seed diffusion strategies that PPB initiates. Rios-Labrada (2009) suggests that participatory seed diffusion would integrate all aspects of the seed system at the household or village level – in effect, participatory seed diffusion would support the institution of provisioning and substantive seed economies, of which formal seed values chains are only one. A substantive seed economy oriented toward reasonable return and recognizing exchange-value in seeds could be instituted by supporting social certification of seeds (Sperling and McGuire, 2010; Thiele, 1999). Social certification generates and guarantees value not through standardized laboratory certification but through interpersonal relationships that facilitate a skilling process for farmers to gain trust in the value associated with seeds from a specific seed producer. Provisioning seed systems based on both stability and sufficiency, and instituted through seed saving and seed gifting, could be supported by trainings for individual and village-level seed production.

Based on the applications of this research presented here, I see two specific areas of research going forward from this project. By connecting language and theories of alternative
economic and social arrangements to seed systems and agrarian change, I work in close relationship to both peasant studies in general and specific articulations of food sovereignty as an alternative approach to agricultural development (Desmarais, 2008; Borras et al., 2008). An under-conceptualized aspect of the food sovereignty agenda has been the relationship between relocalized agricultural and food systems, and the global economy. The theoretical connections I make in this dissertation help to specify and make material the abstract ideas of embeddedness and substantive economies, and could prove useful as analytical tools for those in the food sovereignty movement to clarify their specific systemic goals. Seed sovereignty, as a subset of food sovereignty questions, provides an opportunity to extend the theories I explore in this dissertation to alternative conceptualizations of seed systems and the institutions that organize and establish them (Kloppenburg, 2010; Shiva and Jafri, 2002). A primary research question relates to the generalizability of the substantive seed economies I identify in Sahelian West Africa, and further exploration using similar methodological approaches could be used to support or challenge the categories offered in this dissertation. Seed sovereignty as a movement and project operates at an undefined scale, but one that is both higher than and instituted at the individual and farm level. Applying mixed methodologies developed in this dissertation would further develop the methodological coherence of this approach and support great precision in articulating the appropriate scope and scale of sovereign seed systems.

A second strand of further research is more empirical in nature. The current market-oriented approaches to international agricultural development, though sometime starting at a local or national scale, seek to scale up with the goal of integrating African agriculture into the global economy (Toenniessen et al., 2008; Bair and Werner, 2011; Djurfeldt, 2013). This scaling includes value chains, and several major development entities have recently announced support for regional development corridors that approach agricultural value chain development at a multi-country regional scale (Kuhlmann et al., 2011). The rhetoric around these development corridors
continues to rely on the idea of integration, of local and national systems into regional chains. I see interesting and valuable research questions around comparisons of the scale at which formal seed value chains are being instituted and the type of integration possible for other substantive seed economies and provisioning seed systems. If integration through interconnection creates temporal space for skilling and minimizes scalar mismatch, how much can the temporal and spatial scales be compressed and stretched before integration through incorporation occurs? Furthermore, by distinguishing between market-oriented and development-oriented value chains (Louwaars and de Boef, 2012), questions arise about the role that public international agricultural research institutions should play in seed system integration. In many ways, the research questions arising from the contemporary push for market-oriented sustainable development mirror those being asked in developed country agriculture, about the interactions among non-profit maximizing systems, public research institutions and global market forces (van der Ploeg, 2010; Glenna et al., 2011). Agrarian political economy must increasingly ask the same types of questions in very different settings, in order to strengthen arguments about the exclusionary nature of capitalist agriculture.
### Appendix A Model specifications

Table A-1. Model specifications for unconditional LCM of output-value trajectories

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual variance of indicators</td>
<td>0</td>
<td>Estimated</td>
<td>Time invariant</td>
<td>Time invariant</td>
<td>Time invariant</td>
<td>Time invariant</td>
<td>Time invariant</td>
</tr>
<tr>
<td>Residual variance of latent factors</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
</tr>
<tr>
<td>Variance $\alpha$</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
<td>1</td>
<td>Estimated</td>
<td>Estimated</td>
</tr>
<tr>
<td>Variance $\beta$</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
<td>1</td>
<td>Estimated</td>
</tr>
<tr>
<td>Mean $\beta$</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
<td>Estimated</td>
</tr>
<tr>
<td>Mean $\alpha$</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Indicator loadings on factors</td>
<td>Time invariant</td>
<td>Time invariant</td>
<td>Time invariant</td>
<td>Time invariant</td>
<td>Time invariant</td>
<td>Time invariant</td>
<td>Free</td>
</tr>
</tbody>
</table>

