The Pennsylvania State University

The Graduate School

College of Agricultural Sciences

GROUNDS FOR CHANGE: ASSESSING THE EFFICACY OF PARTICIPATORY RESEARCH AND DEVELOPMENT OF AGRICULTURAL INNOVATIONS

A Thesis in

Rural Sociology

by

Kristal Jones

Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Master of Science

December 2011

The thesis of Kristal Jones was reviewed and approved* by the following:

Leland Glenna
Associate Professor of Rural Sociology and Science, Technology and Society
Thesis Advisor

Carolyn Sachs
Professor of Rural Sociology and Women's Studies

Jill Findeis
Professor of Agricultural and Applied Economics, University of Missouri

Ann Tickamyer
Professor and Head, Department of Agricultural Economics and Rural Sociology

*Signatures are on file in the Graduate School

ABSTRACT

Recent spikes in food prices and subsequent shortages in many developing countries has increased the attention placed on international agricultural research for development. Agricultural programs have followed the general trends in development practice over the past several decades, beginning with a market-based, top-down approach to technology creation and diffusion. However, alternative approaches to development, which focus on participation as both means to social change and an end goal for social organization, have long been championed by both theorists and practitioners as more just and durable than conventional development practice. Perceptions of participation by all actors in a given project or social space often vary, however, raising questions of how to understand different types of action and engagement within the same participatory spaces, as well as their effects on the community. This paper explores the experiences of farmers and researchers involved with participatory plant breeding projects in Mali, Niger, and Burkina Faso, West Africa. Semi-structured interviews were conducted with both farmer and researchers participants in the projects, asking questions of what each individual learned and taught during the projects, as well as how their access to and sharing of information has changed as a result of the collaboration. Based on themes that emerged during the interviews, the paper argues for a typology of participation that is two-fold and dynamic. Participation can be functional or empowering, meeting practical or strategic goals. Farmers' experience with the participatory plant breeding projects suggest that functional participation occurs in situations of knowledge sharing between researchers and farmers, where information moves vertically and meets immediate, material needs. In contrast, exchanges among farmers themselves, facilitated by the project, result in increased weak ties and the ability to make future choices, a more empowering aspect of the participatory process. Researchers, in contrast, emphasized the two-way communication and sharing of ideas between themselves and farmers, seeing their

interactions as moving toward a strategic goal of community-based change. Critics of participation as a means to social change have suggested that this mismatch is precisely the problem with participation – it never occurs on a level playing field, and there will always be certain actors with more institutional power or social status whose knowledge will dominate the collaboration. Nonetheless, this paper suggests that participation is an important first step in moving beyond the top-down research for development paradigm, and explores alternative diffusion models, beyond a classic market-based system, that can build upon and validate the social ties and knowledge created through participatory plant breeding.

TABLE OF CONTENTS

List of figures v
List of tables vi
Acknowledgements vii

Chapter 1 Introduction 1

Chapter 2 Conceptual framework 6
- Development discourses and diffusion: From technology transfer to participation in systems 9
- Gendered interests in processes of social change 16
- Diffusion theory 20
- Meaning and value of social ties 23
- Participatory agricultural research for development: Building practical and strategic networks for diffusion and adoption of new seeds? 27

Chapter 3 Methodology 32
- Goal 32
- Research questions 32
- Methodological overview 32
- Setting 34
- Researcher perspective 36
- Sample 38
- Language and translation 41
- Participatory methods and analysis 43
- Limitations in data gathering and analysis 44

Chapter 4 Results 46
- Farmers, why did you choose to participate? 47
- Farmers, what did you learn from researchers? 50
- Researchers, what did farmers learn from you 52
- Farmers, what did researchers learn from you? 53
- Researchers, what did you learn from farmers? 55
- Vertical knowledge sharing 57
- Observations of the participatory plant breeding process 59
- Farmers, what did you learn from other farmers? 62
- Farmers, what did other farmers learn from you? 63
- Horizontal knowledge sharing 65
- Weak ties 67
- Strong ties 69
- Changes farmers see as a result of participatory plant breeding projects 70
- Seed diffusion: Just how functional are improved variety seeds? 72

Chapter 5 Discussion and conclusion 74

Appendix A Farmer questionnaire 80

Appendix B Researcher questionnaire.....83

Appendix C Photographs of the participatory plant breeding process.....85

References.....87

LIST OF FIGURES

Figure 1: Map of West Africa 33

LIST OF TABLES

Table 1: Sample of farmers and researchers interviewed. 37

ACKNOWLEDGEMENTS

This thesis would not have been completed without the support and encouragement of many people throughout the process. I would like to thank my committee for providing insight and direction as my ideas and plans progressed, as well as for their helpful comments during the defense process. In particular, thanks to Dr. Leland Glenna, for being the kind of advisor I can go to with any thought or idea, however roughly formed, knowing that we can and will talk it to some more useful place. Thank you as well to Dr. Eva Weltzien and Dr. Bettina Haussmann, at the International Crop Research Institute for the Semi-Arid Tropics-West Africa. It was their initial interest and encouragement that started me down this research path, and our work together has taught me so much. Their passion for West Africa and their work there has been inspiring and motivating as I continue the research process.

I would also like to thank colleagues in West Africa who helped me with this research: Tahirou Boye, Aminou Aminou, Mamadou Coulibaly, Diaratou Ndiaye, and Dr. Clarisse Barro, among many others, were incredibly kind in helping me to find and speak with farmers in Mali, Burkina Faso and Niger. Thanks as well go to Deanna Behring, Office of International Programs in the College of Agricultural Sciences at Penn State. Her encouragement and financial support for my initial trip to Africa gave me the boost I needed to get there and start this and future projects.

Finally, I would like to thank my family and friends, for their love and support throughout this process. It has been so meaningful to know that you all are with me even as research takes me far from home.

Chapter 1

Introduction

Recent spikes in global food prices have sparked a renewed interest in agricultural development projects around the world, as images of scarcity and suffering demonstrate that despite increases in technology and knowledge, much of the world's population does not feed itself. Food security, as defined by the Food and Agriculture Organization (FAO), consists of "physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs" (FAO, 2009, p. 8). A panel discussion held ahead of the Food and Agriculture Organization's World Summit on Food Security in 2009 concluded that over the next 40 years, global agricultural production will need to increase by 70% in order to meet growing population demands (FAO, 2009). Calls for "structural changes" that include small-holder farmers are also increasing (FAO, 2010). In exploring approaches to bolstering global food supply, international agricultural research for development generally focuses on yield increases and intensification of farming practices, not more extensive land use. Specific goals necessary for intensification include improving the efficiency of inputs, breeding improved varieties of crops, investing in research and development, and making sure that improvements and technologies are accessible (FAO, 2009). In the developing world especially, many areas have thus far seen little modern agricultural development and innovation, so intensification will start from a very basic level. As Aune and Bationo (2008) point out, in sub-Saharan Africa many farmers are starting at the bottom of the ladder, and initial increases in agricultural productivity will have to focus on low or no-cost strategies that utilize local resources and knowledge to target the specific needs of a given place.

Dissonance exists in international development rhetoric between the global statistics on food insecurity and hunger, and a tacit recognition that the possibility for agricultural change and self-provision differs depending on geographic and ecological region, as well as on political and economic position. Approaches to development have in general broadened over time from an abstract focus on market forces and singular narratives of change, to more recent recognition that needs, and approaches to meet them, are context specific. Past responses to crises of hunger have often involved sending food aid from industrialized countries to those experiencing acute food shortages, with no analysis of the long-term effects or viability of such support (Friedmann, 2005, p. 246). At the same time, longer-term agricultural aid has focused on research for development, the most famous of which gave the world Green Revolution seeds and techniques (Evenson & Gollin, 2003). Agricultural technologies, be they mechanical or genetic, are often seen as a panacea to problems of food insecurity and inadequate production. However, new inputs offered into a variety of systems will be met with a variety of responses, from quick uptake, to adaption and use, to cautious curiosity, to indifference.

In response to the dramatic but vague statistics suggesting both the spread of hunger and the international commodification of agriculture, more grounded and context-specific routes to agricultural development have emerged (FAO, 2009; Friedmann, 1992). On the political and economic side, efforts to "re-regionalize" food chains and recognize the site-specific needs and effects of agriculture have led to myriad international symposia, social movements and consumer spending choices (Friedmann, 2005, p. 259). While these efforts focus on the demand portion of the food chain, most agricultural development projects are geared toward supporting or enhancing the supply side of agricultural production. On the agricultural research and technology side of the food security equation, critical assessment of the Green Revolution suggests that further research for development could still benefit many farmers passed over the first time around (Evenson & Gollin, 2003, p. 762). The Consultative Group on International Agricultural Research (CGIAR)

in particular is placing a renewed focus on "shared responsibility for managing towards outcomes, i.e., uptake of outputs resulting in longer-term livelihoods of end-users" (CGIAR, 2009, p. 7). A consortium of research stations that focus on needs of specific agricultural systems and regions of the world, the CGIAR emphasizes research *for* development, so that application and end-use is foundational to research projects from the beginning. In the area of crop improvement and seed production, CGIAR centers have been leaders in innovative methods of participatory plant breeding.

To address issues of why some technologies are adopted in developing countries, while others never take off, new understandings of how to generate innovations that meet local needs are drawing inspiration from participatory development and diffusion theory. Participatory agricultural research for development has emerged in the past two decades as a development tool applicable across a spectrum of sites and situations, effective because it is "client driven" and therefore practically useful (Ashby & Sperling, 1995, p. 754). Participatory plant breeding in particular offers an effective starting point to improve crop yields and food security, in part by offering "a wide diversity of material to a wide diversity of farmers" (Haussmann & Kapran, 2007, p. 1). The broadening of participatory development projects around the world has strengthened this claim, as not only local varietal selection but also context-specific knowledge and technology transfer continue to address and improve agricultural production systems (Humphries, Jiménez, Sierra, & Gallardo, 2008).

Participatory projects implicitly draw on theories of the diffusion of innovations, where diffusion and adoption are the crux of "processes of social change" effected by newly introduced knowledge (Rogers, 2003, p. 6). The process of participation is suggested to support both functional and empowering changes for farmers and rural communities involved in such projects (Johnson, Lilja, & Ashby, 2003). Functional effects follow from the "client-driven" nature of participatory plant breeding, as the improved varieties resulting from these programs

will be more readily accepted and used by those farmers for whom they are intended. Empowering change derives from active participation in the entire process of generating, diffusing and adopting innovations, including but not limited to the functional participation in making the innovation more readily usable. Evaluation of participatory projects therefore requires an acknowledgement of different types of participation and their possible outcomes, so that expected impacts align with the specific nature of participation.

Often in research for development, assessments of project success are based on the "impact" of an innovation generated by the project, without making it clear if impact focuses on diffusion (the spread) or adoption (the uptake). In addition, impacts are often seen as static – measurable at a single point in time, rather than as part of ongoing, iterative changes. The processes of change through innovation spread and use are thought to be more appropriate and readily incorporated into existing systems if individuals are a part of the process from start to finish. These functional effects of participatory projects are only the most immediate impacts, however. Empowering participation suggests that participants themselves, rather than the innovations they generate, will drive continued change, so that impacts on the entire social and agricultural system must be described and assessed (Johnson, Lilja, Ashby, & Garcia, 2004).

In participatory plant breeding, the temporal and spatial effects of participation are further compounded by the relatively long timeframe over which plant breeding projects take place. Because most plant breeding projects in West Africa have been initiated within the past ten years, improved variety seeds are only recently stable enough for broader dissemination (Weltzien, vom Brocke, Touré, Rattunde, & Chantereau, 2008, p. 166). Functional effects of the projects, therefore, are just beginning to emerge, as farmers have access to improved variety seeds and make choices about whether and how to use them. There is general agreement among practitioners of participatory plant breeding that the next step in the plant breeding chain is seed release and diffusion, with final impacts measured by adoption (Sperling, Ashby, Smith,

Weltzien, & McGuire, 2001; Weltzien et. al, 2008; Ceccarelli & Grando, 2007). Adoption will be conditioned by the empowering effects of participation, as individuals continue the selection and diffusion process with improved variety seeds, in ways that fit their own systems. In order to assess more completely the impacts of participatory plant breeding projects, it is therefore necessary to use methods and analysis that can address both functional and empowering effects of participation.

This study was conducted with farmers and scientists associated with the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), a member of the CGIAR system. Plant breeders and technicians based at research stations in Mali and Niger work with rural farmers in four countries – Mali, Niger, Burkina Faso, and Nigeria – on participatory plant breeding projects for pearl millet and sorghum. These projects entered into a new phase during rainy season 2010, during which the first improved varieties were systematically sold in markets and small agro-input stores. The original goal of this study, then, was to assess farmers' existing networks of information exchange and how they have been affected by participatory development projects, as well as the effects of participation on knowledge and resource distribution. In addition, the study planned to investigate the causes of and constraints to diffusion and adoption. The study was carried out during June and July 2010, primarily using semi-structured interviews with farmers, both project participants and non-participants, in villages where ICRISAT works, as well as with ICRISAT field technicians. As the analysis will show, research questions related to information access and facilitation of two-way communication were effectively addressed by questions and observations during the fieldwork. However, the dynamic nature of diffusion, adoption, and processes of change means that impacts of participatory plant breeding, both functional and empowering, could not be assessed in a single field season. Instead, metrics for measuring and describing different types of change effected through participation in

innovationgeneration and spread will be developed from this study to be used in an a long-term impact assessment of these participatory plant breeding projects.

Chapter 2

Conceptual framework

International development broadly speaking asserts a key focus on "improving the conditions of life" in developing countries (Peet & Hartwick, 1997, p. 17). Historically, those changes have been facilitated and shaped by myriad institutions and financial donors, often with differing visions of which changes to make and how to make them, despite the common goal of "ending world poverty" (Easterly, 2007, p. 331; Escobar, 1995). Research for development takes decidedly different directions when focused on change through economic growth and industrialization ("stages of development"), as opposed to systems thinking, which engages contextual particularities in action (Peet & Hartwick, 1997; Rostow, 1959; Chambers, 1974). International agricultural research, focused on developing technologies and techniques to "achieve sustainable food security and reduce poverty," has been grounded in these different theories of development at different stages of history (CGIAR, 2007). The Green Revolution, with a focus on high yields and efficient, "modern" agricultural practices, resulted from the development-through-modernization era. Research focused on the creation of a few, high-performing modern varieties (most notably of rice and wheat) that could be widely disseminated without regard for the particularities of place, and scaled up to the global level to meet "global" needs (McMichael, 2009). In the decades following, it has become apparent that farmers in the developing world have not benefited equally from these new seeds. Differences in structural

conditions of adoption as well as heterogeneous local realities have pushed new types of agricultural research for development to the fore (Evenson & Gollin, 2003).

Research on agricultural innovations for development is only as good as its ability to be implemented. As a technology-focused agricultural research agenda has failed to "improve the conditions of life" equally for farmers across the developing world, there has been a renewed interest in investigating the spread and uptake of the information and innovations generated. In response to a single vision of modernization and stages of development, participatory development projects seek to address issues of compatibility and relationship to place. Participatory agricultural development involves "the process of combining local farmers' knowledge and skills with those of external agents to develop site-specific and socioeconomically adapted farming techniques" (Reinjtnes, Haverkort, & Waters-Bayer, 1992). To date, little theoretical research has been done on the causes of and constraints to the diffusion and adoption of agricultural innovations generated from participatory research for development projects (Weltzien, Smith, Meitzner, & Sperling, 2003, p. viii; Chiffoleau, 2005, p. 1194). This study adds to the body of literature investigating participatory features of development projects to assess whether participatory methodology supports effective innovation diffusion and adoption, as well as long-term change.

Investigation into the diffusion of innovations is not new, however, and has its roots in rural sociology and the spread of agricultural technologies in the United States. Research conducted in the 1940s on the adoption of hybrid corn seed by Iowa farmers provided an empirical basis for the emergence of diffusion theory in rural sociology (Ryan & Gross, 1943; Rogers, 2003, p. 55). Research in other fields (Coleman, Katz, & Menzel, 1966) was also interested in the spread of information and new ideas, and the theory emerged not based on the particularities of any one discipline, but rather as an articulation that "the diffusion of innovations was a kind of universal process of social change" (Rogers, 2003, p. xvi). Diffusion studies are

today well established across disciplines, but in rural sociology they have shifted focus in recent years. A more complex view of the diffusion process takes in account, and indeed privileges, the role and experience of the end user of an innovation (Glenna, Jussaume, & Dawson, 2011). Clearly, the need to understand knowledge and innovation sharing remains, and especially with the increased presence of rural sociology in international development, building upon diffusion theory continues to be highly applicable to the study of rural agricultural change (Fliegel, 1993, p. xiv; Alumira, Bantilan, & Sihoma-Moyo, 2007). As mentioned above, the spread of new ideas for positive social change is the theoretical goal of international development, but there has been little systematic engagement with diffusion theory, especially in its more complex form, in the international agricultural research community.

Defined by Rogers (2003), diffusion is "the process in which an innovation is communicated through certain channels over time among the members of a social system" (p. 11). Diffusion theory investigates the characteristics of the innovation, communication channels and social system that affect the spread of new ideas. From this broad base, a more specific investigation of communication channels and the features that promote both the diffusion and adoption of innovations within social systems has emerged. Drawing on Simmel's (1982) theories of social distance and the components of social ties, analysis of communication and social networks seeks to characterize interpersonal relationships as they relate to broader social patterns, including the diffusion of information (Granovetter, 1973, p. 1360). Of particular interest is the "strength" of social ties, and their subsequent effects on networks and information spread (Granovetter, 1973). The value of interpersonal connections has also been operationalized with the notion of social capital. Social capital sees interpersonal ties as having value in that they function as resources that individuals can use to maximize rational self-interest (Coleman, 1988, p. 101).

