Demand and Supply Constraints to Improved Sorghum Technology Adoption and their Gender-Differentiated Effects in Burkina Faso

Dr. Andrew Dillon,[1] Dr. Maria Porter,[2] Dr. Melinda Smale[3]
Department of Agricultural, Food and Resource Economics
Michigan State University

Dr. François Lompo and Dr. Hamidou Traore[4]
National Agricultural and Environmental Research Institute
(Institut de l'Environnement et de Recherches Agricoles)
Ouagadougou, Burkina Faso

Total Project Budget: USD 1,484,000
Funds requested from BASIS AMA Research Program: USD 848,722

[1] 517-353-9192 (phone), 517-432-1800 (fax), dillona6@msu.edu
[2] 517-355-2161 (phone), 517-432-1800 (fax), mporter1@msu.edu
[3] 703-231-8492 (phone), 517-432-1800 (fax), msmale@msu.edu
[4] 226 503 40 270 (phone), lompoxa1@yahoo.fr

Abstract

Supply and demand constraints reduce adoption of improved sorghum technology in the West African Sahel. We will work with sorghum breeders and agro-input suppliers in Burkina Faso to compare alternative mechanisms to encourage adoption of improved seed and fertilizer micro-packs. A demand side treatment will be targeted by social network characteristics to understand the information effects of farmer take-up and spillover based on social network characteristics from a randomized distribution of micro-packs. A social network census will reveal the extent to which villagers insure one another against idiosyncratic risk specifically through exchange of seed, use of complementary inputs, intahousehold labor substitution and assets. The supply side of the randomized control trial will test whether consistent market supply, credit constraints and farmer commitment explain low adoption and potential supply side marketing mechanisms to increase adoption. Comparisons of the effects of demand and supply side interventions will inform the development of index insurance to insure farmers against risk. Finally, we will examine the gender dimensions of adoption. If technology adoption diverts women's labor from their fields to sorghum fields, the household's dietary diversity and women's income may decline, as well as induce intrahousehold labor substitution among women and children.

Narrative Description

I. Research Design and Methodology

Motivation and Problem Statement: Sorghum seed systems and microdosing in the West African Sahel

Supply and demand constraints reduce adoption of improved sorghum technology in the West African Sahel, the main food staple and most widely cultivated dryland crop among rural people of the West African Sahel. Although pockets and periods of higher adoption are evident, national area shares, and yields, are generally reported to be far less than for rice, maize or specialty crops. For example, average sorghum yields in Burkina Faso are estimated at 0.8 tons per hectare, despite the potential to attain over 2 tons per hectare with improved varieties. A recurring theme is that although numerous varieties, including those that represent improved "local ecotypes," have been developed by sorghum breeders, farmer demand for certified seed remains "weak" (Ministry of Agriculture, Burkina Faso 2010). Most sorghum seed planted each season in the West African Sahel originates in the grain stores of farm families, their neighbors, or trusted part-time traders, and is exchanged along social lines except in times of extreme duress (e.g., Jones 2013; Sperling et al. (2006); Smale et al. 2010; Weltzien et al. (2006)).

Several structural features of seed systems in the region explain this situation. First, with respect to staple cereals like sorghum, breeding germplasm that surpasses the performance of farmers' seed is not easy in the Sahel. Early improvement programs favored the introduction of unsuitable materials from India, followed by selection programs to eliminate photoperiodicity, the hallmark of local germplasm, which enables varieties to adjust the length of the growing cycle to the length of the growing season (Vaksmann et al. 1996). Although these challenges

have been overcome, the tremendous heterogeneity of biophysical conditions within and among farms makes it difficult for farmers to recognize superior varieties (Weltzien et al. 2006). Seeding rates for sorghum are also very low relative to other crops, so that not much seed is needed to reproduce a crop; sorghum seed stores well from one season to the next, so annual purchase is unnecessary unless the improved seed is hybrid. (Sorghum hybrids have only recently been released.) Field researchers have reported that in some areas, there is social stigma associated with not having seed, and thus with seed purchase (Diakite et al. 2008).

Recognizing that the private sector has not taken responsibility for seed supply, and the public sector has failed to supply improved seed in reasonable quantities, development organizations and donors have sought alternative means to strengthen the linkages between formal and informal seed supply channels over the past decade. Approaches include training and financing of local agro-dealers or seed traders, enabling farmer unions to supply multiple breeder seed and market mini-packs directly to farmers, and extending seed via on-farm testing, with a focus on women farmers (e.g., the HOPE project funded by Bill & Melinda Gates Foundation; ICRISAT's project on "Sustainable Farmer-Managed Seed Initiatives for Sorghum and Pearl Millet in Mali, Niger, and Burkina Faso," funded in part by McKnight Foundation"; and examples reported in Van Mele, Bentley and Guei (2011)).

A complementary scheme to these approaches for providing improved seed access to farmers has been the introduction of a technology for applying small amounts of fertilizer at the time of planting in order to improve yields. This technique, referred to as microdosing, is one in which farmers apply 2 to 6 grams of fertilizer (about a three-finger pinch) in or near the seed hole. The

amount of fertilizer applied is equivalent to about 20 to 60 kg of fertilizer per hectare. Alternatively, the fertilizer can be applied as top dressing from 3 to 4 weeks after the seeded crop begins to emerge. In case of hard soil, farmers dig small holes and fill them with manure before the rain begins. Once the rain starts, the fertilizer and seeds are placed into the moist soil. This technique captures the water, so that it does not run off the hard-crusted soil, thereby encouraging root growth (ICRISAT, Fertilizer Microdosing, January 2009).

When applied to the seeding of improved sorghum varieties, microdosing raises yields considerably. In Burkina Faso, INERA has reported grain yields of nearly 2000 kg/ha for improved sorghum varieties with microdosing. ICRISAT demonstration trials in Mali, Burkina Faso, and Niger showed that sorghum and millet yields were 44 to 120% higher when fertilizer micro-dosing was used over previous farmer practices. In Zimbabwe, microdosing raised cereal production yields by 40,000 tons, resulting in a savings of $7 million in food imports. These efforts have been part of a wider regional project of the Alliance for a Green Revolution in Africa (AGRA), which has targeted approximately 360,000 households to learn the microdosing technology (ICRISAT, Fertilizer Microdosing, July 2012).

The primary drawbacks to microdosing are that it is time-consuming, laborious, and it is difficult to ensure that the correct amount of fertilizer is used for each dose. In addition, there are several major constraints to the widespread adoption of this technology, including access to fertilizer, access to credit, and lack of information and training to farmers (ICRISAT, Fertilizer Microdosing, January 2009).

The primary objective of our experiment is to begin to address farmer constraints from both a demand and supply side perspective. The targeting of seed and microdosing packages based on social network characteristics will also provide policy recommendations on how diffusion of new technology occurs and who benefits from different targeting strategies within the village. By applying a social network census in villages of the study domain, we will have detailed information regarding the specific characteristics of individuals who have little access to credit or knowledge-sharing in the village. Targeting the intervention based on social network characteristics will provide an estimate of the effect of higher connectivity or influence within villages on diffusion of seed and microdosing knowledge and ultimately adoption. As information about new technologies is a primary constraint to demand side adoption, the social network treatments will provide empirical evidence on whether such approaches relieve demand side information constraints. We believe such information will also be of use in designing index-based insurance to encourage investment in sorghum production.

From a supply side perspective, consistent availability within local markets of improved sorghum seed and microdosing packets is also a constraint to adoption. The supply side treatments will experiment with provision of consistent supply in the pre-planting period from agro-input dealers in village markets. This supply side treatment will be compared to three other marketing strategies which will test whether credit and commitment constraints are binding for small farmers by offering them options to purchase improved seed and microdosing packets either earlier or later in the season. These treatments can also be compared to a price subsidy treatment to investigate whether commitment devices or price subsidies induce higher adoption.