1. All models have time-invariant thresholds for categorical indicators and intercepts for latent factors set to 0

2. Model 4 was selected based on fit indices
Table A-2. Overall fit measures for conditional LCMs of output-value trajectories with between-group comparisons by gender, crop or union membership, and time-variant and time-invariant covariates (n=75)

<table>
<thead>
<tr>
<th>Model specifications</th>
<th>Fit statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\chi^2$</td>
</tr>
<tr>
<td></td>
<td>(adj.) $^1$</td>
</tr>
<tr>
<td>Grouping variable</td>
<td>Time-variant covariate</td>
</tr>
<tr>
<td>Gender w6</td>
<td>23.740</td>
</tr>
<tr>
<td>Gender w6 x6 x12 x15 w1</td>
<td>50.861</td>
</tr>
<tr>
<td>Crop w5</td>
<td>28.116</td>
</tr>
<tr>
<td>Crop w5 x5 x6 x12 x15</td>
<td>47.838</td>
</tr>
<tr>
<td>Union w5</td>
<td>30.716</td>
</tr>
<tr>
<td>Union w5 x5 x6 x12</td>
<td>38.517</td>
</tr>
<tr>
<td></td>
<td>54.445</td>
</tr>
</tbody>
</table>

$^1$ Adjusted by MPlus with WLSMV estimator
$^2$ BIC = $\chi^2$ – df (ln (N))
$^3$ Time-invariant and time-variant covariates tested in all combinations, with best-fitting model/combination presented here
Table A-3. Overall fit measures for conditional LCMs of seed saving trajectories with between-group comparisons by gender, crop or union membership, and time-variant and time-invariant covariates (n=75)

<table>
<thead>
<tr>
<th>Model specifications³</th>
<th>Fit statistics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\chi^2$ (adj.)¹</td>
<td>df</td>
</tr>
<tr>
<td><strong>Grouping variable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time-variant covariate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>1.020</td>
<td>2</td>
</tr>
<tr>
<td>Gender w4 w5 w6</td>
<td>21.399</td>
<td>20</td>
</tr>
<tr>
<td>Gender w5</td>
<td>4.054</td>
<td>8</td>
</tr>
<tr>
<td>Gender w5 x5 x6 x12 x15 w1</td>
<td>11.996</td>
<td>12</td>
</tr>
<tr>
<td>Time-invariant covariates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop</td>
<td>.699</td>
<td>2</td>
</tr>
<tr>
<td>Crop w4 w5 w6</td>
<td>12.831</td>
<td>20</td>
</tr>
<tr>
<td>Crop w5</td>
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<td>8</td>
</tr>
<tr>
<td>Crop w5 x5 x6 x12 x15</td>
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<td>12</td>
</tr>
<tr>
<td>Union</td>
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<td>2</td>
</tr>
<tr>
<td>Union w4 w5 w6</td>
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<td>21</td>
</tr>
<tr>
<td>Union w5</td>
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<td>8</td>
</tr>
<tr>
<td>Union w5 x5 x6 x12 x15</td>
<td>12.632</td>
<td>12</td>
</tr>
</tbody>
</table>

¹Adjusted by MPlus with WLSMV estimator
²BIC = $\chi^2$ – df (ln (N))
³Time-invariant and time-variant covariates tested in all combinations, with best-fitting model/combination presented here
Table A-4. Overall fit measures for conditional LCMs of seed sharing trajectories with between-group comparisons by gender, crop or union membership, and time-variant and time-invariant covariates (n=75)