Social capital derives from a resource-maximizing economic ideology, which circumscribes the types of values potentially assigned to interpersonal ties by focusing only on exchange-value. Another important dimension of interpersonal ties, however, is their "use-value," or how they function outside of, and beyond, the market system. The underlying questions of function and value that social capital raises have important implications for the ultimate goals of international development. Can social connections and the networks they create lead to functional changes through the spread and uptake of new information and seed varieties? In addition, do connections made between farmers and researchers, as well as among farmers, during participatory plant breeding projects, empower farmers to direct future learning and sharing processes? Despite much anecdotal evidence that innovation and social network characteristics affect rates of diffusion and adoption, international agricultural research for development projects have yet to apply theories of diffusion and social networks in a systematic way. Field work continues, however, and in the past two decades participatory research for development has emerged as a new paradigm that is implicitly informed by diffusion theory and ideas of the importance of social relationships. Participatory agricultural development seeks to engage members of a social system in innovation processes that generate new ideas and social connections with the essential characteristics articulated by diffusion and network theories.

Development discourses and diffusion: from technology transfer to participation in systems

"Development" as an industry, occupation, and instrumental goal, arose during the post-WWII era, as global engagements shifted from colonial empires and conflict toward economic integration and interdependence. Drawing on the classical Kantian (1963) notion of peace through economic ties and "rational" global governance, international institutions were established to ensure that the world would never again be plunged into grave, all-consuming war.

Rather than a naked statement of self-interest in drawing all non-communist countries into a stabilizing capitalist world economy, the United States, and President Truman in particular, instead began to speak of "underdeveloped" countries and the need to offer benevolent support and aid. Not solely financial support, since "the material resources which we can afford to use for assistance of other peoples are limited. But our imponderable resources in technical knowledge are constantly growing and are inexhaustible" and so must also be mobilized for development (quoted in Rist, 2002, p. 71).

As decolonization progressed and Keynesian economics became dominant in the United States and Western Europe, development theory and rhetoric built upon President Truman's vision of "inexhaustible" technology innovation and transfer for change. Newly independent countries were "traditional" and had yet to "take off" on the trajectory of modern industrialization and mass consumption (Rostow, 1959, p. 1). Couched in terms of seeking to "improve the conditions of life," Western nations embarked on a program of technology transfer and structural influence in underdeveloped countries (i.e. those not yet operating with modern, capitalistic economies) that would also ensure a familiar trajectory of change, and create an interdependent international system to preclude future global conflict (Peet & Hartwick, 1997, p. 17). In agricultural development, that meant changes in agricultural practices "originate within the domain of modern science, and that development follows from transmitting such knowledge to other actors within the agricultural sector for them to adopt" (Pretty & Uphoff, 2002, p. 244). The Green Revolution embodied this technology-centric view of economic and social change, which continues to dominate much of the development discourse today. More recent assessments of the failure of improved varieties to take hold, particularly in sub-Saharan Africa, do concede the necessity of taking into account location-specific needs. The focus, however, often still remains on the diffusion and adoption of technological and economic innovations, leading to efficient entry into international markets (see Evenson & Gollin, 2003; AGRA, 2010).

In the post-WWII period, agricultural development shifted from a more localized focus (directed at immediate and site-specific needs) to efficient commodity production (with the exploitation of land and labor yielding profit for global actors) (Friedmann & McMichael, 1989). Alternate readings of the transfer-of-technology development approach arose as it became clear that even in sharing certain types of knowledge and resources as development "aid," only a relative few countries continued to consolidate economic and political power. Some critics have posited that the capitalist world-system, based as it is on production and accumulation for profit, will inevitably allow and indeed almost require some actors (be they countries, corporations or individuals) to accrue more capital and economic assets than others (Wallerstein, 1974). Approaching development from its classic early rhetoric, the accumulation of wealth and resources by some does not preclude accumulation by all, since our technological and innovative capabilities are unbounded. World-systems theorists take a more critical realist stance, however, suggesting that resource use and innovative capacity are finite, and in a capitalist system based on profit maximization, a ceiling of new wealth generation will be reached (Wallerstein, 1988). One implication of this argument is that development is not equally possible for all actors, since finite resources and results are distributed differently and unequally among them. More focused critiques of the global food and agriculture system uncover similar patterns of unequal access to and distribution of finite resources.

The Marxist tendencies in Wallerstein's assessment of the prospects of capitalist systems became increasingly prominent as critiques of development rhetoric and projects continued to evolve. During post-WWII struggles over how to reconstitute the world political and economic system, multiple theories and approaches were articulated before being subsumed in the West by a singular narrative of markets as *the* road to development and peace. The implications of relying on market exchange to "improve the conditions of life" became clearer in the subsequent decades. As development did not proceed apace, many political economists, mostly from developing

countries, expounded upon the unequal nature of the global capitalist framework, arguing that the "core" countries (those more industrialized and with greater political power at the end of WWII) have a qualitatively different type of autonomy and power than those countries in the "periphery." These power and influence differences are maintained, consolidated and reinforced by both the global capitalist system and social relations within nations and regions. Development in the capitalist system, for both the core and the periphery, is defined by capital accumulation and production relations, which creates one-way and limiting dependencies of the periphery on the core. International markets and free trade cannot provide other types of improvements in life conditions or meet needs not "valued" in the international economic system (Cardoso & Faletto, 1979).

Dependency theories range from demands to revolutionize the system, so that sovereignty and autonomy are regained and non-negotiable for all actors (be they states or social classes) to more reformist calls for change. Cardoso and Faletto (1979), though sympathetic to the theoretical underpinnings of an alternate world system, offer a pragmatic dependency theory. As a first step, to mitigate the effects of core/periphery distinctions, states (that is, institutions reinforcing and recreating on a local scale the world system) and nations (comprised of groups with "authentically popular interests") must realign to give maximum pushback for the periphery against the core (Cardoso & Faletto, 1979, p. 202). This analysis led to import-substitution policies in the 1960s and 1970s, as countries sought to build up internal production capabilities and consumer markets. In agriculture, many states established marketing boards, to buffer small farmers against the global commodity market, and made food self-sufficiency a priority by promoting state-run farms and offering subsidies to growers for food import substitution (Roth & Philip, 1990).

As some periphery states turned inward and focused on enhancing their own production and consumption capacities, which required strong state involvement in economic policy and

decision-making, capitalist core countries grew concerned about their perceived loss of leverage and global "slippage" toward socialism. Still heavily imbued with Keynesian economic theory, but now moving toward a more self-righteous neoliberalism that sought to capture developing world profit for multinational financial institutions and corporations, the United States and United Kingdom (under the leadership of Reagan and Thatcher) pushed back, and pushed harder. Throughout the 1980s, the International Monetary Fund and the World Bank shifted their focus (thanks to the donation-quota voting system that gave the U.S. and the U.K. almost majority decision-making power) to focus on "restructuring" state-assisted capitalism in the developing world (Bello, 2005, p. 133). Structural adjustment came with a variety of austerity measures and market conditionalities, but the overarching principle was a shift from a broad-based focus on development of human and natural resources to a narrower program of liberalizing markets and opening competition to encourage economic efficiency on a global scale (Woods, 2006). For agricultural development, this meant a dismantling of state marketing boards and production subsidies, shifting the focus to export crops (often non-cereal crops of coffee, cocoa or cotton) and increasing food insecurity (Roth & Philip, 1990). Agricultural research for development continued to focus on high-value export crops, as well as input-intensive technology. The assumption that technology could increase cereal productivity was predicated on smallholder farmers' ability to purchase external inputs, using the money they received from growing export crops to shore up their domestic food systems (Uphoff, 2002, p. 6).

Since the height of structural adjustment and neoliberal development policies in the 1980s and 1990s, several new lines of development critique and theory have emerged. There are still those lobbying for free-market distribution of resources, but given the failures of the market in developed as well as developing countries, those arguments are tempered by other concerns. The international community embraced an expanded understanding of development with the Millennium Development Goals, agreed upon in 2000. With eight goals spanning a wide range

of development indicators, the MDGs allow for a broader conception of development, beyond economic growth and production potential (End Poverty 2015, 2010). Markets and private capital still play a central role to development, especially since many development economists argue that in absolute terms, all actors in the capitalist world-system are better off now than they were before being incorporated into the system (Krugman, 2001). In agriculture in particular, with the end focus on decreasing hunger and food insecurity, the MDGs connect wage labor and full employment to halving the number of hungry by 2015 (End Poverty 2015, 2010). If this means more people able to buy their own food, it also means farmers growing enough surplus to sell in local or regional markets.

Though the MDGs shift the focus more towards people and the effects of development in human lives, rather than in national economies (with an assumed "trickle down" effect), the move is incomplete. Technologies, from cell phones to antibiotics to fertilizers, are still the silver bullets that can "save" the future, as long as knowledge and financial resources are focused and dedicated to the identified problems and potential solutions. Where, however, are the people for whom the technologies are ostensibly being developed? This is not a new question, and there has been a dedicated alternative development paradigm at work over the years, focused on change not via technology creating but by "putting people first" (Cernea, 1991, p.7). Many development agents recognized early on that in order for development to be relevant, just and lasting, specific social norms and understandings of local realities needed to guide the creation and management of projects (Cernea, 1991; Chambers, 1974). Participatory development theory offers a clear and unequivocal framework for change: projects must put people first, as they are the primary actors and benefactors in development work (Cernea, 1991, p. 7). In agriculture, this initially meant an adaption of the transfer-of-technology model, with more emphasis on farmer input and involvement, but with research for development still largely guided and carried out by expert scientists (Chambers & Jiggins, 1987). Participatory agricultural development continues to move

toward the "farmer first and last" approach envisioned and articulated by many practitioners, with a focus on social-ecological farming systems with farmers' knowledge, interests and needs at the core (Chambers & Jiggins, 1987; Reinjtnes et al., 1992).

Participatory development theory definitively offers a new development paradigm, taking the focus off of singular end goals and technological outputs, and instead focusing on changes engendered by people themselves, with an emphasis on the process of change. People and their social setting are more complicated than inanimate technology, however, and so using a participatory approach is more complex and ambiguous than conducting research in search of a usable technology. Participation in colloquial terms – the presence and interaction of actors in a given setting – should not be confused with the intent of participatory development theory. Indeed, concerns over the mainstreaming of participation into development work have led to a variety of critiques of the approach. Some theorists, particularly in critical feminism, worry that because participation works within and with already-established social systems, power inequalities, particularly those associated with gender, will be replicated and reinforced through development projects (Cooke & Kothari, 2001). The language of participation as used by major development agencies is also concerning, as a new emphasis on "sharing" power with primary stakeholders and "incorporating participatory methodologies" into conventional development projects seems to fall short of the participatory ethos of putting local people first and last (Blackburn, Chambers, & Gaventa, 2000, p. 1; Crawley, 1998).

Delving deeper into participatory theory, some of these contemporary critiques were anticipated and experienced by early practitioners. Participation is multidimensional and cannot be seen as a static or single type of interaction. Though the focus is always on people, not things, and discussion and engagement is therefore a constant, the actual division of time and energy spent on participatory development projects between locals and experts differs across time and space. Cohen and Uphoff (1980) suggest that participation is not a single phenomenon, but rather

the "involvement of a significant number of persons in situations or action which enhance their well-being" (p. 214). They go on to articulate the types of participation in development projects, from decision-making and implementation through benefitting from and evaluating the outcomes (Cohen & Uphoff, 1980). To addition to differences in stage of participation, others have also suggested varying degrees of participation (Sperling et al., 2001).

Can participation be understood in terms of degrees? Is putting people first an all-or-nothing approach? To counter both critiques of participatory development, of participation as reinforcing power differentials and broadened too much by mainstreaming to be meaningful, some practitioners have suggested that participation occurs across a spectrum, from complete control and acquiescence to "experts," to radical creation and definition of knowledge (Kleinman, 2000). Others suggest that participation as an objective can be either functional or empowering, a means or an end (Johnson et al., 2004, p. 190). The framing of participation as functional versus empowering has corollaries in feminist theories of change, most specifically in Molyneux's (1985) articulation of practical and strategic gendered interests. Understanding the dual-layer metric offered by feminist theorists provides a useful starting point for evaluating whether and how marginalized groups are affected by processes of change.

Gendered interests in processes of social change

Much like world-systems critiques of the roots of global inequality and poverty, feminist critiques of women's subordinate place in the modern social and economic system confront a rational, masculine system that subjugates and exploits less-powerful entities. Merchant (1983) charts the historical roots of social change in perceptions of nature and gender, highlighting the shift that occurred with the Scientific Revolution and the modern focus on technology and science. As a mechanistic world view took hold and consolidated power, both women and nature

came to be seen as unpredictable and needing to be controlled, so that "development" could proceed uniformly apace (Merchant, 1983). Positivist science is inherently unreflexive and validates only "objective" information and processes; its focus on universal scientific knowledge and subjugation of specific natures undermines identities particular to given places and times, thereby making situated and contextual knowledge inferior (Merton, 1973, p. 5). Since women deal with the particularities of reproduction and daily life, their roles are relegated to "emotional," subjective private spheres. As women have recognized that despite having a defined sphere of influence, rationalist framings of public life and exclusion from it affect their well-being, feminism has challenged assumptions of gendered public/private identities and the ensuing domination of women by men (Plumwood, 1991, p. 5).

Feminist theories of social exclusion and change often give primacy to gendered identity and experience, much as development critiques tend to focus on class inequality as the sole basis for international development. Alternative development ideas of social capital start to recognize non-market societal goods and participatory projects push much further with an emphasis on personal and communal processes of ongoing learning and place-based changed that incorporate both economic and non-economic needs and concerns. Feminist theorists also address the tension between putting a singular focus on gender, and linking with overlapping or overarching movements to meet related but perhaps less specific goals (Yuval-Davis, 1994). Just as participatory theory suggests a dual-layered understanding of the effects of participation, so too does feminist theory offer a more dynamic understanding of social change. Feminist movements and their impacts can be understood in terms of practical and strategic goals, each with distinct characteristics but building on and supporting one another in ongoing processes of change (Molyneux, 2002).

Molyneux (2002) asserts that practical and strategic gender interests address different aspects of women's experiences in the world, aspects that are often but not always concurrent and

mutually reinforcing. Practical interests, she suggests, are those "concrete conditions" of women's material reality, their role in labor and production relations (Molyneux, 2002, p. 252). In her example of women peasants in the Sandinista movement, Molyneux (1985) highlights access to land as a material concern that cut across both gender and class divides, suggesting that women fought for a practical need that also stemmed in part from gendered patterns of exclusion from land. Important in the focused identification of practical interests, however, is the lack of overarching analysis of subordination and the articulation of a theoretical framework from which to effect change (Molyneux, 1985). By organizing and mobilizing for practical change, women (and indeed, all people) also often begin to analyze the underlying structural organization of society that has created practical needs in the first place. From this analysis comes the identification of strategic goals or needs, focused more on the ways in which gender is socially constructed and directions in which women would like to shift society (Molyneux, 2002). Strategic goals can come with lofty rhetoric, clear-cut problem statements and definitive solutions that can be powerful and inspiring, as well as limiting. As strategic goals (of gender equality in access to resources, say) are articulated, they can either take into account the material needs of women (the need for preferential treatment due to lack of income), or can override or overlook the more ambiguous practical needs of daily life that cut across gender and other social divides.

Practical and strategic gender interests fit into broader feminist analyses of the rational, objective social relations that govern modern capitalist societies, where material conditions of life and the underlying theoretical assumptions that perpetuate these conditions both must be addressed to achieve lasting change. Similar analyses of global inequality and poverty, and the underlying economic assumptions that govern modern international development, have been initiated by world systems and other theorists, but often with a heavy emphasis on addressing strategic or theoretical change. Participatory development approaches arose in response to material realities and perceived shortcomings in modern development practices that favored a

top-down, one-size-fits-all model. Implicitly, then, the underlying theory of participation begins the dual-layer analysis needed to address both immediate and longer-term needs of communities as they work to effect change. Practitioners of participatory projects have begun to articulate a framework that includes functional and empowering participation as both process and outcome of such projects.

As Johnson et al. (2004) state, participation can be both a method used within a project and an objective in itself, though each use of participation strives for different types of change. Functional participation often means broader inclusion of individuals and communities in order to achieve predefined (usually by outsiders) ends, in a more traditional transfer-of-technology framework. Participation is used here to address material needs of a community by involving them in the development and/or diffusion process of technology that has been generated through the conventional research for development processes (Johnson et al., 2004). Functional participation and practical gender goals parallel one another in their focus on contextual, concrete needs – exclusion from input into and access to new technology based on social position, lack of access to material resources based on socially defined gender roles. Empowering participation focuses on process in addition to outcome, seeking to change the way in which communities and development practitioners create and carry out projects, as well as to restructure their interactions toward a more two-way exchange of partial knowledge and information (Johnson et al., 2004). Empowerment comes by analyzing the underlying assumptions of the development process, and the technologies it creates, that disadvantage "end-users" of development projects. Practitioners from Dewey (1927) to Freire (1970) have highlighted the social importance of describing and discussing material realities in order to achieve change of all kinds. By addressing the strategic needs of communities in the development process, self-defined change through empowering participation itself becomes a development goal.