Finally, we will also examine important labor and gender dimensions of adoption of this new technology. As microdosing in particular requires significant use of labor, we will examine how labor is reallocated across different crops, and how the time use of individual household members is affected. As women and children are a particularly important source of household labor in a variety of dimensions, we will pay close attention to their time use. In addition, there are potentially important household welfare implications. Time children spend in the field may displace time spent in school. Women may have to divert their time away from their own legume crops, resulting in lower health and nutrition for the household. Their bargaining power within the household may also be affected.

In the next section, we will describe the social network census that we plan to collect, as well as the experiments we will implement in order to analyze how best to diffuse adoption of a new technology, and whether knowledge of village-level social networks can promote policies that promote more cost-effective ways of diffusing technology. In the section that follows, we describe the various outcomes we will examine in order to ensure that we have a complete picture of how new technologies impact not only overall productivity levels, but also household welfare, paying particular attention to the well-being of women and children.

B. Experimental Design

The experimental design proposed here is grounded in a theoretical model of technology adoption. This brief exposition underscores the importance of the experimental approach in potentially controlling for confounding unobservable factors that may influence adoption of input intensification strategies.

Consider a non-separable agricultural household model where households choose consumption levels and production levels based on crop choice and input intensity (Singh et al. 1986). Agricultural production in the household's fields depends not only on input intensity, but the specification of the crop production technology and the complementarity of inputs in the production technology such as land, labor and water control. For simplicity, assume that households produce a single crop with a traditional, known technology, q_a. Suppose that the farmer is presented with the option of using a new technology, q_s in one of its primary inputs, $\iota_t = 1$, if the farmer adopts the new technology in period *t* and 0 if the farmer does not adopt (Bardhan and Udry 1999, Bandiera and Rasul 2006). A farmer evaluates the future profitability of a new technology from period *t* to the terminal period *T* such that:

$$V_t(I_{t-1}) = \max_{\iota_t \in \{0,1\}} E_t \sum_{s=t}^{T} \delta^{s-t} \left[(1-\iota_t) q_a + \iota_t q_s(I_{s-1})\right] \quad (1)$$

If expected discounted value of the new technology is higher than the loss in expected profits of trying the new technology, then the farmer will adopt when:

$$q_a - E\, q(0) \leq \delta(V_1(1) - V_1(0)) \quad (2)$$

This model illustrates two important features in how farmers evaluate alternative technologies. First, the farmer updates expectations based on information about the new technology and also potentially the experience of peer farmers. Numerous empirical tests of learning about new agricultural technologies from social networks are now found in the literature including Roster and Rosenzweig 1995, Conley and Udry 2004, Munshi 2004, and Bandiera and Rasul 2006

among others). Second, the expected profitability of a new technology depends on both the farmer's endowments of risk aversion and his discount rate. The farmer's decision about how much risk to take on, and when to adopt new tecnology is simultaneously made with choices about household consumption in this non-separable household model.

In much of the previous empirical literature on technology adoption, social networks and the risk preferences of a farmer are often unobserved variables, but are key determinants of adoption in theoretical models. Hence, in our experimental design, we propose to integrate a social network census into the baseline survey work to observe what are otherwise commonly unobserved characteristics of farmers. These social network characteristics potentially allow us to explain heterogeneity across farmers in adoption and profitability. Second, we propose a randomized control trial approach where new technologies are allocated to farmers with equal probability in a treatment and control group. This design feature ensures that expected endowments of risk aversion and differences in farmer discount rates will be balanced across the treatment groups. On average, estimates of adoption rates and productivity gains between treatment and control groups will be balanced and unbiased.

Working with seed breeders, farmer associations, and seed traders in Burkina Faso, we will identify and test the effectiveness of various mechanisms for supplying improved sorghum seed and fertilizer for microdosing to farming households in the Boucle du Mouhoun in addition to the above demand side constraints noted. Boucle du Mouhoun is considered the "grain basket" of the country, where demand for improved seed is comparatively strong.

Within geographically delineated subregions of Boucle du Mouhoun, weekly markets (foires hebdomadaires) in which seed is sold will be enumerated and sampled. The team will conduct a census of seed sellers, listing and mapping villages that most frequently interact in the market (marketshed, or market catchment). Households in villages located in the marketshed will be enumerated and sampled. A survey of farmer expectations and preferences, as well as a census of social networks, will be implemented. The social network census will enumerate plot neighbors of farmers, other trusted farmers with whom they communicate regularly, as well as farmers with whom seed exchange, sharing of labor or assets, or joint production is common[5]. Using a baseline and follow-up survey, the team will record socio-economic and geo-referenced farm characteristics, some of which can be linked to secondary data overlays (SotubaGIS) including soil characteristics. A fieldwork timeline is provided below which summarizes the fieldwork activities and their timing.

Table 1: Fieldwork Timeline

Date	Activity
October 2013	SN Census and HH Enumeration
November-December 2013	Baseline Survey
January 2014	Treatment for groups A,B,C and D
January-June 2014	Market Availability of Packet at Market Prices in group G
June 2014	Treatment for group E and F
November-December 2014	Follow-up Survey + Adoption Survey

[5] Social network censuses have been integrated into the evaluation design by PI Andrew Dillon and co-authors. Similar tools would be developed for the proposed experiment in Burkina Faso.

The experimental design is summarized in Table 2 below and key research questions in Table 3. There are seven treatments and one control group in the randomized control trial. Within each group a sample of 20 villages will be drawn from similar market-sheds in the Boucle du Mouhoun area of Burkina Faso. Within these treatment and control villages, a village enumeration which will include questions about sorghum production and adoption of improved seeds will be administered along with a social network census described above. 20 farmers per village will also be sampled for the baseline and follow-up survey where we collect a detailed production and socio-economic survey. At the time of the production and socio-economic survey follow-up, we will also conduct a follow-up adoption and sorghum production enumeration within the selected villages. With funding from the Gates Foundation through the Guiding Investments in Sustainable Agricultural Intensification II (GISAIA) project, the demand side interventions have been fully funded. We are requesting additional funding for the supply side interventions and gender analysis described below.

The demand side interventions will target a seed and fertilizer micro-packet to farmers based on their social network characteristics. In treatment groups A, B, and C villagers will also receive a free training on improved sorghum technology. Free micro-packets will be distributed to 20% of farmers randomly in treatment group A, while in treatment groups B and C, free distribution of the micro-packet will be distributed to those farmers with the highest degree of centrality or betweeness, respectively. Degree of centrality and betweeness are two measures of social network characteristics that measure the connectivity of a farmer and the influence of a farmer respectively. Degree of centrality measures the total number of social network connections a farmer has within his or her village. Betweeness measures the share of the shortest paths from

all pairs of households in the network that are connected to that household. Comparing treatment group A to the control group will first permit the study to estimate the productivity effect of the micro-packet and estimate potential gains from adoption of improved sorghum technology. The comparison of groups A,B,C and the control provide differential estimates of the effect of targeting on informational spillovers and adoption of improved sorghum technology based on social network characteristics.

Table 2: Experimental Design

Demand Side		Supply Side	
Treatment	Seed+Fertilizer Packet + Marketing/Training	Treatment	Marketing/Training
A	20% initial free distribution randomly	D	Early commitment offer at fixed 'market' price
B	20% initial free distribution based on degree	E	Late commitment offer at fixed 'market' price
C	20% initial free distribution based on betweeness	F	Late commitment offer at discounted price
Control	No interventions	G	Market Availability

Note: Each group will contain 20 villages where 20 farmers per village will be interviewed.

On the supply side of the experiment, we replicate Duflo et al. (2008)'s influential fertilizer adoption study in the West African context, and with a fertilizer and seed micro-packet, as opposed to only fertilizer. The objective of treatments D,E, and F is to disentangle the effect of the farmer's commitment problem due to liquidity constraints from that of the effect of price on adoption. Both price discounts and offering commitment mechanisms to enable farmers to purchase micro-packets at periods of time with lower liquidity constraints are two significant supply side adoption constraints. A further adoption constraint is simply to ensure that micro-packet supply exists in local markets which in and of itself may increase adoption in a less costly intervention. This is the 'market availability' intervention in treatment group G.