<table>
<thead>
<tr>
<th>Model specifications</th>
<th>Time-variant covariate</th>
<th>Time-invariant covariates</th>
<th>( \chi^2 ) (adj.)</th>
<th>df</th>
<th>Sig.</th>
<th>TLI</th>
<th>RMSEA</th>
<th>BIC</th>
</tr>
</thead>
<tbody>
<tr>
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<td>x5 x6 x12 x15 w1</td>
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<td>2</td>
<td>.306</td>
<td>.821</td>
<td>.050</td>
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</tr>
<tr>
<td>Gender</td>
<td>w5</td>
<td></td>
<td>22.148</td>
<td>20</td>
<td>.333</td>
<td>.976</td>
<td>.038</td>
<td>-64.202</td>
</tr>
<tr>
<td>Gender</td>
<td>w5</td>
<td></td>
<td>10.117</td>
<td>10</td>
<td>.430</td>
<td>.998</td>
<td>.013</td>
<td>-33.058</td>
</tr>
<tr>
<td>Gender</td>
<td>w5</td>
<td></td>
<td>17.797</td>
<td>15</td>
<td>.274</td>
<td>.925</td>
<td>.05</td>
<td>-46.965</td>
</tr>
<tr>
<td>Crop</td>
<td>w5 w6 w7</td>
<td>x5 x6 x12 x15 w1</td>
<td>1.742</td>
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<td>.419</td>
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<td>.000</td>
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</tr>
<tr>
<td>Crop</td>
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<td></td>
<td>27.143</td>
<td>20</td>
<td>.131</td>
<td>.925</td>
<td>.069</td>
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<tr>
<td>Crop</td>
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<td>10.255</td>
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<td>.997</td>
<td>.018</td>
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<tr>
<td>Crop</td>
<td>w5</td>
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<td>17.046</td>
<td>15</td>
<td>.316</td>
<td>.955</td>
<td>.043</td>
<td>-47.716</td>
</tr>
<tr>
<td>Union</td>
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<td>x5 x6 x12 x15 w1</td>
<td>1.508</td>
<td>2</td>
<td>.471</td>
<td>1.168</td>
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<td>Union</td>
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<td>20</td>
<td>.479</td>
<td>1.004</td>
<td>.000</td>
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<tr>
<td>Union</td>
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<td>.000</td>
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<td></td>
<td>15.713</td>
<td>15</td>
<td>.401</td>
<td>.980</td>
<td>.025</td>
<td>-49.049</td>
</tr>
</tbody>
</table>

1 Adjusted by MPlus with WLSMV estimator
2 \( BIC = \chi^2 – df \ln (N) \)
3 Time-invariant and time-variant covariates tested in all combinations, with best-fitting model/combination presented here
Appendix B Seed diffusion maps

Figure B-1. Seed spread through seed access actions, Dédougou, Burkina Faso, 2010-2012
Figure B-2. Relationships between social infrastructure and seed systems, Dédougou, Burkina Faso, 2010-2012

Figure B-3. Connection points of seed systems in Dédougou, Burkina Faso, 2010-2012
Figure B-4. Seed spread through seed access actions in Serkin Haoussa, Niger, 2010-2012.
Figure B-5. Relationships between social infrastructure and seed systems, Serkin Haoussa, Niger, 2010-2012

Figure B-6. Connections points of seed systems in Serkin Haoussa, Niger, 2010-2012
Appendix C Interview questionnaires

Questionnaire for farmers who purchased improved variety mini-packets in 2011

Demographics

Données démographiques

Date:

La date:

Village (with GPS coordinates):

Le village (avec les coordonnées GPS):

Respondent code number:

Le nombre de code du répondant:

Gender:

Le sex:

Age:

L’âge :

Ethnic group:

Le groupe ethnique:

Language(s) spoken:

Les langues parlées:

1) Number of people (adults and children) in household/being supported:

Le nombre de personnes soutenues dans le ménage:

2) Role in the household:

Le rôle dans le ménage:

3) How much land do you cultivate for sorghum? In total?

Combien de terre est-ce que vous cultivez pour le sorgho? En tout?

4) Do you have draft animals or equipment?

Avez-vous des bœufs ou l’équipement?

Decision to buy improved variety mini-packets

Décision à acheter des mini-sachets des variétés améliorées
5) Did you buy improved variety seeds this year? How many packets or how much in CFA?  
*Est-ce que vous avez acheté des variétés améliorées cette année ? Combien des sachets ou pour combien de CFA ?*

7) Which varieties did you buy? Why those varieties?  
*Quelles variétés est-ce que vous avez acheté ? Pourquoi ces variétés?*

8) Why did you decide to buy mini-packets?  
*Pourquoi est-ce que vous avez décidé d’acheter des mini-sachets ?*

9) Had you planted those varieties yourself as part of field trials or demonstrations?  
*Est-ce que vous avez déjà semé ces variétés vous-même en tant que faisant partie des essais du champ ou des démonstrations ?*