Since functional and empowering participation address, respectively, the practical and strategic needs of communities, participation can be seen as a facet of development projects that evolves and changes focus across space and time. Functional participation is often a simpler, more immediate way to begin to open up the development process and take more voices and knowledges into account. However, communication and ultimately, control of problem analysis and project goals, does not shift from "expert" outsiders to the communities themselves. The initial process of including end-users in an already existing project can accompany the development and diffusion of a new technology. Diffusion can address more immediate, practical needs by spreading new ideas and information which people can then try for themselves. Indeed, diffusion of innovations literature draws from a more rationalist epistemology, where the "right" combination of characteristics will facilitate complete spread of a new technology. Full adoption, however, takes place over a longer time scale and involves individuals making new information and technology their own. Adoption is inherently situational, so that even if a technology is static, its use and meaning changes across space and time. Empowering participation in development projects can support adoption by creating the space for communities and researchers to co-create knowledge together and allow it to evolve, as each participant continues the process of adaptation and adoption.

Diffusion theory

Though questions of how and why information spreads through society are hardly new, most scholars point to the Ryan and Gross (1943) study on hybrid corn as the first empirical analysis of diffusion of agricultural innovations (Rogers, 2003; Fliegel, 1993). Rather than identifying traits of individuals and relating them to rate of adoption of the new seed, Ryan and Gross (1943) used characteristics of both the innovation (the seed) and the social connections that

facilitated its spread. For the former, they found that the economic rationality of using more efficient seed was an important factor to its rapid spread, but not the only one. Observability (the new seed growing vigorously in the midst of drought-stricken fields) and complexity (or lack thereof – no new technology was needed to use the new seed) were two key variables affecting rapid adoption (Ryan & Gross, 1943, p. 16). In addition to characteristics of the innovation affecting its successful diffusion and adoption, characteristics of the social system within which it spread were also measured and analyzed. The empirical evidence shows that adoption rates do not follow a normal curve, and are therefore not based on static pre-existing categories of risk aversion and innovativeness. Instead, "the behavior of one individual in an interacting population affects the behavior of his fellows" (Ryan & Gross, 1943, p. 23). Types of communication, as related to social connections, affect how information moves through a society and is accepted or rejected.

Building on the Iowa corn study, researchers continued to use case studies to identify not only individuals but also innovation and social system characteristics related to the spread and implementation of agricultural technologies throughout the 1950s (Fliegel, 1993, p. 38). Drawing on the latter two approaches, Rogers (2003) was the first to articulate a basic theory of diffusion. Diffusion theory takes as its starting point that "the diffusion of innovations is essentially a social process in which subjectively perceived information about a new idea is communicated from person to person" (Rogers, 2003, p. xx). As state above, diffusion is defined as "the process in which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 2003, p. 11). An innovation is any idea perceived as new to an individual (Rogers, 2003, p. 12). The question, then, partially answered by Ryan and Gross (1943), is how must an innovation be perceived by an individual for them to share a new idea with others in their social network?

Based on his review of existing literature at the time, Rogers (2003) identifies five characteristics of innovations that affect both the spread and adoption. Perhaps most obvious is the relative advantage of a new idea (p. 15). This refers not only to economic advantage but also to convenience, satisfaction, increased social status – any normative value with which individuals identify. Judgment of an innovation's relative advantage is straightforward when seen as a variable in rates of adoption; those directly affected choose to adopt or not on the basis of their own norms and values. However, it has been pointed out that especially in developing country contexts (as well as in earlier extension programs in the United States), decisions of which innovations to offer for diffusion are often made not by the end users of new ideas. Instead, those engaged in research (and the funding of that research) often make decisions of which new ideas to offer, using very different values to judge relative advantage (Rogers, 2003, p. 132; Fliegel, 1993, p. xiv; Shepherd, 2006, p. 418).

The other characteristics of diffusible and adoptable innovations are less contentious and more straightforward. Innovations must be compatible with a given reality in order to have any longevity (Rogers, 2003, p. 16). Though this too could be seen as a normative feature, Rogers' can be read to give agency to diffusers/adopters, so that compatibility is determined *in situ* as decisions to spread new ideas are made (Fliegel, 1993, p. 57). In addition, innovations must not be too complex for the given context and adopters. Successful innovations (successful in that they spread and are implemented) must also have trialability and observability (Rogers, 2003, p.16). This means that diffusers and adopters can both experiment with the new idea (presumably to test its relative advantage and complexity) and observe the results of their own and others' trials. This is one reason that agricultural technologies are slower to spread – the lag time of demonstrable results, often over the course of one or more full growing seasons, makes it hard to attribute change to a single new idea or practice.

Rogers' (2003) basic attributes affecting innovation diffusion and adoption remain the classic foundation for diffusion theory. In the past few decades, diffusion studies have been more common in medicine, technology and industrial management than rural sociology and agriculture (Coleman et al., 1966; Agarwal & Prasad, 2007). As interest in social systems and individuals' reflexive role in social networks has grown, there have also been critiques of the classic diffusion model, some suggesting that it is blithely naïve to assume that diffusion and adoption occurs based on uncoerced evaluation of an innovation and complete participation in the social networks creating and conveying new information (note that similar critiques have also been made of participation) (Fliegel, 1993, p. 57; Mosse, 2001). These critiques move diffusion studies toward political economy and power dynamics, with implications for the use of diffusion in power differentiated settings, which can be explored in the alternative framework provided by participatory theory. Another critique of the classic model is that it does not adequately develop the influence of social structures and interpersonal ties on diffusion and adoption of new ideas. Rogers (2003) defines social structures as the "patterned social relationships among the members of a system," which lead to predictability (and therefore trust) in social interactions (p. 24). He goes on to recognize that interpersonal communication can drive diffusion by creating a "critical mass of adopters" (Rogers, 2003, p. 300). The characteristics of a social system that facilitate diffusion and adoption receive only cursory discussion, and more extensive exploration of the nature of interpersonal ties, the types of networks they create, and effects on information spread moves toward a new field.

Meaning and value of social ties

Network theories are social science at its most basic, taking as a starting point for analysis the connections between people and how those ties function to create a social system.

Dewey (1927) offers a succinct explanation of the shift from focusing on individual actors and "objective" decision making processes to a more dynamic understanding of social change: "individuals still do the thinking, desiring and purposing, but *what* they think of is the consequences of their behavior on that of others and that of others upon themselves" (p. 24). Ryan and Gross (1943) observe as well that "the spread of knowledge and the spread of "conviction" are, analytically at least, distinct processes, and in this case have appeared to operate in part through different although complementary channels" (p. 21). Rogers (2003) accounted for this phenomenon with early ideas of communication networks, but it took empirical research to push diffusion theory more explicitly toward investigation of social relations. Coleman et al. (1966) note that "to analyze pairs of individuals instead of single individuals may seem like only a very modest step in the direction of the analysis of networks of social relations" (p. 114). However, analyzing individuals' actions as related to their interactions and relationships with others offers a distinctly new understanding of social change. The first major attempt at articulating a theory of social networks was Granovetter's (1973) "The strength of weak ties."

Granovetter (1973) categorizes interpersonal ties as strong or weak based on characteristics of time invested, emotional intensity and reciprocal services (p. 1361). Ties are either strong, weak, or absent, and create the social system within which individuals act and react. He identifies weak ties as those existing between individuals who do not have other connections to one another – who are acquaintances – implying less investment of time and emotion but not discounting the very real link that does exist and persist due to proximity, shared interest or other overlap (p. 1363). Because weak ties are inherently outward-reaching, connecting networks of closely associated people with other networks through a single "bridge," they are of particular interest and relevance to diffusion studies (Granovetter, 1973, p. 1366). Granovetter (1973) suggests that individuals with a multitude of weak ties are "best placed to diffuse" innovations, especially those that are new to a given social system (p. 1367). This idea has been seized upon

by theorists and popular writers alike, who describe active individuals as "change agents" or "opinion leaders" (Rogers, 2003, p. 27; see Gladwell, 2000). However, the implications of the strength of weak ties for diffusion theory are further reaching than simply identifying ring leaders. Not only can certain individuals with weak ties help spread innovations and convince others in their social networks to adopt them, but all people in a social network who have multiple weak ties to a variety of other networks are more likely to receive and adopt new ideas (Granovetter, 1973, p. 1371). Weak ties, "seen as indispensable to individuals' opportunities and to their integration into communities," can play an important role in development projects and paradigms (Granovetter, 1973, p. 1378; Matuschke & Qaim, 2009).

The role of weak ties in social change has thus far mostly been explored in relation to economic change, and the role that interpersonal connections play in economic decision making. Drawing on his initial assertions of the importance of the strength of weak ties, Granovetter (1985) further develops a theory of social systems within which economic decisions and interactions are embedded. Rather than the atomized views of either rational economics, where individuals act purely in utilitarian self-interest, or social contract theories, positing that human behavior is governed by abstract norms and values, a new conception of social interaction and economic decision-making emerges (Granovetter, 1985, p. 485). Granovetter (1985) builds upon institutional economic theory, which seeks to understand the role that social connections can play in creating an economic framework (Costanza, Low, Ostrom, & Wilson, 2001). In addition, sociological theories have focused on trust and reciprocity, and the role that these interpersonal ties can play in economic decision-making (Granovetter, 1985, p. 491). Though Granovetter (1985) suggests that social ties can also be leveraged for "approval, status, and power," non-economic goals, there remains a need to understand just how those ties can be cultivated and put to use in other decision-making domains, in particular for the diffusion and adoption of innovations (p. 506).

Coleman's (1988) introduction of the term "social capital" into economic and development discussions marks both a new phase in network analysis and also a narrowing of focus on the function of social ties. By defining social connections as a form of capital, social network theory entered the realm of economic analysis and could therefore be used in development paradigms that focus on numbers and economic outcomes as ultimate benchmarks for success (see World Bank, 2010). Measures of social capital can thus be incorporated into development projects that facilitate network creation to generate "productive activity" and durable change (Coleman, 1988, p. 101). Bridger and Luloff (2001) document the more recent emphasis of social capital in sustainable community development, as the trust and reciprocity identified with interpersonal ties fit well into a model of bottom-up change (p. 467). The focus, however, is still on social relationships as variables in economic decision-making and well-being.

As has been already been stated, attempts to understand the economic value and function of varying types of social ties provides a useful if limited next step in network analysis. Assigning economic value (though not a fixed number, a fixed variable in decision-making equations) to interpersonal ties falls short in that it creates a static view of social networks. Questions of the fungibility of social capital have been raised by development scholars, with unsatisfactory acknowledgements that the trust and reciprocity identified in social connections cannot in fact be counted upon to always guide actions in an economically rational way (Granovetter, 1985; Bridger & Luloff, 2001; Fine, 2003). Valuing interpersonal ties solely on the basis of how they contribute to social capital (their function in productive economic activity) limits discussions of the roles of social networks, and does not match up to empirical observation. In the international development field in particular, as programs move toward a more integrated and collaborative approach, practitioners and "clients" (recipients of development aid) are articulating alternate functions and value of social ties that are not explicitly economic, and that change over time based on characteristics of the development project (for example, type and

degree of participation by locals) (see Weltzien et al., 2008; Bandiera & Rasul, 2006). Based on an understanding of the dynamic functions of social networks, new development paradigms like participatory agricultural research have begun to focus on supporting and building social ties to generate and diffuse useful innovations.

Participatory agricultural research for development: Building practical and strategic networks for diffusion and adoption of new seeds?

A common refrain in research for development circles, especially in the developing country context, is frustration with the divide between development of an innovation and its subsequent adoption (Bellon & Reeves, 2002; Braun, Thiele, & Fernández, 2000; Ceccarelli & Grando, 2007). It has been suggested that the disappointing results of many conventional agricultural development projects are due in part to disconnect between the goals of scientists and development agencies, and the needs of farmers and communities they are trying to help (Ceccarelli & Grando, 2007; Uphoff, 1991). Uptake of new varieties and technologies has been slow, and in seeking to understand this disconnect, participatory plant breeding has emerged as an effective way to address not only the biological but also socio-cultural and environmental needs of farmers in developing countries (Ceccarelli & Grando, 2007, p. 7).

Variables constraining innovation adoption are complex and often evaluated based on aspects of a given development paradigm. In a more neoliberal, market-based framework, "client" characteristics of socioeconomic status, political power, and access to inputs are often described, especially when seeking to understand differences in rates of adoption of a new technology (Bellon & Reeves, 2002, p.1). Where client characteristics are found to be constraints to adoption, however, they are usually the same indicators used to justify the need for the development project in the first place. To avoid this teleological trap, social science needs to shift

its focus to characteristics of innovations and innovative processes, to better understand how to facilitate diffusion and adoption of new ideas to even the most resource-poor and disconnected populations. Participatory agricultural research for development, by working with "clients" throughout the process, accounts for the very constraints that keep innovations from being adopted, instead putting the onus on the entire research for development process.

Participatory plant breeding and farmer field schools are two common participatory development techniques used by agricultural scientists as ways to focus research for development on local needs, facilitate innovation and build the capacity of farmers. Encompassing both practical and strategic aims, participatory agricultural projects focus on generating new seeds and techniques that arise out of local needs assessments, as well as the development of technical skills, achieved through hands-on learning and farmer-to-farmer education and exchange (Braun et al., 2000). Participatory projects are usually small-scale and "functionally motivated," so that information and innovations are site and need-specific. The goal, however, is to scale up along the social scale and out from specific techniques to more general goals. Formal researchers leading participatory programs report results, analyze outcomes and seek to use the lessons learned to inform future projects, taking the knowledge gained "up" the development ladder to the institutional level. Farmers participating in the projects and generating practical results are in turn presumed to share this knowledge with others, creating horizontal information spread and building the capacity of farmers to teach one another and continue to innovate (Weltzien, Sperling, Smith, & Meitzner, 2001, p. 55; Ashby & Sperling, 1995, p. 754; Braun et al., 2000, p. 2).

The presumption of knowledge sharing and horizontal diffusion of information and innovations has to-date not been adequately investigated. This is in part due to temporal constraints: especially with participatory plant breeding, the first several years focus on varietal selection, initial breeding and early knowledge transfer (through farmer field days, on-site

demonstrations, etc.) (Haussmann & Kapran, 2007, p. 7; Weltzien et al., 2008, p. 169). The final step in the participatory plant breeding process, however, is seed distribution (Sperling et al., 2001). As participatory plant breeding projects move toward the seed dissemination (adoption) stage, and farmer field schools enter their third decade, there is a renewed need to understand and evaluate the means by which information and innovations, from improved seeds to production techniques to market access awareness, are shared and dispersed in the demand-driven framework created by participatory research for development (Ceccarelli & Grando, 2007, p. 355; Davis, 2008, p.19).

Participatory research for development projects implicitly strive to operationalize Rogers' (2003) characteristics of adoptable innovations. Questions of the relative advantage for and compatibility with the local context are directly tackled by participatory agricultural development projects. Farmer field schools and other collaborative spaces allow for problem identification and experimentation *in situ*, so that innovations are generated and vetted by the same "clients" intended to adopt them. Likewise with complexity and trialability – final innovations and information, generated by researchers and farmers working together, will be simple enough to understand and share with others, and already well-tested and tinkered with during the participatory research process. Finally, observability is achieved through projects that occur in local fields or village common space, so that both those farmers directly involved and others in the area can see first-hand the benefits of new techniques and technologies. For innovations to diffuse, it is not enough that only those directly involved in research for development observe and accept the merits of innovations. Indirect observation, wherein knowers of new information pass it along to unknowers via communication channels, must be achieved for any innovation to spread outside its initial context (Rogers, 2003; Weltzien et al., 2003).

Projects using participatory plant breeding and farmer field schools also seek to scale up and out innovation diffusion and adoption by facilitating the growth and spread of both weak and

strong ties (Rogers, 2003, p. 340; Granovetter, 1974). The question remains, however, of whether these research for development approaches do in fact facilitate the creation of networks, through which the innovations generated are more likely to diffuse. Weltzien et al. (2008) note anecdotal evidence that farmers have expressed appreciation for the chance to share information with one another at organized events like field days and farmer field schools (p. 169). More research, both quantitative and qualitative, needs to be done on observed and articulated changes based on participatory projects. Though, as previously noted, social networks are dynamic and their function should therefore be measured using multiple valuations, in the practical field of international development there is still a need to assess changes not only to networks themselves, but also their effects on people's decision-making and daily lives. The tangible results of innovation diffusion and adoption can be tracked over time, and their success measured on the basis of positive change in quality of life standards and desired future actions, as experience and articulated by those whose lives are directly affected.

This research project is framed, then, through the synthesis of the preceding strands of theory. First off, I take a critical approach to understanding the goals and outcomes of the development process. Based on historical accounts of the effects of different development paradigms, I seek to build on the systems approach taken by many theorists and practitioners who seek to debunk the singularly rational nature of modernization. I do not, however, reject outright the notion of development, or positive change in individuals' and communities' material and social needs. In keeping with an ethos of inclusion and partial knowledge, I have learned from farmers in West Africa the changes they wish to see; in particular, in this case, the desire for improved variety seeds that can buffer uncertain climate conditions. Participatory development theory offers an approach to validate these knowledges and desires, by emphasizing the necessity of putting people first and last. The outcomes of participatory processes are much discussed among development practitioners, but the focus is usually on functional goals, measurable

indicators of success. Diffusion theory can help explain how participatory techniques achieve functional success. However, an emphasis on process as well moves beyond material needs being met and instead focuses on the social relationships that are built and reinforced during the participatory process. I argue that it is the weak ties that develop among farmers, both during and after participatory projects, that can provide a foundation for both empowering participation and further adoption of new agricultural technologies and techniques. Because these interrelationships and processes of adoption are unique to and conditioned by the details of context, this analysis continues to build on the critical tradition of many development and feminist scholars.