By comparing the effects of treatment groups D,E,F, and G, with the control group, we can estimate the effect of providing farmers with the opportunity to purchase micro-packets when they have low liquidity constraints right after harvest at a pre-determined fixed price pegged to the market value of the inputs (treatment D) with the adoption of micro-packets when farmers have high liquidity constraints in the pre-planting period at similar fixed prices pegged to the market value of inputs (treatment E). If liquidity constraints have no effect on adoption decisions, then we would expect to observe equal adoption across treatments D and E, but higher adoption in treatment F, where a price discount is provided in the pre-planting period. If commitment mechanisms are a useful marketing option to farmers, and liquidity constraints are binding, then the farmer will maximize profit by purchasing the micro-packet in treatment D at the higher price, but in the earlier period, relative to either treatment groups E and F. In fact, Duflo et al. (2008) find that farmers with commitment mechanisms take-up improved technologies at higher rates with commitment mechanisms than with price subsidies. Our design experiment will offer a unique opportunity to validate this empirical finding in a different context with a different crop.

The last set of comparisons in our experimental design respond to the last research question found in Table 3 which permits comparison of demand and supply side interventions on adoption and productivity gains. By comparing treatment groups A, G, and the control, we can investigate whether small, random distributions within villages affect farmer knowledge and exposure to new sorghum technology, thereby inducing take-up. Alternatively, consistent supply in the market through ensuring availability with agro-input dealers during village market days may also facilitate learning about improved sorghum technology. Funding from BASIS would permit

additional comparisons beyond the funded portion of the demand-side interventions under GISAIA. Table 3 summarizes the research and policy questions, the comparison necessary to answer this question within the experimental design, and the funder that would be financing the question.

Table 3: Research and Policy Questions, Stage 1

	Comparison	Funder
What is the productivity effect of the packet (seed+fertilizer+training)?	A-Control	Gates
Does targeting based on SN characteristics increase adoption spillovers and aggregate productivity gains?	A,B,C, Control	Gates
Do commitment mechanisms to relieve credit constraints induce higher adoption than price subsidies?	D,E,F,G Control	Basis
What is the effect of supply side constraints on adoption and productivity?	G-Control	Gates, Basis
Are demand side or supply side effects larger constraints to adoption and productivity gains?	A,G, Control	Gates, Basis

C. Labor substitution effects of technology adoption & implications for intrahousehold allocation

The immediate goal of supplying improved seed to sorghum growers in Burkina Faso is to raise yields. Whether or not yield increases are discernible to farmers is an important research question, but yield impacts cannot be measured with a high degree of accuracy in cross-sectional surveys undertaken in a single growing season. Instead, we will focus on the following research questions which directly address the welfare consequences of improved seed and fertilizer micro-packet use, particularly for women and children in the household: How does use of improved sorghum seed affect (1) the allocation of inputs such as labor and fertilizer to the production of other crops and to overall household productivity? (2) the allocation of women's labor among

farm, household, and nonfarm income-earning activities, and does this impact their bargaining position within the household? Below, we address these two questions in turn.

(1) How will households respond to potentially greater sorghum productivity in terms of their allocation of other inputs across different crops and plots? What will be the overall effect on household productivity?

In the ethnically diverse Boucle du Mouhoun region of Burkina Faso, where we will focus our efforts, men tend to farm sorghum among other crops on their plots, while women tend to use their individual plots for farming cowpea, other legumes, and vegetables for family consumption. Since our experiment is to randomly vary the provision of sorghum seed across households, we can attribute changes in production practices regarding other crops to this change in sorghum productivity.

A Pareto efficient input allocation would imply a reallocation of fertilizer to crops and/or plots where an additional unit of fertilizer would have the highest marginal product. Yet, Udry (1996) found that households in Burkina Faso do not necessarily allocate production inputs in a Pareto efficient manner. He found lower yields for women's plots than those of men's plots, controlling for the crop and year. On the other hand, women's plots tend to be comprised of a variety of relatively high value crops, so that the total output per hectare is higher on women's plots than men's plots. The differences in yields are primarily attributed to a greater use of fertilizer and labor on men's plots (Udry 1996). If such inputs were reallocated from plots controlled by men

to those controlled by women, then agricultural production of the household could potentially increase by 10 to 20 percent (Udry, Hoddinott, Alderman, Haddad 1995).

A number of explanations for this behavior have been offered. Kazianga and Wahaaj (2013) found that among the ethnic majority of Mossi in northern Burkina Faso, individual household members have control over their own individual farming plots, and the household head (generally male) is in charge of a larger household plot which produces output shared by all members. They find no productivity differences between individual plots controlled by women and those controlled by other men in the household. So their explanation is that the (generally male) household head can better harness household inputs, including individual labor, because he shares the output with the other members of the household, whereas output from other individual plots is not shared.

We would like to examine the extent to which this may also be true among our surveyed households. But we also plan to extend this analysis further by comparing productivity differences across different male and female household members depending on the characteristics of their social network. We will examine whether those individual household members who may be more closely tied to other villagers may be more likely to access the improved hybrid sorghum seed, whether they will use it for their own individual plots or for the plot controlled by the household head, and whether take-up and use of the new seed differs by gender, age, and relation to the household head.

Another explanation for why productive resources are not necessarily allocated efficiently across plots controlled by different household members is that this would require individuals to provide labor on someone else's plot in exchange for compensation in the future, and that such cooperative agreements would be costly to enforce and monitor. These costs might be sufficiently offset by the benefits to such cooperation when productivity is particularly low, due to low rainfall levels (Akresh 2008). As our intervention may potentially raise productivity levels, we may then expect to see lower levels of cooperation across household members and across different plots. Would this offset any increases in productivity due to the new technology adoption? In addition, for households where members are better insured against negative rainfall shocks perhaps because of social network ties, they may also be less apt to cooperate within the household. Therefore, another question we wish to address is whether cooperation outside the household may be negatively related to cooperation within the household.

A third explanation for differences in productivity across plots is that those who invest more into their plots have more secure land tenure rights (Goldstein and Udry 2008). Indeed, women in Dedougou, in the Boucle du Mouhoun, purchased mini-packs of sorghum seed only when they had access to land. Women and other household members may be deterred from investing in productive inputs because of fear of expropriation or loss of control over their individual plots. Access to credit may also deter investment in productive inputs.

In Ghana, those who lack local social and political power fallow their land for much shorter durations than would be optimal because they are not secure in their rights to the land for a long enough fallowing period (Godstein and Udry 2008). While the Boucle du Mouhoun of Burkina

Faso offers a quite different social and political context, such research findings also beg the question of whether one's position in the social network in the village might relate to security in land tenure, and might therefore influence productivity decisions. As the value of land changes due to changing farming practices, a market for land is beginning to develop in Burkina Faso. In some parts of the country, women are able to obtain land through these market channels, which gives them further access to resources (Kevane and Gray 1999).

(2) How does the use of improved sorghum seed affect the allocation of women's labor among farm, household, and nonfarm income-earning activities? How does this impact their household bargaining power, and the health and education of children?

If sorghum productivity were to increase, this would require more time of all household members to harvesting this increase in sorghum. This will take away time from other activities, particularly farming other crops. If increased women's labor is required on improved technology plots, reduced food availability from the gendered crop cultivation of women (vegetables, legumes) would reduce household dietary diversity and women's income. Recently, in a similar region in Mali, Jeanne Coulibaly modeled the potential impacts of introducing a package of improved sorghum seed, fertilizer and practices into the cotton-based system as relative prices shifted against cotton. Her findings demonstrated that "the most profitable economic opportunity for the household is not the most beneficial for women," and that women are made better off with the adoption of less labor intensive technologies on the communal plot.

Improving the productivity of assets (namely land) controlled by men may raise household income, but may also reduce the productivity of land controlled by women as their labor is diverted to more productive cash crops. The amount of assets controlled by women is positively related to household expenditure on education and children's clothing (Quisumbing and Maluccio 2000). Thus, while household income may increase, if women's bargaining power declines, then the share of household expenditures devoted to children and their education may decline. Indeed, there is a fairly considerable body of evidence demonstrating that money in the hands of women results in greater household expenditure on children, and better outcomes for children in terms of measurements of their nutrition, health, and education (for reviews of this literature, see Haddad, Hoddinott, and Alderman 1998 and Duflo 2005).