10) Had you seen those varieties planted in other people’s fields?  
*Est-ce que vous avez déjà vu ces variétés semées dans des champs appartenant à d’autres personnes ?*

11) Did someone in particular tell you about the varieties?  
*Est-ce que c’était une personne spécifique qui vous a parlé de ces variétés ?*

12) How did you know about the mini-packets? When did you first hear about them or see them?  
*Comment est-ce que vous avez entendu des mini-sachets ? Quand est-ce que vous avez entendu en parler et quand avez-vous les vus pour la première fois ?*

13) Where did you buy the mini-packets?  
*Où est-ce que vous avez acheté les mini-sachets ?*

Cultivation of improved varieties  
*Cultivation des variétés améliorées*

14) Did you plant all of the seeds? How much space did you plant with the improved varieties? Did you plant them in the same field as local varieties?  
*Est-ce que vous avez planté toutes des semences ? Combien de terre est-ce que vous avez semé avec les variétés améliorées ? Est-ce que vous avez les planté dans le même champ que des variétés locales ?*

15) Around what date did you plant the improved varieties? Before or after local varieties?  
*Vers quelle date est-ce que vous avez semé les variétés améliorées ? Avant ou après les variétés locales ?*
16) What are your observations about the improved varieties? What are the advantages and disadvantages of these varieties?
**Quels sont vos observations concernant les variétés améliorées ? Quelles sont les avantages et les désavantages de ces variétés ?**

17) Do you like the grains?
**Aimez-vous leurs grains ?**

18) Do you like the stover?
**Aimez-vous leurs tiges ?**

19) Do you like the yield? How much did you harvest?
**Aimez-vous leur rendement ? Combien avez-vous récolté ?**

20) Which of these varieties are best adapted to your area?
**Lesquelles de ces variétés sont les mieux adaptées pour votre milieu ?**

21) How do the improved varieties compare to your local varieties?
**Comment est-ce que les variétés améliorées comparent avec vos variétés locales ?**

**Future plans**
**Plans pour l’avenir**

22) Did you save any seeds from the improved varieties this year to plant next year?
**Est-ce que vous avez gardé quelques semences des variétés améliorées de cette année pour les planter l’année prochaine ?**

23) Has anyone else asked you about the improved varieties after seeing them in your field?
**Est-ce que quelqu’un d’autre vous a demandé des variétés améliorées après les avoir vus dans vos champs ?**

24) Did you give any improved seeds to anyone else? To whom? In your own village or elsewhere? To your family?
**Est-ce que vous avez donné des semences améliorées à quelqu’un d’autre ? A qui ? Dans votre village propre ou ailleurs ? A votre famille ?**

25) Did you receive any improved seeds from anyone else? From whom? In your own village or elsewhere?
**Est-ce que vous avez reçu des semences améliorées de quelqu’un d’autre ? De qui ? Dans votre village propre ou ailleurs ?**

26) Have you saved local variety seeds this year? Which varieties? Did you select panicles?
**Est-ce que vous avez gardé des semences de variétés locales cette année? Quelles variétés ? Est-ce que vous avez choisi des panicules ?**
27) Have you exchanged local variety seeds with anyone this year? With whom? Which varieties?

Est-ce que vous avez échangé des semences de variétés locales avec quelqu’un cette année? Avec qui? Quelles variétés?

28) Will you buy mini-packets of improved varieties next year? Will you increase the amount of seeds or space planted with them?

Achèterez-vous des mini-sachets des variétés améliorées l’année prochaine? Augmenterez-vous la quantité des semences ou l’espace semé avec ces semences?

29) Do you have any suggestions about the mini-packets? (size, cost, availability)

Est-ce que vous avez des suggestions par rapport aux mini-sachets? (la taille, les couts, la disponibilité)

30) Have you noticed changes in where and how you get seeds, now that there are seeds available for sale?

Est-ce que vous avez remarqué des changements par rapport à où et comment vous procurez des semences, maintenant qu’il y a des semences disponibles à la vente?

31) Have you noticed changes in where you get information about seeds and other cultivation techniques?

Est-ce que vous avez remarqué des changements par rapport à d’où vous recevez de l’information sur les semences et les techniques de culture?

32) What has caused these changes?

Qu’est-ce qui a provoqué ces changements?

33) What other changes in access to seeds and information would you like to see?

Est-ce qu’il y a d’autres changements en termes d’accès et d’information que vous aimeriez voir?