Chapter 3

Methodology

Goal

To describe existing information and technology exchange networks using information from a baseline assessment of farmer and researcher perceptions of participatory research and development in West Africa, and to assess the effects of participatory projects on knowledge and resource distribution, as well as the causes of and constraints to diffusion and adoption of agricultural innovations

Research questions

- How do participatory research and development projects facilitate two-way communication and learning between farmers and researchers, and among farmers?
- How do participatory agricultural development programs increase farmers' connection to and use of new information and inputs (i.e. do the program support diffusion and adoption)?

Methodological overview

As stated above, this project draws inspiration from CGIAR's recent shifts toward research for development with a "shared responsibility for managing towards outcomes, i.e., uptake of outputs resulting in longer-term livelihoods of end-users" (CGIAR, 2009, p. 7).

ICRISAT has established participatory plant breeding projects with the goal of generating more durable outputs, and continues to build on the knowledge and experience generated with new projects that focus on innovation adoption and utilization for livelihood improvement. In that spirit, I undertook research in McKnight Foundation-funded project sites, conducting interviews with farmers and researchers during June and July 2010. I conducted audio-recorded semi-structured interviews with 10-30 farmers in each of the five project areas (two each in Mali and Niger, one in Burkina Faso), for a total sample of 86 farmers, using a questionnaire designed to interrogate both sides of the participatory research and development process (see Annexes A and B for interview guides). Questions of how they participated in the project, what they learned and what they taught, as well as changes they have made or seen made by others based on participation (and the innovations generated) were asked. This approach is the first step toward participatory evaluation of the project, where primary users (farmers) work with trained researchers to assess the effectiveness of a program (Cousins & Earl, p. 399). I also asked researchers similar questions of what they taught and what they learned, in order to compare and contrast the perceptions of *all* participants, farmers and researchers alike.

In addition to semi-structured interviews, I participated in implementing field trials in Niger (see Annex C, figure 1), sat in on planning meetings in Mali and Niger, and attended a results workshop in Mali. Participant observation is another important tool in qualitative research, allowing the researcher to learn through acting and listening simultaneously (Creswell, 2007). Through participation, I was able to gain a more nuanced sense of how farmers and researchers interact, which also provided me with experience upon which to reflect later. Observations and thoughts about them came later, usually at the end of the day, as I wrote field notes about all that I'd seen and heard. Those field notes proved an invaluable resource as I undertook analysis of the interviews and also reflected on other aspects of the research project. Though not directly referenced in the subsequent analysis, field notes have provided context for

many of the observations I made while an active participant in certain aspects of participatory plant breeding.

Participatory evaluation provides an alternative articulation of project achievements. Rather than monitoring change and improvement using development indicators alone, measuring changes in farmers' knowledge and practices, and understanding from what source they received this knowledge and why it is seen as legitimate and useful, fulfills the mandate of "managing toward outcomes" (CGIAR, 2009, p. 7). Outcomes can be assessed through both qualitative and quantitative research, but understanding how and why those outcomes came about, in order to inform future project design, requires a qualitative understanding of why decisions were made. In effect, the following analysis will assess both whether the innovations generated by the McKnight Foundation projects have the characteristics that Rogers (2003) articulates as relevant for diffusion (met functional needs) and whether the participatory process enabled farmers to continue to take independent action in the future (empowering change).

Setting

Figure 1: Map of West Africa
Based on map number 4045 revision 5, April 2009 (UN Cartographic Section, 2009)

ICRISAT maintains its West African regional research station outside of Niamey, Niger, with a secondary station near Bamako, Mali. The principle countries of focus for the PPB projects are Mali (sorghum), Burkina Faso (sorghum and millet), and Niger (millet)[1]. The three countries share similar ecological settings, situated just south of the Sahara, in the Sahelian and Sahelo-Sudanian zone (SWAC/OECD, 2010). All have considerable agricultural sectors, mostly of subsistence farming. In Mali, millet ranks second and sorghum third (behind rice, which is produced solely along the flooded banks of the Niger River) in cereal crop production. In Burkina Faso, sorghum is first and millet second, though their production levels are nearly equal. Millet is overwhelmingly the most important cereal crop in Niger (FAOSTAT, 2010). The three countries share a history of French colonialism, achieving independence in 1960. The United Nations Human Development Index currently ranks these countries at the bottom of the global scale, with Burkina Faso at 177, Mali 178 and Niger at 182 (out of 182) (UNDP, 2010).

ICRISAT is a part of the CGIAR system and has had a presence in West Africa since 1972, with the first research station established in Niger in 1989. Since then, ICRISAT has added a research station in Mali and works across the region of West and Central Africa on agricultural research for development projects that focus on smallholder dryland farming (ICRISAT, 2011). The specific project sites involved in this research vary in the length of time for which they have worked with ICRISAT. In Mali, where political stability and ecological advantage have created conditions for long-term involvement, both areas with project sites have over ten years' experience working with ICRISAT. The area in western Burkina Faso has a history of working with ICRISAT and their collaborating partners in the national research system. In Niger, the sites have a more varied history, with Bokki having more sporadic association with ICRISAT, as projects have come and gone, and Maradi maintaining long-term connections due to a strong farmers' union and organization.

[1] There are also field sites in northern Nigeria, but they were not visited during this study.

Researcher perspective

As a graduate student studying rural sociology and international development, I came into this project as a new member of the ICRISAT research team to help implement impact and evaluation studies of their participatory plant breeding projects. Building upon my training in qualitative research methods as well as the participatory nature of the project, I positioned myself in some ways between farmers and researchers, asking questions of each group and seeking to share that information with the other. Though I share many of the critiques about international development as it has been conventionally conceived over the past 50 years, I do come into this project with some intention toward development. Taking a critical-realist approach to questions of development, I believe that changes defined and enacted by people themselves should be the focus of programs and projects. This is where participatory methods can revolutionize the development process, as "end- users," farmers, can and should be involved in the process of change from start to finish. As an outsider, I am also a part of the process, and have a unique role of which it is important to be aware.

The nature and foundations of both participatory research for development and qualitative methodologies suggest that data is gathered through an interactive process between the researcher and participants, with an emphasis put on the experiences and explanations offered by all involved in the research process. As a researcher, then, it is important to reflect on my own position in the research and work setting, to remain conscientious and critical of the effect that my presence and role will have on the research being undertaken (Naples, 2003). I am a young, white woman working in a region where gender roles follow more traditional guidelines of male/female divides of public/private spheres. Having lived in Senegal for two years (a country with similar cultural customs), I am aware of the signs of respect and understanding necessary to be accepted into the setting on a basic level. By adhering to certain external standards of cultural

understanding, like appropriate dress and basic language skills, I seek to minimize the "othering" effect that outsiders can have on research participants (McCorkel and Myers, 2003).

Two years spent living and working in a rural community in West Africa drew me to continue to live and learn in this part of the world. Having some understanding of culture, ecology, and place provides a foundation from which to explore further specific questions about how development processes work in this particular setting. Adhering to an ethos of contextual and place-based knowledge demands grounding in a certain place, to frame and make specific the theoretical assertions of development and participation. I chose to research development practice *in* West Africa, in order to build on past knowledge and experiences in the region. In addition, having lived in Senegal during the food crisis of 2008, with smallholder farmers trying to make decisions and connections that best met both their immediate and longer-term needs, I would very much like to better understand how they can be supported and served by all of the attention and money being focused on agricultural development in Africa right now. Caring about farmers in Mounting, Senegal pushes me to work for and with farmers across the region.

Though initially an outsider in the communities within which research took place, I entered with the support and introduction of well-established technicians and researchers, providing some context within which this research is being conducted. With a background in the region and acquaintance with many of the participants with whom I wish to work, I have a foundation from which to approach research that makes sense in and is respectful of the context of West African village life. In some ways, I am riding the coattails of ICRISAT's long-term involvement in these areas, and am very conscious of maintaining the standards and practices of such a well-respected organization. Interestingly, I have also acquired some entrée into communities when Peace Corps comes up. Peace Corps has a long history (more than 40 years) in the region, and because I look like the typical Volunteer, people often asked I was serving.

When I would say no, not now, but that I was a volunteer in Senegal, I was met with warm smiles and invitations to talk, eat, stay.

Sample

Table 1: Sample of farmers and researchers interviewed

	Farmers		**Researchers**	
	Gender (percent M/F)	Average age	Gender (percent M/F)	Average age
Mali Farmers n=50 Researchers n=3	48/52	45	100/0	35
Burkina Faso Farmers n=8 Researchers n=1	50/50	44	100/0	36
Niger Farmers n=28 Researchers n=2	39/61	48	100/0	40
Total Farmers n=86 Researchers n=6	45/55	46	100/0	37

I conducted semi-structured questionnaire interviews with farmers at McKnight Foundation project villages in the Mandé and Dioila regions of Mali, the Bokki and Maradi regions of Niger, as well as the Dédougou region of Burkina Faso. I also interviewed the ICRISAT researchers and technicians who work in the project villages (see Table 1 for demographic information of those interviewed). Some of the villages in this study have a history of collaboration with ICRISAT, through McKnight Foundation and other projects, while others are newly established sites. Villages are not chosen at random by ICRISAT, but rather connections are made based on past experience with international organizations, farmer interest and regional characteristics (those with active farmer organizations or extension agents). Site selection, therefore, is not random and is possibly skewed toward more well-connected villages,

so that research results lack some robust external validity. The lack of counterfactual data against which to compare the outcomes of participatory development programs remains a major impediment to adequately assessing their efficacy ("Harnessing opportunities," 2009, p. 21; Davis, 2008, p. 23). A first step toward such a comparison comes in the analysis of responses from two types of farmers: those with a history of ICRISAT collaboration and those who are newly participating in the McKnight Foundation project.

Because my research questions focused on the experiences of farmers directly involved with participatory plant breeding projects, the population of interest was defined as all participants. I therefore took a purposive sample of participating villages in each small region, in order to access farmers with direct experiences. Within each village, I intended to randomly select from all participating farmers (via a list provided by ICRISAT) those to interview. However, those lists were not easily obtained, and so I relied on the local technicians, who had mental lists of participants. Based on time and resource (transport) constraints, as well as farmers' availability, I ended up conducting a convenience sample of farmers from a convenience sample of villages. Some participants were chosen through a sort of modified "snowball" sample, when a farmer being interviewed would recommend someone in his own or a neighboring village with whom to connect (Biernacki & Waldorf, 1981). Because of this convenience sample, there is likely to be a bias toward those more interested in or with a longer history of participation with ICRISAT – local technicians choose enthusiastic farmers and those farmers in turn recommend others like them.

I did do some additional purposive sampling to ensure women's voices and experiences were captured as well. ICRISAT has increasingly made an effort to include women in the participatory plant breeding process, but most of them are newer participants and also have unique experiences with the projects. For example, during an interview with a female farmer in Niger, the woman explained to me that she didn't know how her trial field was going, because her

young sons had been maintaining it for her. She said that she had initially planted but then didn't have the time to consistently take care and follow the ICRISAT protocol. When I mentioned this to one of the researchers, the response was, "Well, we need to tell her that's wrong!" Though well-intentioned (I believe the researcher wanted the woman herself to learn and reap the benefits), this mentality perhaps keeps more women from participating in the projects. Women will continue to be cut out of true participation without attention to the unique realities of female farmers, who grow sorghum and millet but usually in smaller quantities than men, on more marginal fields further from home, and who also have another entire set of household responsibilities. ICRISAT has made efforts to modify the trial protocols for women, scaling down some field tests to only three or five varieties, rather than the standard 32 (see Annex C, figure 2). More questions need to be asked of women, however, about their experiences with the project and how to better support their participation. For this reason, wherever possible I made the effort to speak with at least two women (though in Burkina Faso there was only one female varietal tester – others had only participated in trainings or demonstrations).

Much like the enthusiastic farmers, researchers working for ICRISAT might have characteristics that make them unique in comparison to other development professionals, other agricultural professionals, and similar peer groups. Thus, from the outset researchers are a self-selected group. An important counterfactual that should be pursued in the future would compare development professionals engaged in participatory projects with those working on more conventional projects. That comparison, however, is beyond the scope of this project. I had planned to randomly sample the researchers involved in each site for interviews, so that at least variability among them would be minimized. In the end, however, I was able to interview each local technician (hired by ICRISAT and stationed in the field) and research technician (second-in-command after the principal scientists running the project from ICRISAT research stations). In the subsequent analysis, I will refer simply to "researchers," as both jobs require a strong focus on

implementing the research process. The principle scientists directing these projects provided much background information and support. They were not, however, interviewed separately about their perceptions of and experiences with communication in the participatory plant breeding projects. This was in part a practical move – they are often busy, travelling to international meetings and regional site visits, and so are neither on the research station nor in the field nearly as often as their technicians. In addition, the logistical reality of how much time principal scientists spend in the field means that they are not well-positioned to answer specific questions of communication and exchange. Instead, they provide the theoretical framework for participatory projects through their articles and scholarly work, much of which is cited in this study.

Language and translation

Farmers speak a variety of local languages, and I worked with an ICRISAT translator or technician to translate questions and responses between French (in which I am fluent) and the local language. In Mali, farmers speak Bambara or Malinké, a related dialect that sometimes requires further translation. Project sites in Burkina Faso are centered around Dédougou; farmers there speak either Dioula, Bomu, or Mooré, all unrelated and again, often requiring additional translation from the dominant local language to the more locally specific language. In Niger, sites exist southwest of Niamey, near Bokki, where farmers speak Djerma and sometimes Fulani, and far east in the Maradi region, in several scattered Hausa-speaking villages (Lewis, 2009). Very few farmers speak French, but I was occasionally able to conduct interviews directly with farmers in French.

The multiple levels of translation were dealt with in several ways. My initial interview guide was written in English, in order to share it with advisors and others and receive feedback. I

then translated the questionnaire into French and had it edited and certified by a fluent French speaker on the Penn State faculty. It was this French guide, then, that I shared with technicians and translators while conducting field work. I would pose the question in French, and my co-worker would translate it into a local language. In each country, technicians generally speak the dominant local language, because they have grown up in cities where one local language is predominant. In Mali, this meant that at times the Bambara speaking technician would have to ask for clarification from a villager who spoke Malinké as well. The western area of Burkina Faso where research was conducted contains several distinct local languages, and so translation was at times difficult, with the technician translating from French into Dioula, and another local who spoke both Dioula and the second, more obscure local language further translating. The same was true in Niger, where Djerma and Haussa are each regionally dominant but often not spoken by the same people.

One final step of translation occurred as I transcribed the recorded interviews. Listening to the tapes, half of the conversation is unknown to me, as it occurs in a local language. The French translation and explanation between me and the translator is the part I transcribed, but again, for ease of analysis and sharing, I immediately translated the French into English. The multiple layers of language and translation mean that I will not be able to do a discourse analysis nor pull apart specific vocabulary or phrases. I worked with several translators with varying French skills across three countries, so that variation in word choice could as likely have come from them as from the respondents themselves. As Temple and Young (2004) suggest, interpretation occurs whenever information is shared, as individuals seek common language and meaning to establish mutual understanding. Translating while transcribing, then, is simply one more step taken to make information accessible and comparable across settings.

Participatory methods and analysis

Questions of what farmers have learned and taught address innovation generation and diffusion, the first step toward durable change. Participatory development emphasizes the connections made between farmers during the research and development projects, and so I asked questions about how information was shared during the trainings (direction of flow), how that exchange has continued, and if changes in cultivation practices have been made on the basis of the weak ties reinforced or created through participation or through pre-existing strong ties. I also asked about what other sources of information and inputs farmers access, in order to better understand the broader networks that currently exist and how they might change on the basis of participation in McKnight projects. However, adoption is equally important, and so I asked farmers not only about changes in connections to information, but also about actual changes in practice they have made during this planting season, and where they received the information or inputs being implemented. Adoption, the ongoing use of a new idea or technology, can perhaps go beyond meeting functional needs, and instead be seen as indicative of an empowered change for individuals or communities. Rather than simply taking as static the new varieties of seeds and cultivation techniques, adoption means farmers making this information their own, and having the confidence and knowledge to adapt and apply new ideas as they fit into local contexts.

Because participation implicates all actors in the research for development process, interviewing and understanding changes in farmers' actions is only half of the equation in assessing the long-term effects of participatory projects. Researchers working in a participatory framework also stand to encounter knowledge and innovations that will change the way they do their work (Buruchara, 2008). In participatory plant breeding in particular, farmers' preferences, local seedbanks and varietal selection provide information for plant breeders that can guide research on innovations with diffusible and adoptable characteristics. I therefore interviewed

researchers working on ICRISAT projects in the research sites, asking questions of what they taught and learned during the trainings, and how they participated in the project. I also asked what changes they are making based on the new knowledge they encountered as participants in the projects. As previously mentioned, these researchers are one step below the principal scientists who receive funds, direct projects and report impacts. It is the researchers and local ICRISAT staff who are on the ground with farmers, conducting several field visits per year to support farmers in all steps of the participatory plant breeding process. Principal scientists visit the field less frequently, and so they were not directly interviewed about their consistent communication experiences with farmers. Participant observations were made, however, while on site visits and in field meetings with the principal scientists.

Limitations in data gathering and analysis

As mentioned above, most of the sampling for this research was done by convenience, as time and transportation resources were limited. In addition, because I was new to the communities and establishing relationships, I often started off talking with village leaders or strong project participants, who could then point me to others who might be interested in talking. This bias, however, means that I did not talk to many farmers who were critical of their experiences with ICRISAT, nor to those farmers who have not directly participated in the breeding projects. For this reason, the data is generalizable to only a very limited population of connected and "successful" participating farmers. In addition, given the commitment to contextual knowledge and understanding, findings about the types and effects of participation in these communities can only be applied to a limited frame – communities with similar demographics within the same country, perhaps.