Table 4 below summarizes the research questions that have been outlined here, along with the data that will be needed for addressing each in turn. In order to address these questions, we will primarily rely on baseline and follow-up survey comparisons. Funding provided by BASIS will allow us to include a much richer set of suveys than was originally planned for GISAIA, thereby enabling us to address these important dimensions of technology adoption.

Table 4: Research and Policy Questions, Stage 2

Research/Policy Question	Treatment Comparison	Funder
How will households reallocate inputs such as labor and fertilizer to the production of other crops in response to potentially greater sorghum productivity? What about to plots controlled by the household head, other men and other women? What will be the overall effect on household	A-Control; Baseline & Follow-up Survey Comparisons	Gates, Basis

productivity?		
Does take-up and use of the new seed differ by gender, age, and relation to the household head?	A,B,C, Control; Baseline & Follow-up Survey Comparisons	Gates, Basis
Will those individual household members more closely tied to other villagers have higher takeup rates? Will they use the packet for their own individual plots or for the plot controlled by the household head?	A,B,C, Control; Baseline & Follow-up Survey Comparisons	Gates, Basis
Would potentially higher productivity levels reduce cooperation across household members and across different plots? Would this offset any increases in productivity due to the new technology adoption?	A-Control; Baseline & Follow-up Survey Comparisons	Gates, Basis
Is cooperation outside the household negatively related to cooperation within the household?	A,B,C, Control; Baseline & Follow-up Survey Comparisons	Gates, Basis
Is one's position in the social network in the village related to security in land tenure, thereby affecting productivity decisions?	A,B,C, Control; Baseline & Follow-up Survey Comparisons	Gates, Basis
Are women and other household members deterred from investing in productive inputs because of fear of expropriation or loss of control over their individual plots, or because of credit constraints?	A,G, Control; Baseline & Follow-up Survey Comparisons	Gates, Basis
How does the packet affect the allocation of women's labor among farm, household, and nonfarm income-earning activities? How does this impact their household bargaining power, and the health and education of children?	A-Control; Baseline & Follow-up Survey Comparisons	Gates, Basis
Does the packet reduce food availability from the gendered crop cultivation of women (vegetables, legumes); does it reduce household dietary diversity and women's income?	A-Control; Baseline & Follow-up Survey Comparisons	Gates, Basis

II. Policy Integration and Outreach

The challenges of promoting development of seed markets for staple cereals in the West African Sahel are considerable. Since independence, governments in this region have largely relied on publicly-funded, state-managed seed corporations to produce seed and on publicly-funded extension services to assess farm-level demand and to diffuse the seed. Alternative approaches have been proposed and tested in recent years, but empirical evidence concerning their impacts remains sparse. In Burkina Faso, we intend to engage with the national agricultural research institute (INERA), farmer associations, and seed sector actors during research design, in discussing preliminary findings, and in dissemination of final results.

The research we propose under BASIS also contributes to national projects that are part of a larger research and policy framework "Guiding Investments in Sustainable Agricultural Intensification in Africa (GISAIA)." GISAIA is funded by the Bill & Melinda Gates Foundation and managed by the Food Security Group at Michigan State University. The project spans 8 countries (including Mali, Burkina Faso and Nigeria, in West Africa) and will be implemented over a four-year period. The vision of the project is to respond to the expressed need, by governments across Sub-Saharan Africa, for technical guidance in the design of input programs. The 9-million dollar project involves engagement with policymakers in various national and regional meetings to maximize best practices and lessons learned across countries. Linking to this umbrella effort will enhance our potential to bring credible research findings into high-level policy discussions. The goal of GISAIA, and of this potential BASIS project, is to have tangible impacts on policy and the composition of public investments that promote productivity growth among farming households. By linking to GISAIA, we increase the potential impact of our research on policy processes. GISAIA will directly inform and contribute to ongoing African

initiatives, including the Comprehensive African Agricultural Development Programme (CAADP) national investment plans.

We envisage four entry points for our engagement with policy stakeholders in Burkina Faso and the region. The first is the set of national partners that are currently collaborating on the GISAIA project. There are two key partners for GISAIA - INERA and DGPER. INERA, is the national agricultural research institute whereas DGPER (Direction Generale de la Promotion de L'Economie Rurale) is the principal Ministry unit for providing policy analysis to the Minister and his senior advisers. Links between DGPER and INERA are very strong. As part of the GISAIA project, DGPER will organize an annual policy roundtable discussion with research, government and private sector actors to discuss project findings and policy implications. Results from the BASIS CRSP activities thus have a direct and regular channel to policy making.

A second entry point is the Collaborative Crops Research Program (CCRP) of the McKnight Foundation. The CCRP supports clusters of projects in four geographical regions of high food insecurity, bringing each set of regional grantees together to operate as a Community of Practice (CoP) that collectively supports agroecological intensification (AEI). The CoP in West Africa focuses on improving food security for people who depend on millet- and sorghum-based farming systems in Mali, Burkina Faso and Niger. The current project portfolio includes applied research related to soil and water conservation, sorghum and millet breeding, and seed systems. Grantees include INERA scientists, researchers with universities in the region, the US and Europe, and researchers associated with the International Crops Research Institute of the Semi-Arid Tropics (ICRISAT). To achieve greater impacts in rural communities, projects generally

now emphasize "pluralistic" innovation systems that involve collaboration among non-governmental associations, traders and processors, and farmer associations. Our research team, and INERA scientists who are likely to be involved in this project, are already linked to the CCRP.

ICRISAT scientists have worked intensively with national agricultural research systems in this region for many years. Their accumulated experience and perspectives on fertilizer micro-dosing and sorghum improvement will be essential to research design and also to interpretation of the findings in a broader policy context. Our third entry point for policy processes is therefore the Consultative Group on International Agricultural Research, represented in the region by ICRISAT. ICRISAT scientists have been informed about this project and have already served as resource persons in its development.

In addition, we will seek the guidance of the USAID Mission in Burkina Faso in developing a more detailed outreach and dissemination strategy. We will establish regular contact with staff at the Mission, and seek their advice in order to identify outreach opportunities and vehicles for presenting policy messages derived from the research.

Through these means, and GISAIA, we also expect regional spillovers via interactions with the USAID Mission, the CCRP and other participants in GISAIA. GISAIA will provide the framework for the timing and structure of our engagement with policy stakeholders in this project (Figure). GISAIA is funded by the Bill & Melinda Gates Foundation and managed by the Food Security Group at Michigan State University. The project spans 8 countries (including

Mali, Burkina Faso and Nigeria, in West Africa) and will be implemented over a four-year period. The vision of the project is to respond to the expressed need, by governments across Sub-Saharan Africa, for technical guidance in the design of input programs. The 9-million dollar project involves engagement with policymakers in various national and regional meetings to maximize best practices and lessons learned across countries. GISAIA will directly inform and contribute to ongoing African initiatives, including the Comprehensive African Agricultural Development Programme (CAADP) national investment plans.

The timeline below describes a set of activities for our proposed outreach and dissemination process. In the first step, principal investigators and key resource persons will draft a stakeholder map for the project and more generally, the research domains in the project, at the provincial, national, and regional scales. A policy focal point will be named, and possible a sub-team identified with the task of developing and documenting an outreach strategy. Before field work is implemented, we will need to ensure that any necessary measures are put in place to protect communities and follow research ethics in study villages. As the field work is implemented, we intend to begin outreach with media contact and small group discussions among stakeholders according to the map and draft strategy.