34) Do you listen to a radio station? Which one? Do you get agricultural information from it?

Ecoutez-vous à une station radio? Laquelle? Est-ce que vous recevez l’information agricole de cela?

35) Have you worked with ICRISAT or another agricultural project in the past?

Avez-vous travaillé avec ICRISAT ou un autre projet agricole au passé?
Questionnaire for farmers who received improved variety seeds through exchanges with mini-packet buyers in 2011

Demographics

Date:

Village (with GPS coordinates):

Respondent code number:

Gender:

Age:

Ethnic group:

Language(s) spoken:

1) Number of people (adults and children) in household/being supported:

2) Role in the household:

3) How much land do you cultivate for sorghum? In total?

4) Do you have draft animals or equipment?

Decision to receive improved varieties to cultivate

5) Did you receive improved variety seeds last year? From whom?

6) Did you ask someone for these seeds? Why?
Avez-vous demandé ces semences à quelqu’un? Pour quoi ?

7) Which varieties did you receive? How much? Why did you choose them?
Quelles variétés avez-vous reçu? Combien? Pourquoi avez-vous choisi celles-ci ?

8) Did you give something in return for these seeds?
Est-ce que vous avez donné quelque chose en échange de ces semences ?

9) How did you first hear about these seeds?
Comment avez-vous entendu parler de ces semences?

Cultivation of improved varieties
Cultivation des variétés améliorées

10) Did you plant all of the seeds? How much space did you plant with the improved varieties? Did you plant them in the same field as local varieties?
Est-ce que vous avez planté toutes des semences? Combien de terre est-ce que vous avez semé avec les variétés améliorées ? Est-ce que vous avez les planté dans le même champ que des variétés locales ?

11) Around what date did you plant the improved varieties? Before or after local varieties?
Vers quelle date est-ce que vous avez semé les variétés améliorées? Avant ou après les variétés locales ?

12) What are your observations about the improved varieties? What are the advantages and disadvantages of these varieties?
Quels sont vos observations concernant les variétés améliorées ? Quelles sont les avantages et les désavantages de ces variétés ?

13) Do you like the grains?
Aimez-vous leurs grains ?

14) Do you like the stover?
Aimez-vous leurs tiges ?

15) Do you like the yield? How much did you harvest?
Aimez-vous leur rendement ? Combien avez-vous récolté ?

16) Which of these varieties are best adapted to your area?
Lesquelles de ces variétés sont les mieux adaptées pour votre milieu ?

17) How do the improved varieties compare to your local varieties?
Comment est-ce que les variétés améliorées comparent avec vos variétés locales ?
Decision to buy improved variety mini-packets
18) Did you also buy improved variety seeds last year? How many packets or how much in FCFA?
Est-ce que vous avez acheté des semences des variétés améliorées l’année passée? Combien de sachets ou combien en CFA ?

19) Which varieties did you buy? Why those varieties?
Quelles variétés est-ce que vous avez acheté ? Pourquoi ces variétés?

20) Why did you decide to buy mini-packets? Where did you buy them?
Pourquoi est-ce que vous avez décidé d’acheter des mini-sachets ? D’où est-ce que vous les avez achetés ?

21) Did you plant those varieties yourself as part of field trials or demonstrations?
Est-ce que vous avez semé ces variétés vous-même en tant que faisant partie des essais du champ ou des démonstrations ?

22) Did you see those varieties planted in other people’s fields?
Est-ce que vous avez vu ces variétés semées dans des champs appartenant à d’autres personnes ?

23) Did someone in particular tell you about the varieties?
Est-ce que c’était une personne spécifique qui vous a parlé de ces variétés ?

Future plans
Plans pour l’avenir
24) Did you save any seeds from the improved varieties this year to plant next year?
Est-ce que vous avez gardé quelques semences des variétés améliorées de cette année pour les planter l’année prochaine ?

25) Has anyone else asked you about the improved varieties after seeing them in your field?
Est-ce que quelqu’un d’autre vous a demandé des variétés améliorées après les avoir vues dans vos champs ?

26) Did you give any improved seeds to anyone else? To whom? In your own village or elsewhere? To your family?
Est-ce que vous avez donné des semences améliorées à quelqu’un d’autre ? A qui ? Dans votre village propre où ailleurs ? A votre famille ?