Reliability of analysis is also a constant concern in any type of explanatory research, and remains an important constraining factor to this type of research project. Because this research is part of a long-term, on-going project, I have been able to use a modified constant-comparison approach, taking my interpretations and findings back to the communities to receive their input (Glaser and Strauss, 1967). In addition, I have used triangulation methods to add multiple dimensions to my analysis (Creswell, 2007). Participant observations from group meetings and field visits, individual interviews and literature about the projects will all be analyzed and compared to increase reliability. I was limited by time, however, in how much participant observation I could do, as I was only in each project site for a few weeks. The literature is also sparse, since most of these projects are ongoing and have not yet conducted extensive ex-post reviews. This research project seeks to fill part of that gap, but also suffers from a lack of previous impact assessments and qualitative work.

Chapter 4

Results

Participatory plant breeding projects (and indeed all participatory approaches to development) profess to effect change both through their final product and the process by which it is reached – that is, they can create both functional and empowering change (Johnson, Lilja, & Ashby, 2003). The results of semi-structured interviews with participating farmers and research technicians about their experiences with ICRISAT's participatory plant breeding projects suggest that both groups place an emphasis on the functional needs being met, but also highlighted certain empowering aspects of the project. From questions of why farmers chose to participate, to discussion of what both farmers and researchers learned from and taught one another, and finally descriptions of changes as a result of the projects, the duality of practical and strategic interests emerges. Results and analysis will be presented much as the questions were posed to either the farmer or the researcher – that is, a step-by-step discussion of their thoughts on and experiences with the participatory plant breeding process. Responses to each question tended to cluster thematically and fairly consistently across countries. For example, many farmers in each country emphasized access to inputs as a reason for participating in the first place. These substantive divisions were then coded as suggestive of either functional or empowering effects of the project.

As coding progressed, a typology began to emerge that will be used throughout the following analysis. Functional changes are those that address material or practical needs, and are more likely catalyzed by vertical knowledge sharing between farmers and researchers. The practical outputs that address these needs are improved variety seeds. Recalling Rogers' (2003) discussion of the characteristics of diffusable innovations, comments by both farmers and researchers suggest that the participatory process has in fact created more functional final outputs.

Empowerment as a result of the participatory plant breeding projects was expressed by farmers as based upon knowledge gain, expanded choices, and the ability to make independent decisions. Horizontal sharing of information and experience (among farmers themselves) accompanied statements of empowerment. Finally, within this empowering horizontal information exchange, weak ties are characterized by many farmers to be important connections that in fact make this type of knowledge sharing possible and more powerful. Farmers mentioned a new-found ability to seek out information and ask questions of others with whom they had little prior connection. They also often highlighted the weak ties that exist in groups like cooperatives and unions as a mean of indirectly accessing new and varied information (through their connections to those actually receiving the information). In contrast, strong ties, usually expressed as familial, are more ambiguous. Though strong ties, to other participants and those with agricultural knowledge, can inspire initial participation, they can also hamper and at times, due to social expectation inherent in those strong ties, actually cut off the process of broader change.

Farmers, why did you choose to participate?

> "When you are a part [of the project], you get good quality seeds and also, inputs."
>
> "He thought that with that number of varieties, they would have their choice within them."
>
> "He chose because …they will give plants to grow, and also there is fertilizer."
>
> "She accepted because when they came, the yield here was low. And ICRISAT brought varieties to help them."
>
> "She said that, she wanted to have an improved variety that performs. That gives a good yield."
>
> "And also, he accepted in order to have performing varieties, early varieties."
>
> "He accepted because he really wanted to have good agricultural techniques."
>
> "He knows that they can gain new knowledge. And with INERA, there is information and also seeds. And with the utilization of improved seeds, people can improve their harvest."

> "He said that before the arrival of ICRISAT, he used traditional practices. But he saw that traditional practices weren't enough. When he thought about it some more, he decided to enter into the ICRISAT project. Now he works with them."

In all three countries, most farmers expressed interest in the practical aspects of the participatory plant breeding projects. The single strongest reason for choosing to be involved was the perception that participation would bring access to inputs. Seeds, fertilizer and implements were all mentioned, although the focus was generally on improved variety seeds and chemical fertilizers. In addition to inputs, farmers also placed a strong emphasis on increasing their yields, highlighting the changes in soil quality and rainfall as reasons that improved inputs were required. For the most part, these requests suggest that a primary reason for participation was to meet material, functional needs. In addition to explicitly mentioning these functional ends, many farmers also expressed interest in connecting to ICRISAT's knowledge about new techniques and inputs, focusing not on the process of acquiring that knowledge but rather on what practical use it has for them – again, for the most part, increased yields. This vertical transfer of knowledge, from researcher to farmer, seems to be a strong motivator for most farmers who have chosen to participate in the project. Their interest was usually framed in the context of changes in their fields and their weather, so that the current lack of access to inputs and information was not analyzed at a more strategic level, with an eye to longer-term structural changes that could make that knowledge more available. Instead, there was an underlying sense of appreciation and need for knowledge to be passed from researchers to farmers – a sentiment that was repeated as I continued to ask questions about two-way knowledge sharing throughout the projects.

> "He did it to look for a variety of his choice, so that he could keep planting that."
>
> "She wanted to see the different varieties, their kind…she's going to choose the technology that is best suited for her, so that she can really apply that in her field."
>
> "She said that within the varietal tests, there are varieties that have proved to perform well…so, those that perform well, they save them as seeds, and grow them in their own fields."

> "Why he chose to work with the INERA researchers, is because he himself is looking for new knowledge. He would like to create new knowledge to take it and use it in his own field."
>
> "If someone comes here to your place, and asks if you can work together, if you accept, you will see if they have a good solution."
>
> "She said that when you choose to participate in activities, you will learn new knowledge from participation. That's what motivated her, knowledge. "
>
> "Because she wants to learn and teach others."

Many farmers also expressed a strong desire to learn more and make their own decision, rather than simply assuming that any new information would be immediately useful. Because the focus of participatory plant breeding is on varietal selection for preferred traits, farmers tended to focus on the choice of which variety would work best for them. This interest in combining their own knowledge of their unique situations with the "expert" knowledge captured in improved variety seeds suggests a more strategic goal for participation. Many also expressed an interest in knowledge to be shared with others, as a way to help beyond their own fields. Though farmers did not explicitly explore the differences between having knowledge within the community and knowledge coming from the outside, the interest and confidence in gaining knowledge to use and share as they see useful suggests an empowered feeling that emerged from the participatory process. Indeed, these sentiments were strongest amongst farmers in the Siby region of Mali, where ICRISAT has been working on participatory plant breeding projects for almost ten years. By valuing the ability to share knowledge among themselves, the importance of horizontal communication already begins to emerge.

> "She accepted because her husband asked her to."
>
> "Because she heard a neighbor in her village talking about ICRISAT's work. That's what was in her head, to get her to work with ICRISAT."
>
> "Well, because I am a member of UGCPA [a union], we spoke of it."
>
> "It was thanks to Namakan [village union president]. Because when Namakan got the information in Siby, he came back and explained it to them."

Knowledge sharing among farmers became a stronger and stronger theme as conversations progressed about where they get information and what it means to them. Even in the question of why they initially chose to participate, however, it becomes clear that both weak and strong ties push people toward the decision. For women in particular, strong ties seemed to be the most influential social pressure in convincing them to participate. Usually, it was at the suggestion of their husband. Sometimes, through the support of a close female friend or relative. Women very rarely cited weak ties as reasons for participating, which is likely due to the fact that in all three countries, women are less likely to be members of unions or cooperatives, as well as having less access to land. For men, on the other hand, membership in unions and cooperatives was a primary means of entry into the participatory plant breeding projects. Sometimes it was directly through the union that they received the information, but more often, the weak ties of the union did their job – one person received information which they then shared with their network of fellow union members. Each farmer could then make the individual decision about whether to participate or not.

Farmers, what did you learn from researchers?

"Characteristics of improved varieties."
"Use of fertilizer."
"Spacing, weeding, thinning."
"How to use manure."
"Modern practices."

Over and over, farmers discussed the functional effects of participation. Over 75% of the responses to the question "What did you learn from researchers?" focused on the outputs – technologies or techniques – and why they were useful. The primary focus was on seeds, of course – learning the new varieties' names and characteristics, and how and when to use them.

Because many of the farmers interviewed were involved in demonstration fields that also incorporated different agronomic practices, there was also a strong emphasis on complimentary techniques. Farmers would often start out very specific, listing the spacing rules or the timing between rounds of weeding. As they continued to talk, however, many would come to a point of characterizing what they'd learned: "modern practices." The knowledge learned from the researchers was new and called for change, and many farmers contrasted this to their own, traditional practices that were no longer sufficient. For the most part, farmers talked about changes in climate (mostly rainfall) as the reason for needing new practices. They also talked about degraded soil and "bad" local varieties of seeds. There was virtually no discussion of what might be causing the changes that demand new seeds, nor of ways to deal with these changes in other, less material ways.

> "I didn't do it just for techniques, but for comparisons. And I had results also."
>
> "With the arrival of the project, they have seen improved varieties. And if there is an advantage, they will switch."
>
> "He learned about lots of varieties. So now, he makes a choice."
>
> "Thanks to the project, they have learned how to select the early maturing varieties."
>
> "She learned how to do a test…she saw that it's a good thing, to do all of that to be able to see what is a good variety."
>
> "He saw that it [the project] was very good…and also he put in his head. And he said that he learned a lot of things, because now when he plants his own field…he manages his field that way."

Despite the predominant focus on functional ends, some farmers did highlight the process of participation, stating that they gained a new ability to act and make decisions for themselves with the knowledge they gained. Again, the focus was mostly on improved variety seeds. All of these farmers talked about choice – new knowledge has given them new ability to make decisions that make sense for their own reality. Many talked about knowing about the improved varieties, so that they can find what will best work for them. A few farmers mentioned that training in varietal selection meant that they could continue to create, evaluate and choose varieties to meet

future needs. A few mentioned the use of other field management techniques that they had learned as an example of how they continue to work with the knowledge they gained. Though those needs are still material, the confidence to use those skills in new ways suggests a sense of empowerment to make participatory plant breeding their own. As will be discussed further below, the functional knowledge communicated through vertical channels, from researchers to farmers, becomes empowering when farmers can use that information in their own ways, after assessing their needs and goals for change.

Researchers, what did farmers learn from you?

> "Selection of the best varieties."
>
> "To see the difference between the old practices and the new system."
>
> "The farmers…compare the varieties that are sensitive to these practices and the varieties that are not sensitive to this. Sometimes, they can choose one variety [that they prefer]. That's what we did last year."
>
> "Because really our emphasis is on participatory work. We don't just tell the farmers, it's better to be behind them, and they do it. And that really helps them find a solution."

Researchers, like farmers, had mixed perceptions of what farmers learned from them. All mentioned the practical outcomes. Varietal selection, knowledge of improved varieties and the usefulness of new practices were emphasized by all. Among the farmers, descriptions of this functional knowledge remained just that – information that is useful without necessarily being analyzed or built upon. Only a few farmers more explicitly mentioned the ways in which they planned to use the knowledge, and how having more choices could start to be empowering. Researchers, on the other hand, seemed to assume this two-step process, with comments about farmers choosing a variety set in broader expressions of supporting farmers in making their own decisions. Some of the researchers suggested that their role is in fact just that – supporting, facilitating, even structuring the learning process. There seemed to be little awareness, however,

that the ways in which the learning was structured, by individual researchers, grant obligations and ICRISAT guidelines could have a profound effect on if and how the participatory process empowered farmers to build upon the functional knowledge gained.

Farmers, what did researchers learn from you?

This question proved to be the most interesting and at times entertaining of any I asked throughout the study. I would pose the question in French, to the translator, who often for the first few times would think that he or she was hearing me incorrectly. The translator would then translate into the local language, and almost invariably, the farmer would listen, seem a bit confused, look at the translator, then at me. I learned quickly to nod encouragingly and smile a bit, which usually got a smile and often a laugh back. Then there would be a long pause…followed by, "Eeehhh?!" A typical exclamation in West Africa when someone is a bit bemused, a bit unsure, a bit caught off guard. This was often followed by another long pause, while the person tried to take in what I was asking, and think about what they could have offered to ICRISAT. Once they took that time, however, all kinds of answers emerged, which speak to the complex nature of participation and communication in international development.

> "The varieties which are good for eating."
>
> "They learned their [farmers'] traditional practices."
>
> "One year ICRISAT came here, asked him to give them a little bit of seed, of local seeds. They took that to ICRISAT, and they were going to try that there."

For most farmers, once they thought about it, it was information and sometimes seeds that they could have offered to the researchers. Many saw their opinions as possibly useful information, saying that ICRISAT learned their varietal preferences and other thoughts about the projects. A few mentioned other researchers like me who had come to ask their opinions in the past. There seemed to be little annoyance or suspicion about this, but rather a simple statement

that their opinion was all they had to offer. Some also mentioned teaching researchers about traditional practices and local varieties of seeds. Though again, farmers never mentioned any problem with sharing this knowledge, I did ask a few technicians and union leaders if there was ever any tension around the sharing of seeds to be taken to the research station. They said no, and that in fact some farmers are proud to share, because the name of the variety is maintained, so that everyone can tell where it came from. The general attitude seemed to be that it was fine to share this knowledge, but there was certainly no mention of how ICRISAT might have used it. No discussion of things said that hadn't been acted upon, or decisions made as a result of conversations with researchers.

> "She said that there were people from ICRISAT who visited her field. So, they exchanged. Aside from that, the researchers asked which variety she would like to grow. She made her choice, and they wrote it down."
>
> "So, after the harvest, they [ICRISAT] asked them to harvest themselves and then weigh. They asked them to do that without the help of ICRISAT, because they could do that."
>
> "But it was collective work, they worked together, so maybe, maybe they learned something with him."

Some farmers did highlight the action that they had taken from which ICRISAT learned – weighing harvest and sharing the figures, discussing choices they had made in their own fields. In one comment in particular, a farmer mentioned that he was able to carry out the weighing of the harvested grain, and that ICRISAT has asked him to do it alone, knowing that he could. Though there is a functional component to that knowledge, as it is useful to the farmer and the researchers, there also seemed to be a sense of pride in being able to do the work without the direction of the researchers. Whether this confidence came from being a part of the participatory plant breeding projects is unclear, and raises an interesting question: does ICRISAT pick farmers with whom to work who already have some skills and knowledge that fits into the project's needs? And can working with these farmers still help broaden the spread of new information? One other interesting comment made by someone, after recovering from their shock at the

question, was to highlight the collective nature of the work. The implication seemed to be that working together usually teaches both parties something, so that it is likely that ICRISAT learned something from him. However, there seemed to be no awareness on the part of the farmer as to what ICRISAT might have learned.

> "Because it is they who learn, how is ICRISAT going to have something?"
>
> "He doesn't think that they learned anything from him."
>
> "ICRISAT gave them knowledge but she, she didn't give them anything."
>
> "She said that she learned from ICRISAT, but what did ICRISAT learn from her? She doesn't know…but it's possible."
>
> "He said that, that's not a question we can ask him. We have to ask that question of the researchers…"

Almost half of the farmers responded to this question with a much more simple statement: what could we have possible taught the researchers? After getting over the initial moment of confusion at the question, many simply said that it was ICRISAT who had the knowledge, and they, the farmers, were there to learn. Many people seemed not to have noticed researchers taking in new information and learning as they worked together throughout the projects. Some seemed open to the idea that the researchers could have learned something. And several suggested that I ask the researchers themselves. Even those who thought it possible that ICRISAT had learned something found themselves hard-pressed to describe what that might be. I found it interesting that even with the strong focus on practical interactions and outputs that exists in these projects, many farmers didn't see themselves as contributing functional knowledge to the participatory plant breeding process.

Researchers, what did you learn from farmers?

> "I really discovered…the real world."
>
> "It was eye-opening."

> "Traditional practices that they really do in their own fields."
>
> "There are lots of things that the farmers know. For example, in the fight against *striga*. They have a method. They look for *nere* powder, mix it with the seeds, and there the striga doesn't grow."
>
> "Interpersonal relationships aren't as smooth as portrayed by groups to outsiders."

Researchers, on the other hand, seemed to have a mix of curiosity and awe from their interactions with farmers. From dramatic statements about discovering the real world to a respect for traditional knowledge, researchers were emphatic that they learned a significant amount from farmers while working together on participatory plant breeding projects. There was no mention of conveying this learning and appreciation to farmers, however. It seemed that researchers saw the process of participation as evidence of their interest in farmers' knowledge and skills, and might be surprised to know that farmers aren't aware of that the exchange. This feedback is perhaps missing because there is no immediate, practical use for such information. Unless researchers are following up on things they learn while working with farmers, there is no clear function for this knowledge. However, if researchers could convey that they do indeed value learning from farmers, some of the power dynamics and assumptions about knowledge-sharing could start to shift. Farmers might feel empowered to share more, and to assert their knowledge when it is important or necessary for them. One other interesting comment made by a researcher was the observation that despite a heavy emphasis on village and community relationships in participatory projects, those relationships are not as simple and consistent as sometimes assumed. I found it interesting that a researcher was noticing and interested in the social dynamics of the communities in which he was working. I asked him to say more, about what made him notice that or if he's ever asked farmers their thoughts, and he said no.

Vertical knowledge sharing

Braun et al. (2000) suggest that there is an assumption of horizontal information sharing and knowledge creation throughout the process of participatory projects, as farmers work together to discuss and create new solutions to challenges they face. The process of researchers finding and bringing information to farmers, then, can be called vertical knowledge sharing. Though there are assumptions that seem to accompany this term – that researchers are "higher" than farmers, and that knowledge comes from only one direction – these assumptions seem to align with the farmers' understanding of learning from researchers. This is not to say that farmers feel looked down upon or otherwise belittled. Instead, the functional side of even participatory projects continues to utilize the idea of transferring outside knowledge to local farmers, in a process that at least to farmers, feels one-way. Researchers seem more open to the idea of knowledge being shared back "up" the chain, but based on conversation and observation, there seems to be a lack of true focus on learning vertically.