Policy Integration and Outreach Timeline

Date	Activity
Sept-October2013	Stakeholder map generated, policy focal point (or sub-team) identified
October-December 2013	Develop outreach strategy
January-June 2014	Media contact and stakeholder consultations as baseline and RCT is implemented
November 2014-May 2015	Periodic follow-up stakeholder consultations based on preliminary findings
June-August 2015	Policy forum to present key findings as research report is prepared
September 2015	Policy brief and other dissemination activities via stakeholder nodes
October/November 2015	Journal Paper Submission; Media engagement

III. Contribution to Research Capacity in Burkina Faso

We intend to work closely with scientists and field technicians at INERA in all aspects of the research design and implementation. Consultations with INERA leadership in Burkina Faso during a field trip conducted by MSU staff in March 2013 confirmed strong interest in socio-economic research support to the extensive, on-farm trial and demonstration programs geared to fertilizer micro-dosing. These programs have been implemented with major contributions from

ICRISAT and the Alliance for a Green Revolution in Africa (AGRA), but with no particular emphasis on social and economic considerations. The work we propose will initiate this research.

We will also have the opportunity to strengthen social science research at INERA through linkages with ongoing seed system projects funded by the Bill and Melinda Gates Foundation and the McKnight Foundation, and also implemented through plant breeding programs at INERA and ICRISAT. Potential sites for the field research we propose are the Boucle du Mouhoun and Kaya sub-regions. In both sites, given the relative weakness of the commercial seed system for sorghum, the seed system projects conduct field experimentation, multiply and distribute seed via farmers' associations, farmer networks, and agro-dealer enterprises, experimenting with innovative, pluralistic approaches for promoting use of improved seed. Our research will provide useful information about input complementarity and gender dimensions for the future design of these activities.

Our proposed emphasis on gender analysis will also address a prominent research gap concerning the potential impacts of improved seed and fertilizer application within farming households. In composing our field teams, we intend to include a Burkinabe gender specialist who is placed to carry this research avenue forward.

IV. Support of USAID Objectives

This research contributes to all of the priority areas for investment identified by Feed the Future. We seek ways to enhance staple food production and support the development of local sorghum value chains, with a focus on improved seed inputs. Through linkages to the GISAIA framework,

we strengthen the potential for credible research to support sound public policy among not only Burkinabe policy-makers, but also those in neighboring Sahelian countries and in other regions of Sub-Saharan Africa. Our proposed research has an explicit focus on gender considerations, which is a cross-cutting theme in the Feed the Future strategy. By focusing on smallholder producers of staple foods, and on women household members, we address the concepts of "inclusive" agricultural growth and "gender integration" that are important pillars of Feed the Future. In working with seed traders, we seek ways to engage the private sector more effectively in the seed sector. Consistent with Feed the Future, we will support the agricultural research system in Burkina Faso through working with INERA scientists to design the experiment, record seed use, and document the incidence of benefits among members in farming communities of Boucle du Mouhoun. Finally, working with improved, locally-adapted ecotypes of sorghum is a climate-smart way to promote yield improvement by combating production risk. We recognize the need for complementary soil fertility management practices and erosion control in raising productivity, and thus for systems research, but given our experimental design, we view seed as an entry point to the system.

Our proposal also links closely to USAID's current program in Burkina Faso emphasizes efforts to expand beyond subsistence farming by helping farmers market their products and expanding their access to credit, while ensuring appropriate natural resource management in this landlocked country with harsh growing conditions and high levels of food insecurity. A disaster was declared due to poor harvests in March 2012. Since then, the situation has been exacerbated by a growing number of refugees from neighboring Mali. In line with these challenges, the research we propose focuses on how best to tackle constraints to raising the productivity of the staple

food crop, sorghum, in the Sudano-Sahelian region of Burkina Faso. Research will also have implications for similar regions in Mali.

Anticipated Outputs

I. Dissemination Activities Targeted at Policy Makers

As noted above, the GISAIA project will also furnish an overarching framework in which to disseminate research findings throughout the West African Sahel but also other countries of Eastern and Southern Africa.

A major pathway for policy impact will come through the involvement of local collaborators who have entrée and are trusted by the local policy process. MSU has a long history of capacity building support for and collaboration with national policy institutes and ministries of agriculture in sub-Saharan Africa.

MSU and consortium partners have in recent years made good use of the local media in several African countries to upgrade the level of understanding of agricultural policy issues. Examples are available upon request. We aim to make greater use of local newspapers and magazines to upgrade the coverage of major agricultural policy issues for the benefit of a more educated voting public.

We will work with social media organizations to disseminate research findings and color stories in local newspapers, magazines, TV, and the internet. In addition, all research reports and briefs will be posted on MSU and local organization websites for wider circulation. We also propose to have periodic consultations with private agribusiness firms to explore how our research findings

might help identify profitable opportunities for private agribusiness expansion in ways that contribute to sustainable intensification of smallholder agriculture.

II. Academic Publications

We anticipate publication of two primary papers to be published in either general interest or top development field journals. The first paper will focus on the research questions outlined in Table 3, while the second paper will focus on the research questions outlined in Table 4. There may be additional papers that are written after these initial papers, depending on the data analysis. One Ph.D. dissertation will be produced under this project which will also contribute additional potential papers to top development field journals.

Anticipated Impacts

We anticipate impacts through two primary channels. The first channel is through the academic community through dissemination of working papers and journal articles to inform the larger development community, potentially creating spillovers into other research projects in the West Africa. The second impact channel anticipated is through policy dissemination and outreach activities led by INERA within Burkina Faso to include agricultural policymakers, donors and the Burkinabe agricultural research community. Within BASIS, we anticipate actively participating in BASIS research meetings and dissemination activities to multiple the effect of our initial research report across a wide range of USAID actors and collaborators. We plan to initiate the project through engagement with local stakeholders to validate our experimental design and provide some initial training to INERA staff and agricultural stakeholders on randomized control trial methodologies. With this training, local Burkinabe researchers and policymakers will be better able to contribute their own local expertise to the project, better

understand the project's final results, and be able to communicate these results correctly through dissemination conferences at the local and regional levels which are currently planned through the GISAIA grant.

Timeline

Date	Activity
June/July 2013	Stakeholder consultation and design validation, training in impact evaluation designs
October 2013	SN Census and HH Enumeration
November-December 2013	Baseline Survey
January 2014	Treatment for groups A,B,C and D
January-June 2014	Market Availability of Packet at Market Prices in group G
June 2014	Treatment for group E and F
November-December 2014	Follow-up Survey + Adoption Survey
January-May 2015	Data Analysis and Synthesis of Key Results
June-August 2015	Research Report Preparation for Dissemination
September 2015	Dissemination Activities in Coordination with INERA and GISAIA
October/November 2015	Journal Paper Submission

Summary of Qualifications

MSU is unique among US universities for the breadth and history of its capacity-building programs, applied research, and outreach in Africa. The University has over 150 African-specialist faculty members, is home to one of the 3 largest Africana libraries in the US, is currently involved in over 70 projects in 24 African countries, and over the past 20 years has

produced more Ph.D. dissertations on Africa than any other US university. The Food Security (FS) program of the Department of Agricultural, Food, and Resource Economics (AFRE) has developed what the Rockefeller Foundation called "the largest aggregation of individuals focusing on African agricultural development anywhere." MSU has been deeply involved in research and capacity building in francophone West Africa since the 1970s. AFRE's Food Security Group has engaged in various long-term agricultural support projects in Senegal and Mali as well as at the regional level through collaboration with INSAH/CILSS, NEPAD/CAADP, and SADAOC (the Network for Research on Sustainable Food Security in West and Central Africa). For example, from 2009 through the present time, MSU has helped both the Malian national CAADP team and the ECOWAS Department of Agriculture, the Environment and Water Resources develop their national and regional CAADP investment plans. MSU has carried out research and outreach on food security in West Africa since 1985. Andrew Dillon is currently involved in two large scale impact evaluations in Mali for the Millennium Challenge Corporation's Alatona Irrigation Project and in Burkina Faso for the impact evaluation of Helen Keller International's Homestead Food Production program financed by USAID. He has led 25 data collection efforts over the past 5 years primarily in Mali, Burkina Faso and Nigeria, many in the context of agricultural randomized control trials and longitudinal panel surveys. Since completing her Ph.D. in Economics from the University of Chicago, Maria Porter has been teaching courses and publishing research on gender, health, and marriage markets in development. While a Research Fellow at the University of Oxford, she has been actively engaged in research on intra-household resource allocation in developing countries. Melinda Smale has over 25 years of experience working on research issues related to the adoption and impacts of improved seed among smallholder farmers, recently in the sorghum and

millet seed systems of the Malian Sudano-Sahelian zone. François Lompo and Hamidou Traore are the Director General and Assistant Director of Research Programs of Research, respectively at INERA. Their research leadership of a collective of researchers facilitates cereal crop, livestock and environmental research, training and extension activities in Burkina Faso.