27) Have you saved local variety seeds this year? Which varieties? Did you select panicles?
Est-ce que vous avez gardé des semences de variétés locales cette année? Quelles variétés ? Est-ce vous avez choisi des panicules ?
28) Have you exchanged local variety seeds with anyone this year? Avec qui? Which varieties?
Est-ce que vous avez échangé des semences de variétés locales avec quelqu’un cette année ? Avec qui? Quelles variétés?

29) Will you buy mini-packets of improved varieties next year? Will you increase the amount of seeds or space planted with them?
Achèterez-vous des mini-sachets des variétés améliorées l’année prochaine ?
Augmenterez-vous la quantité des semences ou l’espace semé avec ces semences ?

30) Have you noticed changes in where and how you get seeds, now that there are seeds available for sale?
Est-ce que vous avez remarqué des changements par rapport à où et comment vous procurez des semences, maintenant qu’il y a des semences disponibles à la vente?

31) Have you noticed changes in where you get information about seeds and other cultivation techniques?
Est-ce que vous avez remarqué des changements par rapport à d’où vous recevez l’information sur les semences et les techniques de culture?

32) What has caused these changes?
Qu’est-ce qui a provoqué ces changements?

33) What other changes in access to seeds and information would you like to see?
Est-ce qu’il y a d’autres changements en termes d’accès et d’information que vous aimeriez voir ?

34) Do you listen to a radio station? Which one? Do you get agricultural information from it?
Ecoutez-vous à une station radio? Laquelle ? Est-ce que vous recevez l’information agricole de cela ?

35) Have you worked with ICRISAT or another agricultural project in the past?
Avez-vous travaillé avec ICRISAT ou un autre projet agricole au passé?
Questionnaire for farmers who participated in field trials in 2011

Demographics
Données démographiques

Date:
La date:

Village (with GPS coordinates):
Le village (avec les coordonnées GPS):

Respondent code number:
Le nombre de code du répondant:

Gender:
Le sex:

Age:
L’âge :

Ethnic group:
Le groupe ethnique:

Language(s) spoken:
Les langues parlées:

1) Number of people (adults and children) in household/being supported:
Le nombre de personnes soutenues dans le ménage:

2) Role in the household:
Le rôle dans le ménage :

3) How much land do you cultivate for sorghum? In total?
Combien de terre est-ce que vous cultivez pour le sorgho? En tout?

4) Do you have draft animals or equipment?
Avez-vous des bœufs ou l’équipement?

Decision to participate and use improved varieties
Décision de participer et utiliser les variétés améliorées

5) Why did you choose to participate in the field trials this year?
Pourquoi avez-vous choisi à participer avec les essais cette année?

6) Was this your first year as a tester? If no, how many years have you participated?
Est-ce que cette année était votre première année comme un testeur ? Si non, depuis quand avez-vous participé ?
7) Did someone in particular tell you about the trials?
Est-ce que c’était une personne spécifique qui vous a parlé des essais?

8) Have you also purchased mini-packets of improved varieties?
Est-ce que vous avez acheté aussi des mini-sachets des variétés améliorées?

9) How did you know about the mini-packets? When did you first hear about them or see them?
Comment est-ce que vous avez entendu des mini-sachets ? Quand est-ce que vous avez entendu en parler et quand avez-vous les vus pour la première fois?

10) Where did you buy the mini-packets?
Où est-ce que vous avez acheté les mini-sachets ?

Cultivation of improved varieties
Cultivation des variétés améliorées
11) What are your observations about the improved varieties? What are the advantages and disadvantages of these varieties?
Quels sont vos observations concernant les variétés améliorées ? Quelles sont les avantages et les désavantages de ces variétés ?

12) Which of these varieties are best adapted to your area?
Lesquelles de ces variétés sont les mieux adaptées pour votre milieu ?

13) How do the improved varieties compare to your local varieties?
Comment est-ce que les variétés améliorées comparent avec vos variétés locales ?

Future plans
Plans pour l’avenir
14) Did you save any seeds from the improved varieties in your trials this year to plant next year?
Est-ce que vous avez gardé quelques semences des variétés améliorées dans vos essais de cette année pour les planter l’année prochaine ?

15) Has anyone else asked you about the improved varieties after seeing them in your field?
Est-ce que quelqu’un d’autre vous a demandé des variétés améliorées après les avoir vus dans vos champs ?