> "What they say, what the researchers say, that's what he does. He doesn't make changes."
>
> "They [ICRISAT] give the seeds to other villages to try and test. They're the first here, and they're going to do it every year."
>
> "He chose to participate with ICRISAT because he heard that truly, ICRISAT has the trainings and experience in agriculture… There is really a competence in knowledge of improved varieties. So if he participated with ICRISAT, he could have this experience and knowledge.
>
> "He said that he has information, he has been trained, because there is a school field."
>
> "They [ICRISAT] did a workshop there, and she learned a lot. And ICRISAT also, doing it with them, they had a lot to learn also."

The comments above reflect the varied thoughts that farmers expressed that are

related to vertical sharing of information. No direct question was asked about communication, but instead, comments made throughout the interviews seemed to offer insight into the communication processes at work in the participatory plant breeding projects. For the most part, farmers see themselves as recipients of useful information. Their experiences with the process of participation vary widely, as some seem to remain very hesitant to take a more active role in using and modifying that knowledge ("What the researchers say, that's what he does."). Most farmers seem to focus on the functional use of the knowledge they gain from ICRISAT researchers, as already discussed in their comments about what they learned during the projects. Some did highlight the collaborative nature of the project, suggesting that working together means that everyone will learn. However, even after asking explicitly about what farmers felt they had taught the researchers, there was no further discussion of how that information might have been used. Indeed, farmers seem unconcerned by the one-way knowledge sharing they describe.

> "We are in contact with the farmers. As opposed to research [controlled trials], it's different there…we bring it to the farmers' field. To really see the variety, and often, to see the appreciation of the farmers."
>
> "Because in research, participatory selection, it's the farmers who are involved from the beginning to the end."
>
> "Sometimes things I think that what farmers don't know, it's just that research is strange for the farmers. They know how to call it something else."
>
> "Together we work, in collaboration, a collaboration, you know? In other projects, we only give to the farmers."
>
> "It's no longer top-down. Almost all of the projects have changed the methodology. Like if I take the classic example of a demonstration field. If we have a demonstration field, with a problem, now with the farmers, what are we going to do?...we use their knowledge. Now we have the knowledge of researchers too. We speak of the two, together."

Once again, researchers, in contrast to farmers, perceive much more balance and two-way flow of knowledge throughout the participatory plant breeding process. From learning farmers' opinions to gathering information within their own context, researchers value the communication

that flows back "up." However, the emphasis is still on functional outputs – learning farmers' varietal preferences and breeding *in situ* makes for much more practical and immediately useful outputs (we begin to see parallels here to diffusion theory and the characteristics of useful innovations). There is very little explicit recognition of any kind of strategic use of the knowledge shared by farmers with researchers. Even when I directly asked what changes researchers would make as a result of this eye-opening information, they didn't have much to say. This lack of real focus on engaging with farmers' knowledge and sharing in return, in a more iterative learning process, suggests that perhaps the empowering effects of the participatory process are not being fully realized here. If farmers don't feel that their knowledge and insights have the possibility to make structural changes – for example, in who is chosen to participate or how the trials are actually laid out – they are less likely to look critically at the entire process with an eye to meeting their own strategic needs.

Observations of the participatory plant breeding process

Though I have not been a part of these projects since the beginning, I was able to spend some research time doing participant observations of some aspects of the participatory plant breeding process. In particular, I spent a day installing a field trial in Bokki, Niger, and attended a workshop to present the previous year's results in Siby, Mali. The installation of the field trial emphasized more than anything the complex nature of participatory plant breeding. The principal scientist, a millet breeder, had worked with her research technicians to create the protocol (taking into account farmers' interests in varieties and different techniques). In other words, they had created guidelines for actually organizing and planting the field – in which section each variety with each type of treatment (fertilizer or no) would be used. The research technician (who I generally refer to as researchers throughout this paper) then worked with the local village trainer

(*animateur*), to explain the planting protocol. The farmer in whose field the trial was being installed was there as well, along with several of his children (see Annex C, figure 1). Having so many different people, with different interests and responsibilities, working together on one project was a little dizzying. The researcher directed everything, the *animateur* measured out the field and started digging holes, the farmer and his kids brought manure and planted seeds and covered holes when they were finished.

My strongest impression was that the farmer himself, whose participation is key to the very nature of the project, felt overwhelmed and unsure where he fit. There was very little explanation of why things were being done in a certain way and which seeds were being planted where. On the other hand, the trial ended up following the protocol and very well-organized, which is a necessary component for the principal scientist to be able to use the results for future breeding projects. Everyone's participation was very practical, in that the trial was set up and the farmer would be able to learn from the results. Since it was the first year for trials in this particular area, the researcher seemed to be directing more than teaching, and certainly there was no open conversation for other people's points of view. I found myself imagining what the process is like in places with longer history of collaboration with ICRISAT and participatory plant breeding projects. Do the farmers take more control of the process, and feel confident enough to make changes to meet their other needs? Or does the process become more empowering as the seasons progresses, and farmers have the time to experiment and learn by doing? As Cohen and Uphoff (1980) suggest, participation is not a static concept across space and time.

The second aspect of participatory plant breeding that I was able to observe was a findings workshop held in Siby, Mali in spring 2011, while working on a related research project. Several ICRISAT technicians and researchers organized a day-long meeting to discuss the results of the previous two years' field trials in the village in which the workshop was held. All farmers

in the area were invited, though there was a special emphasis on those who had participated in the field trials. Results from individual farmers' fields were presented – by ICRISAT researchers, not the farmer who conducted the tests – as well as results of village varietal selection field days (which are open to all) for each of several varieties of sorghum. The workshop was run entirely by ICRISAT, though there was plenty of time for questions and discussion. The presentation of information, in tables and charts drawn on large flip-chart paper, was accessible in that it didn't require reading. It was, however, very onerous to go through each of ten categories for each of ten varieties. The ranking of each variety and each characteristic was given, with no prompt for discussion or questions. Farmers did seem comfortable and open to offering their opinions, and there were some discussions about varieties and their traits, as well as how the trials had gone the year before.

Again, there was a strong focus on the functional side of participation – how farmers had found the tests and the varieties useful, how they had "done well" in terms of working within the ICRISAT protocols, and what they could expect for the upcoming year. Notably, there was no time for planning for the coming year, for asking farmers what they wanted to work on and why. There was also no time for farmers to share what they'd been doing as a result of the projects, for them to describe how they have taken this knowledge and built upon it for themselves. The most lively and interesting discussion took place among the farmers themselves, either in response to something happening in the front of the room or seemingly spontaneously. It was good to see that farmers are interested in sharing with one another, and exemplified the comments made to me a year earlier, about the more meaningful nature of interactions among farmers during and after participatory plant breeding.

Farmers, what did you learn from other farmers?

> "He learned something from each one. If you see someone who has done very well with their field, you can approach them, and ask them, you, how did you do that in your field?"
>
> "He said that, with the inter-farmer visits, if you go to someone else's field, and if you see that he's done good work. You can ask, how did you do that? And they can tell you, and you can learn the techniques."
>
> "So, what she learned from other farmers, is that there are varieties shown to be good for something."
>
> "He said that, what he learned from other farmers, it's exchange of varieties."

Much of what was learned during the participatory plant breeding process seemed functional in nature. Farmers often mentioned learning about better techniques and improved seeds by just noticing certain fields and asking their owners what they were doing right. Often, it was those involved in trials or some other aspect of participatory plant breeding who were doing something different in the first place, so that the knowledge started to spread beyond just the participants themselves. Even here, there is a sense of something more than just the practical value of the information being learned. Farmers are expressing that they have access to information through channels that they can choose to use, or not. There is no formal project for stopping by the field on the way home to ask about a new variety you just noticed. Instead, farmers can make use of others' knowledge when and how they see fit, as it fits into other goals they have. There was still very little direct discussion of broader, more strategic use of information and the participatory process. However, some farmers did highlight the ways in which participation in exchanges among themselves fit into their broader lives.

> "He said that he learns a lot, because each year they do inter-farmer visits. So when you go to the fields with them, there are things to learn…"
>
> "He said that the exchanges between farmers brought him a lot...knowledge, that's the first thing."
>
> "If she sees that a farmer has a variety that really produces well, she can ask that farmer for seeds."

> "She said that, what she has learned with Alo, Alo really is like a counselor. She gives good advice. It's she who directs a groupement [union], but Alo really gives advice about how to work with people, and how to coordinate people."

> "Because since she's been married, she'd never been in the field. She'd never done that work. But when the school field came, she said that she wanted to be a member of the school field. And it was at the school field that she learned how to plant, how to prepare, how to weed. Everything you have to do, she learned at the school field with the other women farmers."

I was particularly struck by one woman, who shared with us that her husband had just recently died, and so she was becoming a farmer for the first time. She had not, as an adult at least, worked in the fields, and so she didn't have the skills needed to keep her and her children alive and well. But in deciding to join the demonstration field in the village, she gained not only the immediate, practical knowledge that came from the researchers and other farmers. She also gained a broader group of people from whom she can continue to ask for help. Another woman focused on the ability to organize that comes from working together and sharing knowledge, this time within a women's group. This women's group is incredibly active and assertive, and hearing comments about what members learn from one another while a part of it, I can't help but feel that these are "empowered" women. Other farmers expressed similar sentiments about how the knowledge gained will somehow be more than just functional in their lives. Even the ability to ask for seeds or information is an important step toward thinking about needs and priorities in a more strategic way. In keeping with some interpretations of empowerment, as something that must come from within an individual or community (Freire, 1970), many farmers expressed not only functional but also more empowering experiences working with and learning from one another.

Farmers, what did other farmers learn from you?

> "On his return, he calls a meeting to inform the other farmers of what to do in their demonstration field."

> "She said that the other farmers made visits to her, in her field. There was a variety that farmers wanted for seeds. So, those who didn't do tests, asked for a little bit of seed from her."
>
> "After she has an ICRISAT training, she calls a meeting. She chooses a field, and she'll call all of the members of the groupement."
>
> "Outside of the village, there are people who have asked her questions, and she has been able to tell them, this is how to do it."
>
> "He did a demonstration field last year. So that when people passed by cart, they saw it, they came and said what type of field is this? What variety? And he would explain to them, the demonstration plan, and the different varieties. So he found that people learned from him. But it wasn't just the varietal selection, because he was very close to the road, and he furnished a lot of information."

Similar to discussing what they learned from others, many farmers saw what they taught as being useful in a practical, immediate way. Unlike with the question of what ICRISAT researchers learned from them, farmers had no problem identifying and discussing what their fellow farmers had learned from them. Mostly it was about new techniques and varieties of seed, which did often originate from the participatory plant breeding project itself, meaning that the knowledge was originally passed vertically from researcher to farmer. Some farmers were very clear about that, seeing themselves as more of a conduit to spread the exact same information. Others, however, discussed sharing their knowledge, of varieties and practices, with those who asked. Rather than continuing to see that knowledge as static from its initial use with the researchers, many farmers seemed to see themselves sharing their knowledge, learned in a variety of ways.

> "She said that, at the beginning, she looked for information from Namakan, about varieties. But now, actually, because she has been doing the tests, there are women also who come to her house and ask for information."
>
> "So, he did a training there on that, to say I did this, I have this variety that produces a lot. And you also, you can try it like this. So he does exchanges."
>
> "He said that he taught the other farmers, not the other testers, but the other farmers. He would call them and show them what they are doing, and then the others too can apply it in their own fields."
>
> "So he always shares his knowledge with his fellow farmers, whether they are in the project or not."

> "If someone goes to a training, if she comes back and went only for the training, that's not good. You are obligated to do a *restitution* [an explanatory workshop]."

As farmers talked about what they had taught one another, the tenor of the conversation often changed. People seemed proud, content, and often wanted to emphasize the responsibility they felt to share their knowledge with others. I wonder if this ethos comes from the participatory plant breeding projects directly. Throughout my time working with farmers who work with ICRISAT, people would consistently mention how dedicated the principal breeders were to the projects and to the farmers themselves. The researchers and technicians also work long and hard to keep the projects going. It seems possible, then, that the process instills in participants a sense of duty to continue the sharing and exchange process forward. Many farmers expressed a responsibility to share what they have learned with others, whether those other farmers have directly participated in the project or not. Many also highlighted the nature of exchanging information, so that knowledge is created. The energy and confidence with which people spoke about learning from and teaching one another suggests to me that something more strategic, more empowering than (still very important) better seeds will emerge out of the participatory plant breeding process.

Horizontal knowledge sharing

Horizontal diffusion of information is a key assumption of participatory agricultural development approaches (Braun et al, 2008). Despite occurring toward the end of the participatory plant breeding process, the very inclusion of knowledge sharing among participants or end-users of a research for development project is a departure from the traditional top-down approach. Recall that one researcher remarked that things are no longer top down – "we use [the farmers'] knowledge. Now we have the knowledge of researchers too. We speak of the two,

together." However, farmers "have" and use one another's knowledge, outside and beyond the actual participatory process. As already mentioned, Weltzien et al. (2008) suggest that there has been little systematic analysis of farmers' perceptions of information exchange and the effects it has on individuals and communities. Farmers, however, were very clear in their appreciation of learning and sharing together.

> "Because if you see something in someone's field, you can ask someone, my field is like that, is that good? And if the person says it's not good, they can tell you what to do. And there will be an exchange."
>
> "Yes, he said that if you see someone who's field is done well this year, next year, you can approach and ask him, how did you do that, to get it so well?"
>
> "There are 30 of them, and they come from villages to exchange, to look at the fields. So each one explains what they do for cultivation techniques. So she, she learns something at your field, and also you learn at her field."
>
> "At the moment of exchange and evaluation, she learned something, and they also learned something from her, in regard to the varieties good for different things… She said that she thinks in each case, they have made changes. Because when they have an example, people change."

Exchanges of information were strongly emphasized as farmers talked about their interactions with one another, in contrast to the one-way communication with researchers. The idea of demonstrating and discussing new possibilities seems to stem from the participatory plant breeding project. The comparisons that are done with participatory plant breeding, of different fields, different techniques, and different varieties, might have influenced some farmers to continue the comparison, between their own fields and others'. Having an example to talk about and discuss is also an important aspect of participatory agricultural development, which speaks again to Rogers' (2003) injunction that new ideas must be observable. In addition, implicit in farmers' discussions of how they learn from one another is the fact that some type of relationship exists between at least certain key members of different groups in order for sharing to occur.

> "Because during the workshop, everyone gives their point of view. So there are others also who learned his point of view. That's knowledge."
>
> "He learned by talking."

> "Now it's other villages that come because they say here, in Elkolta, there is a women's group of farmers. And the people therefore come here to get information on agriculture."
>
> "They could talk about the project, and see that the ICRISAT project is bringing things between the farmers."

Talking, giving one's point of view. These are key aspects of knowledge sharing and creation. Where does this talking occur? At times farmers cited unions and cooperatives as creating the links through which they access information. Others noted that the participatory plant breeding project itself helped connect them to one another, likely through the process of meetings, workshops and field days. Generally speaking, farmers did not say that they learned and discussed with their family members or close neighbors. Instead, it was through different types of groups, as well as out in the field and or during field events, that they built upon existing connections to learn from one another. Despite the common assumption that tight-knit, interconnected villages are more likely to work together for change, these farmers suggest that slightly further removed social ties are more likely to be used to learn new information.

Weak ties

Cooperatives. Unions. Local technicians. Innovative farmers who live nearby. These are the sources of information for most farmers, and the people who bring together groups to help make exchanges happen. Over and over farmers said that they learned from others in their unions, at women's group meetings, and through run-ins while walking to the fields for work. These weak ties, as Granovetter (1973) suggests, often link individuals to other groups (and the knowledge they possess) to which they would not otherwise be connected.

> "When Namakan got the information in Siby, he came back and explained it to them."
>
> "He [the local technician] had other exchanges between those who aren't testers in the village… So, the visits are organized, and there are testers and farmers who aren't testers…"

> "Because it is in that group that there is exchange of information in relation to the school field."
>
> "The researchers brought them a lot of things…they allowed different farmers to learn. Because a lot didn't know one another. Each one did his work, passed by, but didn't learn much."

Village group presidents connect to ICRISAT researchers in town, bringing back work of the projects. Local technicians reach out to surrounding villages to share the information generated by the participatory plant breeding projects. Field schools are convened for farmers to exchange information. Indeed, the participatory process is often an important catalyst for farmers to make the initial connections that become weak ties over the course of the project and follow-up. While travelling around the Siby region in Mali, I met farmers who had made connections with the seed cooperative through ICRISAT workshops (see Annex C, figure 3). These men lived only 50 miles apart, but had no ties to one another until they attended a training together. Now they are building their own connections to one another through further trainings and exchange of seeds.

> "The women too…they exchange them between themselves. If I have a variety, I will give a part to someone, and she also, will give me."
>
> "She said that for example, if we take an example, if they planted, and she didn't have a chance to go to the field to participate in that activity, when they come back she can ask one member and they can explain, here's what we did this week. So there is already an exchange of information."
>
> "With the cooperative, the ideas of the projects are not going to fall apart, are not going to disappear."
>
> "And also, even if not within agriculture, you have relationships… Relationships, friendships, are reinforced. And you can other things that aren't just about agriculture."