Other Potential Resource People

Minim Sông Pânga, an enterprise directed by farmer-leader **Roger Kabore**, is a dynamic association of farmers interested in agricultural innovations, established as an outcome of a development project. The organisation is administrated by 10 members from Kaya (province de Sanmatenga, Centre-Nord du Burkina), with 6 sections in other locations of the province of Sanmatenga, Centre-Nord). The main fields of intervention are: testing and production and commercialisation of seed; soil conservation, animal production and technology transfer. Farmers of this organisation have established seed production and marketing groups in collaboration with INERA and local NGOs.

Union de Groupement pour la commercialisation des Produits Agricole, Boucle du Mouhoun (UGCPA/BM) was created in 1993 and is active in the six provinces of north-west Burkina. Its mandate is to develop a cooperative system for commercializing agricultural products of the region, in addition to providing quality products and promoting marketing standards and quality verification. UGCPA has evolved as a major supplier of larger quantities of seed for government and FA managed seed projects. UGPCA also manages large grain supply contracts with the World Food Program, private processing enterprises and others. **Adama Sidibe** is the primary contact for UGCPA/BM in Dedougou.

Our principal collaborators at ICRISAT's HOPE project (Harnessing Opportunities for Productivity Enhancement of Sorghum and Millets in Sub-Saharan Africa and South Asia) and the Seed Systems project (Sustaining farmer-managed seed initiatives for sorghum and pearl millet in Mali, Niger and Burkina Faso, funded by the Collaborative Crops Research Program, McKnight Foundation), are **Dr. Clarisse Barro** (INERA) and **Dr. Eva Weltzien** (ICRISAT), both leading the sorghum improvement program.

Budget

I. Personnel

The data collection will require the design of a social experiment to enable the project team confidently ascertain various impacts and offer policy prescriptions. This effort will also require the design and collection of at least 2 rounds of household level information including agricultural production information. Detailed household, plot level and individual level social network information will also be collected. While our local counterparts will play a significant role in this exercise, leadership of these activities will be conducted by MSU researchers. Consequently, the proposed budget proposes to spend about $ 334,282 on personnel costs over the life of the project. This includes 3 months of MSU personnel research time for the lead investigator to manage the project and the research activities as well as for the lead investigator and another MSU assistant professor to design and implement the experiment. It also includes a full time graduate student to work with the research team in all three years. The graduate student will work with the team to translate the experiment design to an implementable reality. This will involve conducting necessary literature reviews, gathering of information at various levels and management of such information. The student will work with the research team in the development of the sample frame as well as the final determination of stratification criterion and

survey design. Where necessary they will assist in the extraction of data and the generation of descriptive statistics. In addition to designing of various survey instruments and assisting with the analysis of the data, the graduate student will also provide support services to all researchers in the report writing.

All direct costs associated with MSU staff and the graduate student are based on standard established MSU salaries for faculty and associated costs as well as established procedures for assessing graduate student costs.

A total of 18 months of MSU faculty time has been budgeted as follows with the following allocation and responsibilities:

- Dillon: 3 months over the life of the project, campus-based with lead technical responsibility for baseline and experiment design, and joint responsibility for analysis.
- Porter: 9 months over the life of the project, campus-based with lead technical responsibility for data analysis, and joint responsibility for baseline and experiment design.
- Smale: 3 months over the life of project, providing technical contribution to all research outputs.

In addition, 36 months of MSU full-time Graduate Research Assistant time is anticipated to support all research activities.

A subcontract for INERA will also be provided to cover technical expertise provided by Lompo and Traore, and one INERA gender specialist in the amount of $65,000. Costs of staff for participation and technical expertise associated with providing training to ag-input dealers is also covered in this subcontract. The primary source of INERA funding is via the GISAIA grant

which already has considerable resources allocated to facilitating INERA collaboration with MSU.

II.Travel

2 trips by MSU faculty are planned from the USA to Ouagadougou over a three year period. Trips are budgeted at an average 10 days each including travel time. Lodging and per diem are based on current US State Department rates for lodging and M&IE in Ouagadougou. In addition travel has been budgeted for all 3 MSU PI's to travel to the Annual CRSP meeting each year expected to be held at UC Davis.

III. Data Collection

The major proposed cost in the budget is $ 300,000 budgeted for data collection in Burkina Faso. These costs are based on the costs for similar experiments conducted across other developing countries in sub Saharan Africa as well as standard survey costs in Burkina Faso based on the experience of the lead investigator. The major activities the proposed amount will cover is necessary listings and the follow-up adoption survey of households on survey villages, a baseline survey for about 1,600 households in treatment groups D,E,F,G, the treatment groups not covered under the GISAIA grant. The GISAIA grant currently has sufficient funding for listing and the social network census in these additional villages. The logistics associated with the study intervention and another post treatment survey to enable us to compare the survey households in different categories of exposure to the intervention. These activities will require a baseline and follow-up survey of the 80 study villages in treatment groups D, E, F, G. The baseline and follow-up surveys for the 1,600 observations is currently budgeted at $78 per

household per round. We anticipate each household interview will average 3 hours. These costs are low comparable to standard costs in other countries and lower than the lead investigator paid for a similar number of villages in Mali in December 2011. The follow-up adoption survey will be a repetition of the initial enumeration activities. We have budgeted $625 per village to complete the adoption follow up survey based on recent comparable activities by the PIs in Burkina Faso. This comes to about $50,000 for the adoption survey in year 2 and $125,000 each for the baseline and follow-up survey. This comes to a grand total of about $300,000.

References

Ahmed, Sanders, and Nell. 2000. "New sorghum and millet cultivar introduction in Sub-Saharan Africa: impacts and research agenda." *Agricultural Systems* 64:55-65.

Akresh, Richard. 2008. "Inefficiency in Intrahousehold Allocation." University of Illinois at Urbana Champaign Working Paper.

Bandiera, Oriana and Imran Rasul. 2006. "Social Networks and Technology Adoption in Northern Mozambique." *Economic Journal* 116(514): 869-902.

Bardhan, P.K. and C. Udry. 1999. *Development microeconomics*. Clarendon Press: Oxford.

Conley, T.G. and C.R. Udry. 2010. "Learning about a new technology: pineapple in Ghana." *American Economic Review* 100(1): 35-69.

Diakite, L., A. Sidibe, M. Smale, and M. Grum. 2008. Seed value chains for sorghum and millet in Mali: a state-based system in transition, IFPRI Discussion Paper No. 749, Environment and Production Technology Division, International Food Policy Research Institute (IFPRI), Washington, DC.

Duflo, Esther. 2005. "Gender Equality in Development." BREAD Policy Paper No. 011.

Duflo, Ester, Michael Kremer, andn Jonathan Robinson. 2011. "Nudging Farmers to use Fertilizer: Theory and Experimental Evidence from Kenya." *American Economic Review* 101(6): 2350-90.

Foster, A.D. and M.R. Rosenzweig. 1995. “Learning by Doing and Learning from Others: Human Capital and Technical Change in Agriculture.” *Journal of Political Economy* 103(6): 1176-1209.

Goldstein, Markus and Christopher Udry. 2005. “The Profits of Power: Land Rights and Agricultural Investment in Ghana.” *Journal of Political Economy* 116(6): 981-1022.

Haddad, Lawrence and Hoddinott, John and Harold Alderman. 1998. *Intra-household Resource Allocation in Developing Countries: Models, Methods and Policies*. The Hopkins University Press.