16) Did you give any improved seeds to anyone else? To whom? In your own village or elsewhere? To your family?
Est-ce que vous avez donné des semences améliorées à quelqu’un d’autre ? À qui ? Dans votre village propre où ailleurs ? À votre famille ?
17) Did you receive any improved seeds from anyone else? From whom? In your own village or elsewhere?
Est-ce que vous avez reçu des semences améliorées de quelqu’un d’autre ? De qui ? Dans votre village propre où ailleurs ?

18) Have you saved local variety seeds this year? Which varieties? Did you select panicles?
Est-ce que vous avez gardé des semences de variétés locales cette année? Quelles variétés ? Est-ce vous avez choisi des panicules ?

19) Have you exchanged local variety seeds with anyone this year? Avec qui? Which varieties?
Est-ce que vous avez échangé des semences de variétés locales avec quelqu’un cette année ? Avec qui? Quelles variétés ?

20) Will you buy mini-packets of improved varieties next year? Will you increase the amount of seeds or space planted with them?
Achèterez-vous des mini-sachets des variétés améliorées l’année prochaine ?
Augmenterez-vous la quantité des semences ou l’espace semé avec ces semences ?

21) Do you have any suggestions about the field trials?
Est-ce que vous avez des suggestions par rapport aux mini-sachets ?

22) Do you have any suggestions about the mini-packets? (size, cost, availability)
Est-ce que vous avez des suggestions par rapport aux mini-sachets ? (la taille, les couts, la disponibilité)

23) Have you noticed changes in where and how you get seeds, now that there are seeds available from trials and for sale?
Est-ce que vous avez remarqué des changements par rapport à où et comment vous procurez des semences, maintenant qu’il y a des semences disponibles des essais et à la vente?

24) Have you noticed changes in where you get information about seeds and other cultivation techniques?
Est-ce que vous avez remarqué des changements par rapport à d’où vous recevez de l’information sur les semences et les techniques de culture?

25) What has caused these changes?
Qu’est-ce qui a provoqué ces changements ?

26) What other changes in access to seeds and information would you like to see?
Est-ce qu’il y a d’autres changements en termes d’accès et d’information que vous aimeriez voir ?
27) Do you listen to a radio station? Which one? Do you get agricultural information from it?

*Ecoutez-vous à une station radio? Laquelle? Est-ce que vous recevez l’information agricole de cela?*

28) Have you worked with ICRISAT or another agricultural project in the past?

*Avez-vous travaillé avec ICRISAT où un autre projet agricole au passé?*
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VITA

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Education
2005  B.S. with Highest Honors, International Politics, University of North Carolina-Chapel Hill
2011  M.S., Rural Sociology, The Pennsylvania State University
2014  Ph.D., Rural Sociology and International Agriculture and Development, The Pennsylvania State University

Awards
2014  Alumni Association Dissertation Award, The Pennsylvania State University
2013  Graduate Student Award, W. LaMarr Kopp International Achievement Award, The Pennsylvania State University
2010  Kenneth P. Wilkinson Memorial Scholarship in Rural Sociology, The Pennsylvania State University

Grants
2013-14  Francena L. Miller and Michael F. Nolan Graduate Scholarship in Agricultural Economics and Rural Sociology, The Pennsylvania State University ($1,000)
2012  Graduate International Research Competitive Grant, College of Agricultural Sciences, The Pennsylvania State University ($2,000)
2010-14  Dissertation research award, International Crop Research Institute of the Semi-Arid Tropics-West Africa (McKnight Foundation grant) ($75,000)
2010  Summer Travel and Research Support, College of Agricultural Sciences, The Pennsylvania State University ($1,500)
2010  Selected participant Rice Research & Production Short Course, International Rice Research Institute-Philippines (Course and travel costs covered)
2009-10  Alex and Jesse Black Graduate Fellowship, College of Agricultural Sciences, The Pennsylvania State University ($15,000)

Research experience
2013  Special topics research assistant, USAID innovATE project, The Pennsylvania State University
2013  GIS consultant, Susquehanna Mapping projects of the Place Studies Initiative, Bucknell University
2010-14  Social science research coordination, Seed Systems Project, McKnight Foundation and International Crop Research Institute for the Semi-Arid Tropics
2009-10  Research assistantship with Dr. Leland Glenna, The Pennsylvania State University

Publications
Smale, M. and Jones, K. Sustaining access to seed resources through local markets. (Invited conference paper for annual meeting of the American Association for the Advancement of Science in Chicago, IL, Feb. 13-17, 2014)