Weak ties also provide a kind of insurance that knowledge and information will continue to be exchanged. Women who see each other every few weeks in the market can exchange seeds. People in the same village can count on finding one another if questions arise. Establishing seed cooperatives is one aspect of participatory plant breeding projects that seeks to formalize the weak ties created through the participatory process. By helping farmers create an organization

that supports ongoing exchange and knowledge sharing (as well as cost sharing), cooperatives provide a durable alternative to seeking outside assistance each time a new challenge is faced. Perhaps my favorite sentiment is one that calls to mind critiques of social capital. Just as social ties are about more than their value in economic transactions, weak ties are about more than just the ability to access information. They are also neighborly exchanges, friendships, providing support and inspiration that might empower farmers to seek out other kinds of knowledge for change.

Strong ties

"Interpersonal relationships aren't as smooth as portrayed by groups to outsiders." This comment, made by a researcher in response to the question of what he had learned from farmers, offers a window into the more ambiguous role that strong ties seem to play in helping farmers connect and share new information.

> "You must start with the husband…there can be a roadblock there."
>
> "Why didn't she ask, being close to her husband who is close to Namakan [the technician], to be chosen for the tests? So, it's was maybe that she didn't have the courage."
>
> "She gets information from her husband… But it's not frequent. Because here the men and women don't talk a lot."
>
> "I: Do you get information from other farmers?
> T: He said that they all come from the same family."

There is much grumbling among researchers about how family social dynamics influence field trials and other participatory processes. In particular, gender roles and expectations hamper women's ability to access new information and participate in its creation. Men are often in charge of deciding who participates, as they are the heads of associations and chiefs of the village. Some men are suspicious of their wives getting involved with thing outside of their home, and so won't allow the women to participate. More often, however, women's exclusion

from knowledge sharing is more de facto – men and women simply don't interact very often outside of the home. With weak ties being non-existent and strong ties dictating that the women access only their husband's knowledge, it is difficult for new ideas to emerge. Other family dynamics can also hamper the spread of information. Because some families and villages are so interconnected, there are few weak ties on which to build. These farmers also might be at a disadvantage, if none of their kin are connected to other groups either.

> "Her husband is an animateur[trainer] in the village, and a big producer of sorghum. She brings her husband's seeds to her field… So, if a woman asks, she tells them, she'll pick a variety with her husband that is very productive."
>
> "He has a brother. If there is something that he sees there that he doesn't know, he asks his brother, how did you do that?"

Strong ties can be helpful as well. Since most men are more mobile than women and have more weak ties, women can access knowledge and new information through their husbands. In addition, family members can turn to one another for "inside" information that might not be shared widely. Seeds in particular are a closely guarded resource. Not so much because they are secretive, but rather are hard to obtain and keep around because they get moldy, get eaten in the hungry season, or fall prey to some other practical reality. Any seeds remaining before the rainy season, then, are valuable and usually shared only within families. The same is true for improved variety seeds acquired through the participatory plant breeding process. Further research already suggests that farmers are only willing to share the even more-valuable improved seeds with those with whom they have strong ties.

Changes farmers see as a result of participatory plant breeding projects

> "The men have a lot of seeds, have made a lot of changes. They cultivate and use the seeds."
>
> "There is not a single member of their group who isn't aware of buying varieties, of buying improved varieties."

"They come to the village or the union to buy improved varieties."

Many farmers discussed the practical implications of participatory plant breeding – higher yields, modern techniques and an increased awareness of improved varieties. The single most important change, however, might be the changes in seed markets. As mentioned earlier, many agricultural development practitioners see the release and dissemination of improved varieties as the final step in the participatory plant breeding process (Sperling, et. al, 2001; Weltzien, et al., 2008; Ceccarelli & Grando, 2007). These varieties are being sold in market places for the first time, causing a significant shift in the material lives of farmers in West Africa. It is important to note that many farmers mentioned buying seeds as a significant change resulting from participatory plant breeding projects. In the past, seeds were not a commodity, but instead, were seen as a conservable and sharable resource. As will be discussed below, further work needs to be done to better understand the broader implications of shifts toward monetary seed networks, including the exclusion of certain people and the strengthening of different types of relationships.

> "Now he looks for information with those who do the tests."
>
> "It's good to have information, to have a lot not just for yourself. Because there is a program on the radio, with the technicians."
>
> "So there are people who brought changes to their fields. But it's not too many…there is always work to do…he will continue to give information to people, and his choice is that everyone changes. But the changes that he seen are not enough to really succeed with improved things."

Farmers also expressed more general effects of participatory plant breeding, in changing information networks and cultivation decisions. In each country, radio programs have been produced by local unions to inform farmers about the improved varieties, their characteristics and where to buy them. Some farmers perceived this as a positive change, a more open way to share information. Others appreciated the fact that testers, those farmers who had actually participated in field trials, are now a reliable resource for information. However, as one farmer pointed out,

most do not see the changes to-date as adequate to meet their needs, either practical or strategic. Though the outputs of the project, improved variety seeds, appear to be functional and appropriate, broader questions remain of farmers' ability to benefit from and make their own the improved variety seeds.

Seed diffusion: Just how functional are improved variety seeds?

If the practical end goal of participatory plant breeding is improved variety seeds that will be used by farmers, then we should be able to assess the diffusability of these based on farmers' comments about them. Using Rogers' (2003) five criteria of diffusible innovations, it seems that the final improved variety seeds should be quickly spread. The relative advantage of the new seeds was made very clear by farmers. They provide higher yields, better quality, and more reliability in uncertain climates. As mentioned previously, in the traditional transfer-of-technology model of development, it is often the expert outsider who decides which innovations have the greatest relative advantage. Participatory approaches, in contrast, build farmers' interests ("We ask the farmers why, how, the goals.") in to the development process, so that the final output has already been vetted. Similarly, the compatibility of the seeds with farmers' needs and context is at the heart of participatory plant breeding. By working through varieties and characteristics that are unnecessary and perhaps at times unhelpful in a given setting, the resulting varieties are more likely to be immediately useful.

Observability can also be seen as fundamental to the participatory plant breeding approach. As previously discussed, weak ties facilitate connections among farmers that ensure more individuals will have access to the new information and the ability to check it out before making their own decisions about it. Trialability is more limited, since only some farmers will be directly involved in the participatory plant breeding projects. This is a place where strong ties

could perhaps be better utilized – if one member from each family group in a village were a part of the project, more farmers would have access through their existing strong social networks. However, strong ties can also limit individuals' ability to try out, and even access, new information. For women in particular, strong ties the proscribe gender roles can actually exclude women from the diffusion process. Finally, we come to complexity. As Rogers (2003) seemed to conceive of it, complexity refers to ease of understanding and use. I would expand this to include ease of access. That is, even if an innovation is perfectly adapted to all other needs of the end user, if it is too complicated to access or if access is constrained, it will not be pursued. Calling to mind changing seed networks and the newly established monetary markets to purchase improved variety seeds, it is important to keep accessibility in mind as a necessary component of complexity. Indeed, accessibility will be the focus of my future work on seed networks, as they respond to changes effected by the introduction of improved varieties.

Chapter 5

Discussion and conclusion

The typology laid out at the beginning of this analysis offers a multi-dimensional view of participatory plant breeding projects and their effectiveness. Key to the distinction between functional and empowering participation is the purpose of the participatory process. Functional participation seeks to create diffusible information or technologies that can address material needs in individuals' lives. A strength of participatory methods is that they have built into them mechanisms to ensure that the final output is indeed useful in a given context, for those with whom it was developed. Functional participation also meets the general goal of most development efforts, to improve material conditions of life of a given community. Especially in the realm of plant breeding, which often occurs in controlled environments far from the intended place of final use, participatory plant breeding can significantly shorten the amount of time needed to create a stable improved variety (Ceccarelli & Grando, 2007).

Based on farmers' comments about their own motivations for becoming involved in ICRISAT's participatory plant breeding projects, as well as the changes they have seen as a result, is appears that the projects were appropriate and successful in placing practical needs at the forefront. Farmers highlighted their desire for material inputs, as well as access to information for material gain, and expressed appreciation for the final outputs of the projects. Participation to meet functional goals was facilitated by farmer-researcher interactions and vertical knowledge exchange. Researchers also noticed the practical effects of such knowledge sharing, describing part of their role as a sharer of new knowledge. In one sense, then, this participatory plant breeding project's goals and effects are shown to be aligned: farmers choose to participate in order to address material concerns, and feel that they gained much in terms of practical outputs.

Participatory plant breeding's ability to support empowering participation is still an open question. As farmers' comments suggest, there has been increased interest in critically analyzing their needs and the ability to meet them as a result of the participatory process. Farmers focused on their ability to choose, based on knowledge learned during the project, their own individual needs, and the changes in material reality as a result of the project. This aspect of empowering participation is not to be overlooked. As Molyneux (1985; 2002) suggests, it is often necessary to address practical needs in order to focus on more strategic goals. The social impacts of participation are also important components of potential empowerment. The overarching trend in farmers' comments about different interactions that occurred throughout the participatory plant breeding process suggest that horizontal knowledge sharing, often through weak ties, is an important empowering resource. It is important to note here researchers' perceptions of their support as empowering was not strongly reflected in farmers' comments. Nonetheless, the more functional knowledge shared in one direction, from researchers to farmers, was an important foundation for empowering exchanges among farmers themselves.

The disparity between farmers' and researchers' perceptions of the researchers' role must be unpacked and scrutinized. For researchers, functional and empowering goals and actions seem inextricable – sharing of information automatically allows farmers to build upon the new knowledge in ways that are unique to their own settings. In addition, researchers claim to have learned about the specificities of different contexts from farmers themselves, and seem genuinely appreciative of this knowledge. When asked if they have made changes based on this knowledge (in some ways, the corollary to empowerment of farmers), however, researchers drew a blank. Their general response seemed to be that they'd already reached the end point of "participation" of farmers, and there was very little critical reflection on the participatory process, either on what they have learned or how to continue to adapt and improve.

Equally as important, it was clear from interviews with farmers that there is no feedback loop from researchers to farmers, in terms of ongoing learning and analysis of how to continue to work together. The difficulty that farmers had in answering the question of what researchers learned from them demonstrates the limiting nature of vertical knowledge sharing. Recognition of the sources of new information, which can have an empowering effect for those who provide new knowledge, seems to be a one-way street. Researchers also lack an understanding of the effects of the structure of participatory processes. A prime example of this was the feedback workshop in which I participated. Rather than allowing farmers themselves to share the knowledge they had gained, researchers presented the information in a rather static way, with no space for farmers to offer their own analysis or share how they have used this information. By failing to include farmers in an ongoing process of sharing and learning, researchers inadvertently limit their own ability to fully engage in the strategic role of facilitator and supporter that they see for themselves. Farmer empowerment is also limited by the lack of focus on process, despite farmers' own statements that it is exchanges among themselves that provide the foundation for ongoing change.

This project confirms suggestions in the literature that farmers appreciate the ability to learn from and with one another, in part because exchanging information broadens overall knowledge from which to make personal decisions (see Weltzien et. al, 2008). The sentiments expressed by farmers when discussing their interactions with researchers focused on material needs that can now be met with new information and seeds. In contrast, farmer-to-farmer exchanges were characterized as ways to learn, share, make choices, use knowledge in new ways. The sense of responsibility to share new information seemed to come in part from a recognition that just as an individual farmer had taken new knowledge, made it his or her own and benefitted from it, so too should others. Though farmers do not explicitly emphasize process, but rather the end ability to make individual choices, discussions of their interactions with one another

continually reference the mutual learning and exchange that takes place during participatory plant breeding projects. The weak ties that are formed through ongoing interactions are perceived to persist after the projects, strengthening farmers' ability to continue to share useful information and providing a sense of confidence in continued change.

Further exploration of weak and strong ties brings up questions of power dynamics among farmers themselves. The use of the term "farmer," as a unified, singular category, is in itself problematic, since in reality, farmers in West Africa are a heterogeneous population. It is particularly important to recognize differences between male and female farmers, in terms of both their participation in and the effects of participatory processes. In the generally patriarchal societies in which this research was conducted, men tend to be less constrained than women by strong ties. They can rely on their strong networks, particularly their families, while at the same time build on that stability through connections to other groups and individuals. The stability that Strong ties afford men stability that allows them to experiment with the new information to which they are more likely than women to have access. A particularly important source of this stability comes from having a wife who fills holes in household needs through her own production and seeking out of resources, Women, on the other hand, are often constrained by their strong ties, and end up relying on their husbands and relatives for any access to new information. The irony here is that though strong ties can enhance women's connection to outside knowledge, these same social relationships also limit the empowering effects that come from freedom to experiment with and adapt new technologies and techniques for their own uses. Women who participated in women's groups and other weak ties networks highlighted the importance of learning from one another, in effect combining their partial abilities to experiment in order to gain a wider range of knowledge.

Given the complex view of participation and its effects taken here, future research can go in a variety of directions. As previously mentioned, the material effects of changing seeds

networks could have wide-ranging effects on how participatory plant breeding projects continue to evolve, as well as effects on farmers' decisions. If market creation becomes a prime focus, so that the sole goal is a functional one (creating seeds that can and will be sold), the participatory process and support for more strategic development for farmers could be lost. This would not be entirely surprising, given that the predominant development model continues to follow modernization theory and ideas of a singular path to change. The creation of improved variety seeds through participatory plant breeding could, on the other hand, support the creation of place-based markets as well. The new end goal of seed markets, then, could continue to align with the ethos of participatory development of putting people and their needs ahead of economic or other theoretical concerns.

One key prospect for creating "empowering" markets is the notion of social certification of seed (Sperling & McGuire, 2010a, 2010b). In traditional plant breeding, the production and certification of improved variety seeds is a long and expensive process, leading to relatively high prices and keeping many small seed producers and farmers out of the market. Since participatory plant breeding focuses on alternatives to the one-size-fits-all model, social certification of seed would be a potentially appropriate end goal for such projects. Seeds can be produced and sold within smaller, more local areas (perhaps a radius around a weekly market or in small nearby town). Because they would be produced and sold in the same circumscribed place, the seeds would be more likely functional and appropriate for the given environment. More importantly, however, the seed producers would be known by the farmers purchasing their seeds, since they live in the same area and would have overlap in other aspects of their lives (Remington, as cited in Sperling & McGuire, 2010b). Social certification builds on the idea of weak ties – that is, individuals who have real and meaningful connections to one another that inspire trust and confidence would be willing to buy based on those connections. Costs would be lower, since the seed producers' word, not some official stamp, is all the insurance the farmer needs that the seeds

will be what they say. And seed producers have incentive to honesty and quality, since they not only need the income but also have connections to the communities in which they do business (Sperling & McGuire, 2010a).

As participatory plant breeding projects enter later stages, innovative methods of diffusing and supporting the adoption of seeds will be necessary to maintain the focus on people and their needs. This research offers a starting point for understanding the processes and outcomes of participatory plant breeding, and seeks lessons to learn as the projects progress. I have already begun the next stage in this research process, and will be following changes in farmers' seed networks and the decisions they make about purchasing and sharing improved variety seeds over the next four years. In addition, I plan to build upon the knowledge gained in this project, about the importance of weak ties, as well as future understanding of seed networks, to explore social certification of seeds as an alternative to conventional markets. Participation as a process is ongoing throughout a project and ideally, beyond. The needs being met, however, can be explored and described at a given point in time, and the participatory process altered accordingly. The initial needs of farmers, for functional improved variety seeds, seem to have been met, as evidenced by their comments and the rapid diffusion of the seeds. More strategic needs of empowerment to continue to enact change could be hampered by a reversion to traditional markets for seeds sales, making these "seeds of the people" in accessible to those who need them most. On the other hand, listening to farmers and their experiences with the participatory plant breeding process will help farmers, development practitioners, and researchers continue to explore together empowering alternatives for agricultural development.

Appendix A

Farmer questionnaire

Effects of participatory agricultural research and development on farming practices and livelihoods
Preliminary questionnaire to be conducted with farmers in HOPE sites, June-July 2010

Demographics
Interviewer name:

Date:

Village (with GPS coordinates):

Respondent code number:

Gender:

Age:
(if unsure, interviewer can use 1=18-30, 2=30-45, 3=45-60, 4=60+)

Ethnic group:

Language(s) spoken:

Level of education:

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

Agricultural practices
Do you cultivate your own fields?

If yes, how long have you cultivated your own fields?

If no, in whose fields do you work? For how long have you been working there?

How much land do you cultivate?

What are you growing this year? How much land for each crop?

Has the type or amount of crops you cultivate changed during your lifetime?

If yes, what caused those changes?

Are there other changes in agriculture that you have seen?

Are there other changes in agriculture that you would like to see?

Participation in agriculture research and development
Have you worked with ICRISAT researchers/projects?

If yes, which ones?

Why did you choose to participate/choose to not participate? How many people in your household participated?

What did you learn from the researchers during the projects?

What did the researchers learn from you during the projects?

What did you learn from other farmers during the projects?

What did other farmers learn from you during the projects?

Have you made any changes in your cultivation practices because of what you learned or who you met during the projects?

Have other farmers you know made any changes in their cultivation practices because of what they learned or who they met during the projects?

Have you asked for agricultural information or inputs since participating in the program? To whom?
Have you been asked for agricultural information or inputs since participating in the program? By whom?

Do you see other effects of the projects? Did they address the changes you would like to see (if discussed earlier)?

Farmer organization and access to information
Are you part of a group within your village that cultivates land together? If yes, what do you grow?

Are you part of a farmer organization? What type?

How active are you or someone in your household in this group?

How does one become a member of this group?

What types of things does the group do? Does it help you with cultivation decisions?

Is there a Boutique d'Inputs near to where you live? Where?

If yes, do you receive information or inputs for farming there?

Is there a government extension agent/office near to where you live? Who? Where?