ICRISAT. 2009. Fertilizer Microdosing, January 2009

ICRISAT. 2012. Fertilizer Microdosing, July 2012

Jones, K. March 2013. Personal communication based on doctoral research, Penn State University, funded under the project “Sustaining farmer-managed seed initiatives for sorghum and pearl millet in Mali, Niger and Burkina Faso.”

Kazianga, Harounan and Zaki Wahaaj. 2013. “Gender, Social Norms and Household Production in Burkina Faso.” *Economic Development and Cultural Change*.
Kevane and Gray. 1999. “A Woman's Field Is Made At Night: Gendered Land Rights And Norms In Burkina Faso.” *Feminist Economics* 5(3): 1-26.

Ministere de l’Agriculture, de l’Hydraulique et des Ressources Halieutiques. 2010. *Diagnostic du secteur Semencier du Burkina Faso.* Document final. Ouagadougou, Burkina Faso, November.

Munshi, K. 2004. “Social leanring in a heterogeneous population: technology diffusion in the Indian Green Revolution.” *Journal of Development Economics* 73(1): 185-213.

Quisumbing, Agens R. and John A. Maluccio 2000. “Intrahousehold Allocation and Gender Relations: New Empirical Evidence From Four Developing Countries.” IFPRI FCND Discussion Paper No. 84.

Singh, R.S., S.K. Singh and D.M. Maurya. 1986a. “Metroglyph analysis of low land rice cultivars.” *Int. Rice Res. Newsletter* 11(4): 10.

Singh, R.S., S.P. Chuhan and D.M. Maurya. 1986b. “Metroglyph analysis of some upland rice cultivars of India.” *Int. Rice Res. Newsletter* 11(4): 11

Smale, M., L. Diakité, and M. Grum. 2010. When grain markets supply seed: village markets for millet and sorghum in the Malian Sahel, in L. Lipper, C. Leigh Anderson and T. Dalton (eds), *Seed Trade in Rural Markets: Implications for Crop*

Diversity and Agricultural Development, London: Earthscan.

Sperling, L., E. Weltzien, M.B. Sangar´e, et al. 2006. *Seed system security assessment (SSSA), Douentza, Northern Mali.* Catholic Relief Services/Mali and Partners, Bamako, Mali.

Udry, C. 1996. "Gender, Agricultural Production, and the Theory of the Household." *Journal of Political Economy* 104(5): 1010-46.

Udry, C., J. Hoddinott, H. Alderman, and L. Haddad. 1995. "Gender differentials in farm productivity: implications for housheold efficiency and agricultural policy." *Food Policy* 20(5): 407-423.

Vaksmann, M., S.B. Traore, and O. Niangado. 1996, Le photoperiodisme des sorghos Africains', Agriculture et Développement 9: 13–18.

Van Mele, P., J.W. Bentley, and R.G. Guei (eds.). 2011. African Seed Initiatives: Sowing the Seeds of Food Security. FAO, Africa Rice Center, and CAB International. Wallingford, UK: CABI.

Weltzien, E., A. Christinck, A. Touré, F. Rattunde, M. Diarra, A. Sangar´e, and M. Coulibaly (2006), Enhancing farmers' access to sorghum varieties through scaling-up participatory plant breeding in Mali, West Africa, in C. Almekinders and J. Hardon (eds), AgroSpecial 5: Bringing Farmers Back into Breeding: Experiences with Participatory Plant Breeding and Challenges for Institutionalisation, Wageningen: Agromisa Foundation.

Weltzien, E. and D. Bazile (eds.). 2008. Agrobiodiversité des sorghos au Mali et au Burkina Faso. *Cahiers d'études et de recherches francophones/Agricultures*. Numéro Spécial. Volume 17 (5). Mars-avril.

MELINDA SMALE
Department of Agricultural, Food and Resource Economics
Michigan State University, East Lansing, MI 48824 USA
msmale@msu.edu

Education

Ph.D., Agricultural Economics, University of Maryland, College Park, 1992
M.S., Agricultural Economics, University of Wisconsin, Madison, 1983.
M.A., International Studies (Africa Area),
Johns Hopkins School of Advanced International Studies, 1979.
B.A., History/French, Duke University, 1977.

Melinda Smale joined the Food Security Group at Michigan State in 2011, after working for a number of years with developing country researchers through the Consultative Group on International Agricultural Research (CGIAR). She now works collaboratively with Tegemeo Institue of Egerton University in Kenya and the Zambian Agricultural Research Institute. From 2002, as a Senior Research Fellow at the International Food Policy Research Institute (IFPRI) and Economist at Bioversity International, she led a global research program about the impacts of biotech crops, agricultural biodiversity, local seed markets, and underutilized crops. She conducted extensive research in Uganda and Mali. From 1989 to 2000, while living in Malawi and later in Mexico, she analyzed the adoption and impacts of improved wheat and maize seed as an economist for the International Maize and Wheat Improvement Center (CIMMYT). During the 1980s, Melinda worked in Pakistan, Somalia, Mauritania and Niger on shorter-term assignments for CIMMYT, Chemonics International, Volunteers in Technical Assistance (VITA), and USAID. She is an Honorary Fellow with Bioversity International, serving on the Advisory Committee of the Collaborative Crops Research Program of the McKnight Foundation, and on the editorial committees of two journals. She received awards for outstanding journal articles from the Agricultural and Applied Economics Association and the Crop Science Society of America. Over the years, Melinda has had the opportunity to advise PhD and MSc students from developing countries, and is now a member of the Core Faculty of the African Studies Center at Michigan State University. She has advanced proficiency in French, basic Spanish, and has studied Chichewa, Swahili, Urdu, Hassaniya, and Somali briefly during field work.

Professional Expertise

- Adoption and impact processes for seed, including biotechnology, and improved crop management practices, including practices to rehabilitate soil fertility and moisture
- Analysis of farm productivity
- Cost-effective survey research methods and sample designs
- Crop biodiversity, on-farm and ex situ conservation of crop genetic resources
- Formal and informal seed systems

Summary of publications

70 articles in internationally refereed journals; 5 edited books or special issues
29 book chapters
over 100 working papers, technical reports, proceedings papers
over 60 invited or selected presentations at professional meetings and conferences

Illustrative Publications

Smale, M. L. Diakite and N. Keita. Participation in Village Markets, Millet Diversity, and Household Welfare in Mali. Forthcoming. *Environment and Development Economics.*

Smale, M., M. Mathenge, T.S. Jayne, E. Magalhaes, J. Olwande, L. Kirimi, M. Kamau, and J. Githuku. 2012. Income and poverty impacts of USAID-funded programs to promote maize, horticulture and dairy enterprises in Kenya, 2004-2010. IDWP 122, Michigan State University, East Lansing, Michigan.

Cohen, M. and M. Smale 2012. *Global Price Shocks and Poor People: Themes and Issues*. Routledge, New York and London.

Smale, M., A. Niane, P. Zambrano. 2010. Impact Economique des Cultures Transgéniques sur les Producteurs dans l'Agriculture Non-Industrialisée: La Premiére Décennie. *Economie rurale* 315, janvier-février: 60-75.

Reij, C., G. Tappan, and M. Smale. 2009. Re-Greening the Sahel: Farmer-led innovation in Burkina Faso and Niger. In D. J. Spielman and R. Pandya-Lorch (ed.),*Millions Fed: Proven Successes in Agricultural Development*. International Food Policy Research Institute, Washington, D.C.

Smale, M., P. Zambrano, G. Gruére, J. Falck-Zepeda, I. Matuschke, D. Horna, L. Nagarajan, I. Yerramareddy, H. Jones. 2009. *Measuring the Economic Impacts of Transgenic Crops in Developing Agriculture During the First Decade: Approaches, Findings, and Future Directions*. Food Policy Review 10. International Food Policy Research Institute, Washington, DC.

Smale, M. (ed). 2006. *Valuing Crop Biodiversity: On-Farm Genetic Resources and Economic Change*. Wallingford, Oxon, UK: CAB International.