If yes, do you receive information or inputs for farming there?

Is anything you do with these groups the same as with ICRISAT? Different?

Market access

Do you buy any agricultural inputs in the market? Which inputs? (seeds, fertilizer, pesticides, tools)

Do you sell any of your harvest in the market? Which crops?

How far away is the market? How do you get there?

Do you sell any of your harvest to a middle-man? Which crops?

If yes, does he come to the village or do you take the crops to him?

Do you get the same price all year?

If no, why do you not sell your harvest?

Does your family have other sources of income? From where?

If yes, do you use that to buy agricultural inputs?

Appendix B

Researcher questionnaire

Effects of participatory agricultural research and development on farming practices and livelihoods
Preliminary questionnaire to be conducted with researchers in HOPE sites, June-July 2010

Demographics
Interviewer name:

Date:

Village(s) in which the researcher works:

Respondent code number:

Job title/position:

Employer:

Gender:

Age:

Ethnic group:

Language(s) spoken:

Level of education:

Agricultural practices
Has the type or amount of crops cultivated changed during your time working here?

If yes, what caused those changes?

Are there other changes in agriculture that you have seen?

Are there other changes in agriculture that you would like to see?

Participation in agricultural research and development
How did you first learn about participatory research and development methods?

Have you had any formal training in participatory methods?

What did you learn from the farmers during the projects?

What did the farmers learn from you during the projects?
Have you made any changes in your research agenda or practices because of what you learned or who you met during the projects?

Have other researchers or organizations you know made any changes in their research agendas or practices because of what they learned or who they met during the projects?

Have you asked or been asked for agricultural information or inputs since participating in the program? To whom/by whom?

Do you see other effects of the projects? Did they address the changes you would like to see (if discussed earlier)?

Appendix C

Photographs of the participatory plant breeding process

(all photos taken by author)

Figure 1: Installation of participatory plant breeding field trials, Bokke, Niger

Figure 2: Demonstration/trial field, Elkolta, Niger

Figure 3: Massama Camara, president of the seed cooperative established as a part of participatory plant breeding activities in Siby, Mali

References

Agarwal, R., & Prasad, J. (2007). The role of innovation characteristics and perceived voluntariness in the acceptance of information technologies. *Decision Sciences, 28*(3), 557-582.

AGRA. (2010). About the Alliance for a Green Revolution in Africa. *Alliance for a Green Revolution in Africa*. Retrieved from http://www.agra-alliance.org/section/about.

Alumira, J. D., Bantilan, M.C. S., & Sihoma-Moyo, T. (2007). Evolution of social science research at ICRISAT, and a case study in Zimbabwe. *SAT eJournal, 3*(1), 1-19.

Ashby, J., & Sperling, L. (1995). Institutionalizing participatory, client-driven research and technology development in agriculture. *Development and Change, 26*(4), 753-770.

Aune, J. B., & Bationo, A. (2008). Agricultural intensification in the Sahel – The ladder approach. *Agricultural Systems, 98*, 119-125.

Bandiera, O., & Rasul, I. (2006). Social networks and technology adoption in northern Mozambique. *The Economic Journal, 116*(514), 869-902.

Bello, W. (2005). *Dilemmas of domination*. New York: Metropolitan Books.

Bellon, M.R., & Reeves, J. (2002). Quantitative analysis of data from participatory methods in plant breeding. *International Maize and Wheat Improvement Center*. Mexico City: CIMMYT.

Biernacki, P. and Waldorf, D. (1981). Snowball sampling: Problems and techniques of chain referral sampling. *Sociological Methods and Research, 10*(1), 141-163.

Blackburn, J., Chambers, R., and Gaventa, J. (2000). Mainstreaming participation in development. *World Bank, OED Working Paper No. 10*. Washington, D.C.: World Bank.

Braun, A., Thiele, G., & Fernández, M. (2000). Farmer field schools and local agricultural research committees: Complementary platforms for integrated decision-making in

sustainable agriculture. *U.K. Department for International Development*. London: Overseas Development Institute.

Bridger, J., & Luloff, A. (2001). Building sustainable community: Is social capital the answer? *Sociological Inquiry, 71*(4), p. 458-72.

Buruchara, R. (2008). How participatory research convinced a skeptic. In L. Fortmann (Ed.), *Participatory research in conservation and rural livelihoods* (pp. 18-35). Hoboken, NJ: Blackwell Publishing.

Cardoso, F.H., and Faletto, E. (1979). *Dependency and development in Latin America*. Berkeley: University of California Press.

Ceccarelli, S., & Grando, S. (2007). Decentralized-participatory plant breeding: an example of demand driven research. *Euphytica, 155*, 349-360.

Cernea, M. (1991). Knowledge from social science for development policies and projects. In M. Cernea (Ed.), *Putting people first* (pp. 1-41). New York: Oxford University Press.

CGIAR. (2007). Who we are: History of the CGIAR. *Consultative Group on International Agricultural Research*. Retrieved from http://www.cgiar.org/who/history/index.html.

CGIAR. (2009). Voices for change: The new CGIAR. *Consultative Group on International Agricultural Research*. Retrieved from http://www.cgiar.org/pdf/Business%20Meeting%202009/voices_for_change_final_jan2010.pdf.

Chambers, R. (1974). *Managing rural development: Ideas and experiences from East Africa*. New York: Africana Publishing Company.

Chambers, R., & Jiggins, J. (1987). Agricultural research for resource-poor farmers – Part 1: Transfer-of-technology and farming systems research. *Agricultural Administration & Extension, 27*, 35-52.

Chiffoleau, Y. (2005). Learning about innovation through networks: The development of

environment-friendly viticulture. *Technovation, 25*, 1193-1204.

Cohen, J. & Uphoff, N. (1980). Participation's place in rural development: Seeking clarity through specificity. *World Development, 8*, 213-235.

Coleman, J.S. (1988). Social capital in the creation of human capital. *The American Journal of Sociology, 94*(Supplement), S95-120.

Coleman, J.S., Katz, E., & Menzel, H. (1966). *Medical innovation: A diffusion study*. New York: The Bobbs-Merrill Company, Inc.

Cooke, B. and Kothari, U. (2001). The case for participation as tyranny. In B. Cooke and U. Kothari (Eds.), *Participation: The new tyranny?* (pp. 1-15). New York: St. Martin's Press.

Costanza, R., Low, B.S., Ostrom, E., & Wilson, J. (Eds.). (2001). *Institutions, ecosystems, and sustainability*. New York: Lewis Publishers.

Cousins, J. B. and Earl, L.M. (1992). The case for participatory evaluation. *Educational Evaluation and Policy Analysis, 14*(4), 397-418.

Crawley, H. (1998). Living up to the empowerment claim! The potential of PRA. In I. Guijt and M. Kaul Shah (Eds.), *The myth of community: Gender issues in participatory development* (pp. 46-57). London: Intermediate Technology Publications.

Creswell, J.W. (2007). *Qualitative inquiry and research design*. Thousand Oaks, CA: Sage Publications.

Davis, K. (2008). Extension in sub-Saharan Africa: Overview and assessment of past and current models and future prospects. *Journal of International Agricultural and Extension Education, 15*(3), 15-28.

Dewey, J. (1927). *The public and its problems*. Denver: Alan Swallow.

Easterly, W. (2007). Was development assistance a mistake? *American Economic Review, 97*(2), 328-332.

End Poverty 2015. (2010). End Poverty 2015 home page. *United Nations Millennium Campaign*. Retrieved from http://www.endpoverty2015.org.

Escobar, A. (1995). *Encountering development: The making and unmaking of the Third World*. Princeton, NJ: Princeton University Press.

Evenson, R.E., & Gollin, D. (2003). Assessing the impact of the Green Revolution. *Science, 300*(5620), 758-762.

FAO. (2009, September 25). 2050: Increased investment in agricultural research essential. *United Nations Food and Agriculture Organization*. Retrieved October 25, 2009, from http://www.fao.org/news/story/en/item/35686/icode/.

FAO. (2010, November 23). Investments in agriculture must go. *United Nations Food and Agriculture Organization*. Retrieved September 1, 2011, from http://www.fao.org/news/story/en/item/47881/icode/.

FAOSTAT. (2010). Agricultural production. *Food and Agriculture Organization of the United Nations*. Retrieved from http://faostat.fao.org/site/339/default.aspx.

Fine, B. (2003). Social capital: The World Bank's fungible friend. *Journal of Agrarian Change, 3*(4), 586-603.

Freire, P. (1970). *Pedagogy of the oppressed*. New York: Continuum.

Fliegel, F.C. (1993). *Diffusion research in rural sociology*. Westport, CT: Greenwood Press.

Friedmann, H. (1992). Distance and durability: Shaky foundations of the world food system. *Third World Quarterly, 13*(2), 371-384.

Friedmann, H. (2005). From colonialism to green capitalism: social movements and the emergence of food regimes. *Research in Rural Sociology and Development, 11*, 227-264.

Friedmann, H., & McMichael, P. (1989). Agriculture and the state system: The rise and decline of national agricultures, 1870 to the present. *Sociologia Ruralis, 29*(2), 93-117.

Gladwell, M. (2000). *The tipping point: How little things can make a big difference*. New York: Little Brown.

Glaser, B. and Strauss, A. (1967). *The discovery of grounded theory: strategies for qualitative research*. New York: Hawthorne.

Glenna, L., Jussaume, R.A., & Dawson, J. (2011). How farmers matter in shaping agricultural technologies : social and structural characteristics of wheat growers and wheat varieties. *Agriculture and Human Values, 28*, 213-224.

Granovetter, M. (1973). The strength of weak ties. *The American Journal of Sociology, 78*(6), 1360-1380.

Granovetter, M. (1985). Economic action and social structure: The problem of embeddedness. *The American Journal of Sociology, 91*(3), 481-510.

Harnessing opportunities for productivity enhancement (HOPE) of sorghum and millets in sub-Saharan Africa and South Asia. (2009). *International Crop Research Institute for the Semi-Arid Tropics*. Received October 21, 2009 from personal communication with Eva Weltzien.

Haussmann, B. I.G., & Kapran, I. (2007). *Farmer-participatory improvement of sorghum and pearl millet genetic resources for increased adaptation to diverse production environments in West Africa*. Retrieved from http://www.icrisat.org.

Humphries, S., Jiménez, J., Sierra, F., & Gallardo, O. (2008). Sharing in innovation: Reflections on a partnership to improve livelihoods and resource conservation in the Honduran hillsides. In L. Fortmann (Ed.), *Participatory research in conservation and rural livelihoods* (pp. 36-54). Hoboken, NJ: Blackwell Publishing.

ICRISAT. (2011). Facts about ICRISAT in West and Central Africa. *About WCA*. Retrieved from http://www.icrisat.org.

Johnson, N., Lilja, N., & Ashby, J.A. (2003). Measuring the impact of user participation in agricultural and natural resource management research. *Agricultural Systems, 78*, 287-306.

Johnson, N., Lilja, N., Ashby, J.A., & Garcia, J.A. (2004). The practice of participatory research and gender analysis in natural resource management. *Natural Resources Forum, 28*, 189-200.

Kant, I. (1963). *On history*. New York: Macmillan Publishing Company.

Kleinman, D.L. (2000). *Science, technology, and democracy*. Albany: SUNY Press.

Krugman, P. (2001, April 22). Reckoning; Hearts and heads. *The New York Times*. Retrieved from http://www.nytimes.com.

Lewis, P. (2009). *Ethnologue: Languages of the world*. (Web version). Retrieved from http://www.ethnologue.com/web.asp.

Matuschke, I., & Qaim, M. (2009). The impact of social networks on hybrid seed adoption in India. *Agricultural Economics, 40*, 493-505.

McCorkel, J. and Myers, K. (2003). What difference does difference make? Position and privilege in the field. *Qualitative Sociology*, *26*(2), 199-231.

McMichael, P. (2009). The world food crisis in historical perspective. *The Monthly Review, 61*(3). Retrieved from http://www.monthlyreview.org/090713mcmichael.php.

Merchant, C. (1983). *The death of nature: Women, ecology and the Scientific Revolution*. New York: HarperCollins.

Merton, R. (1973). *The sociology of science: Theoretical and empirical investigations*. N. Storer (Ed.). Chicago: University of Chicago Press.

Molyneux, M. (1985). Mobilization without emancipation? Women's interests, the state, and the revolution in Nicaragua. *Feminist Studies, 11*(2), 227-255.

Molyneux, M. (2002). Conceptualizing women's interests. In N. Halstrom (Ed.), *The socialist feminist project* (pp. 250-257). New York: Monthly Review Press.

Mosse, D. (2001). 'People's knowledge,' participation and patronage: operations and representations in rural development. In B. Cooke & U. Kothari (Eds.), *Participation: The new tyranny?* (pp. 16-35). New York: St. Martin's Press.

Naples, N. (2003). *Feminism and method: Ethnography, discourse analysis, and activist research*. New York: Routledge.

Peet, R., & Hartwick, E. (1997). *Theories of development*. New York: Guilford.

Plumwood, V. (1995). Nature, self and gender: Feminism, environmental philosophy and the critique of rationalism. *Hypatia, 6*(1), 3-27.

Pretty, J., & Uphoff, N. (2002). Human dimensions of agroecological development. In N. Uphoff (Ed.), *Agroecological innovations: Increasing food production with participatory development* (pp. 243-250). Sterling, VA: Earthscan Publications Ltd.

Reinjtnes, C., Haverkort, B., & Waters-Bayer, A. (1992). *Farming for the future: An introduction to low-external-input and sustainable agriculture*. London: MacMillan Press.

Rist, G. (2002). *The history of development: From Western origins to global faith*. New York: Zed Books.

Rogers, E.M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Rostow, W.W. (1959). The stages of economic growth. *The Economic History Review, 12*, 1-16.

Roth, M.J., & Philip, C.J. (1990). Agricultural price policy, food aid and input subsidy reform in Burkina Faso. *Journal of Agricultural Economics, 41*(3), 327-345.

Ryan, B. & Gross, N. (1943). The diffusion of hybrid seed corn in two Iowa communities. *Rural Sociology, 1*, 15-24.

Shepherd, C. J. (2006). From in vitro to in situ: On the precarious extension of agricultural science in the indigenous 'third world'. *Social Studies of Science, 36*, 399-426.

Simmel, G. (1982). *The philosophy of money.* (First published 1907). T. Bottomore and D. Frisby (Eds). Boston: Routledge and Kegan Paul.

Sperling, L., Ashby, J.A., Smith, M.E., Weltzien, E., & McGuire, S. (2001). A framework for analyzing participatory plant breeding approaches and results. *Euphytica, 122*, 439-450.

Sperling, L., & McGuire, S. (2010a). Persistent myths about emergency seed aid. *Food Policy, 35*, 195-201.

Sperling, L., & McGuire, S. (2010b). Understanding and strengthening informal seed markets. *Experimental Agriculture, 46*(2), 119-136.

SWAC/OECD. (2010). Ecological Zones in West Africa. *The Organization for Economic Co-operation and Development Sahel and West Africa Club*. Retrieved Mar. 2, 2010, from http://www.oecd.org/document/63/0,3343,en_38233741_38246685_38265151_1_1_1_1, 00.html.

Temple, B., & Young, A. (2004). Qualitative research and translation dilemmas. *Qualitative Research 4*, 161-178.

UNDP. (2010). Statistics of the Human Development Report. *United Nations Development Programme*. Retrieved Mar. 2, 2010, from http://hdr.undp.org/en/statistics/.

UN Cartographic Section. (2009). Africa, Revision 5. *United Nations Cartographic Section.* Retrieved from http://www.un.org/Depts/Cartographic/map/profile/africa.pdf

Uphoff, N. (1991). Fitting projects to people. In M. Cernea (Ed.), *Putting people first* (pp. 467-512). New York: Oxford University Press.

Uphoff, N. (2002). The agricultural development challenges we face. In N. Uphoff (Ed.), *Agroecological innovations: Increasing food production with participatory development* (pp. 3-20). Sterling, VA: Earthscan Publications Ltd.

Wallerstein, I. (1974). Dependence in an interdependent world: The limited possibilities of transformation within the capitalist world economy. *African Studies Review, 17*(1), 1-26.

Wallerstein, I. (1988). Development: Lodestar or illusion? *Economic and Political Weekly, 23*, 2017-2023.

Weltzien, E., Smith, M. E., Meitzner, L. S., & Sperling, L. (2003). *Technical and institutional issues in participatory plant breeding - from the perspective of formal plant breeding*: CGIAR.

Weltzien, E., Sperling, L., Smith, M.E., and Meitzner, L.S. (2001). Farmer participation and formal-led participatory plant breeding programs: Types of impact to date. In N. Lilja, J. Ashby and L. Sperling (Eds.), *Assessing the impact of participatory research and gender analysis* (pp. 55-76). Cali, Colombia: PRGA Program.

Weltzien, E., vom Brocke, K., Touré, A., Rattunde, F., & Chantereau, J. (2008). Review and outlook for participatory plant breeding in West Africa. *Cahier Agricultures, 17*(2), 165-171.

Woods, N. (2006). *The globalizers: The IMF, the World Bank, and their borrowers*. Ithaca, NY: Cornell University Press.

World Bank. (2010). Measuring social capital. *World Bank*. Retrieved February 21, 2010, from http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTSOCIALDEVELOPMENT/EXTTSOCIALCAPITAL/0,,contentMDK:20193059~menuPK:418220~pagePK:148956~piPK:216618~theSitePK:401015,00.html.

Yuval-Davis, N. (1994). Identity politics and women's ethnicity. In V. Moghadam (Ed.), *Identity politics and women: Cultural reassertions and feminisms in international perspective* (pp. 408-424). Boulder, CO: Westview Press, Inc.