Smale, M., M.P. Reynolds, M. Warburton, B. Skovmand, R. Trethowan, R.P. Singh, I. Ortiz-Monasterio, J. Crossa. 2002. Dimensions of Diversity in Modern Spring Bread Wheat in Developing Countries since 1965. *Crop Science* 42: 1766-1779.

Heisey, P., M. Smale, D. Byerlee, E. Souza. 1997. Wheat Rusts and the Costs of Genetic Diversity in the Punjab of Pakistan. *American Journal of Agricultural Economics* 79: 726-737.

Smale, M., P.W. Heisey and H.D. Leathers. 1995. Maize of the Ancestors and Modern Varieties: The Microeconomics of HYV Adoption in Malawi, *Economic Development and Cultural Change* 43 (January): 351-368.

MARIA PORTER
Department of Agricultural, Food and Resource Economics
Michigan State University, East Lansing, MI 48824 USA
mporter1@msu.edu

Education

Ph.D., Economics, University of Chicago, 2007
M.A., Economics, University of Chicago, 2003
B.A., Mathematical Economics (Honors) and International Relations, Brown University, 1999

Maria Porter will be joining the faculty of the Department of Agricultural, Food and Resource Economics at Michigan State in August 2013. She is currently a Research Fellow in the Department of Economics and Nuffield College at the University of Oxford. From 2009, she was also a Research Fellow at the Oxford Institute of Population Ageing. While at Oxford, she has been teaching courses and publishing research on gender, household bargaining, and marriage markets in development. She has been actively engaged in research on intra-household resource allocation, health, and aging in developing countries. From 2007 to 2009, she was a Postdoctoral Fellow at the Center on the Demography and Economics of Aging at the University of Chicago. Since 2007, Maria has also worked as a Research Consultant for the Research Department at the World Bank, where she conducted a comparative cost-benefit analysis of policies aimed at promoting gender equality in sub-Saharan Africa and South Asia. She also conducted a research study for the Hewlett Foundation on the relationship between fertility and women's labor force participation, focusing primarily on sub-Saharan Africa and South Asia. In 2006, Maria worked in the Office of Oversight and Evaluations at the Inter-American Development bank, conducting impact evaluations of early childhood development programs in Mexico and a social fund in Nicaragua.

Professional Expertise

- Analysis of decision-making behavior across individual household members
- Policy evaluation for promoting gender equality in developing countries
- Female labor supply in developing countries
- Health and aging issues in developing countries

Publications

Porter, M. "Intra-Household Bargaining and Support of Elderly Parents in China"
Invited to revise and resubmit

Porter, M. 2010. "Health, Longevity, and the Role of the Family in China." *Journal of Population Ageing* 3-4: 103-109.

Porter, M. 2010. "Marriage and The Elderly in China" in *Aging Asia: The Economic and Social Implications of Rapid Demographic Change in China, Japan, and Korea*, edited by K. Eggleston and S. Tuljapurkar, Washington, DC: Brookings Institution Press.

King, E. M., S. Klasen, and M. Porter. 2009. "Women and Development." in *Global Crises, Global Solutions*, edited by B. Lomborg, 2nd edition, Cambridge: Cambridge University Press.
over 60 invited or selected presentations at professional meetings and conferences

Other Working Papers

"Sex Ratios in China, Marriage, and Intra-Household Resource Allocation"

"Housing Windfalls and Intergenerational Transfers in China," with Albert Park

"Characterising Preferences for Giving to Parents in an Experimental Laboratory Setting," with Abi Adams

"Fertility and women's labor force participation in developing countries," with Elizabeth King

"Rural Credit in Bangladesh: Estimating Gender-Specific Effects using Panel Data"

Research Grants

(2011) Understanding Altruism towards Elderly Parents in an Experimental Laboratory Setting. British Academy Small Research Grant - 6,200 *GBP*

(2011) Understanding Altruism towards Elderly Parents in an Experimental Laboratory Setting. OUP Fell Fund - 5,300 *GBP*

(2011) Understanding Inequality in Elderly Well-being in China and the UK, ESRC Grant, with Winnie Yip, Xuan-Mai Stafford, Andrew Steptoe, and Albert Park - 99,261 *GBP*

Honors, Scholarships and Fellowships

Predoctoral Dissertation Research Fellowship, University of Chicago Center for Excellence in Health Promotion Economics, September 2006-June 2007

Immasche Dissertation Research Fellowship, Department of Economics, University of Chicago, September 2005-June 2006

Graduate Fellowship, Department of Economics, University of Chicago, September 2001-June 2005

ANDREW DILLON
Department of Agricultural, Food and Resource Economics
Michigan State University, East Lansing, MI 48824 USA
dillona6@msu.edu

Education

Ph.D., Applied Economics and Management, Cornell University, 2008
B.A., Economics and Political and Social Thought (Honors), University of Virginia, 1999

Andrew Dillon is an assistant professor at Michigan State University in the Department of Agricultural, Food and Resource Economics. He is currently involved in randomized evaluations of projects in Burkina Faso, Mali and Nigeria. This current research includes work on household labor supply and education decisions, the agriculture, health and nutrition nexus, and social networks. Over the past 5 years, he has led over 25 data collection projects including randomized control trials, panel surveys, and tracking surveys, primarily in West Africa. Andrew holds a PhD in Applied Economics and Management from Cornell University and was a Peace Corps Volunteer in Mali from 1999-2001. Before coming to Michigan State, he was a research fellow at the International Food Policy Research Institute.

Professional Expertise

- Agricultural, Health and Nutrition
- Agricultural Labor
- Social Networks
- Survey Design, Research Methodology, and Measurement

Selected Publications

1. Dillon, Andrew. (2011). "Do differences in the scale of irrigation projects generate different impacts on poverty and production? Evidence from large and small-scale projects in Northern Mali" *Journal of Agricultural Economics*, 62 (2): 474-492

2. Dillon, Andrew; Manohar Sharma, Xiaobo Zhang (2011). "Estimating the Impact of Rural Investments in Nepal" *Food Policy,* 36 (2): 250–258.

3. Dillon, Andrew; Mueller, Valerie; Salau, Sheu (2011). "Migratory Responses to Agricultural Risk in Northern Nigeria," *American Journal of Agricultural Economics*, 93(4): 1048-1061.

4. Bardasi, Elena & Beegle, Kathleen & Dillon, Andrew & Serneels, Pieter. (2011) "Do Labor Statistics Depend on How and to Whom the Questions Are Asked? Results from a Survey Experiment in Tanzania," *World Bank Economic Review*, 25(3): 418-447.

5. Dillon, Andrew. (2011) "The Effect of Irrigation on Poverty Reduction, Asset Accumulation and Informal Insurance: Evidence from Northern Mali," *World Development,* 39 (12): 2165-2175.

6. Beaman, Lori and Dillon, Andrew. (2012) "Do household definitions matter in survey design? Results from a randomized survey experiment in Mali," *Journal of Development Economics*, 98 (1): 124-135.

7. Dillon, Andrew & Bardasi, Elena & Beegle, Kathleen & Serneels, Pieter. (2012) "Explaining Variation in Child Labor Statistics" *Journal of Development Economics*, 98 (1): 136-147.

8. Dillon, Andrew. (2013) "Child Labor Responses to Production and Health Shocks in Northern Mali" *Journal of African Economies*, forthcoming.

Other Working Papers

1. Olney, Deanna, Abdoulaye Pedehombga, Marie Ruel, Andrew Dillon; 2013. "Maternal participation in an integrated homestead food production and nutrition and health-related education program increased children's hemoglobin levels in Burkina Faso: Results from a cluster randomized control trial."

2. Dillon, Andrew; Friedman, Jed; Serneels, Pieter; 2013. "Experimental Estimates of the Impact of Malarial Infection on Worker Earnings, Labor Supply, and Productivity"

3. Beaman, Lori and Andrew Dillon; 2013. "Diffusion of Agricultural Technologies within Social Networks: Evidence from Composting in Mali"

4. Dillon, Andrew; 2013. "Nutrition Information, Networks and Childhood Anemia"

Recent Research Grants

1. Guiding Investments in Sustainable Agricultural Intensification II (2013)
Gates Foundation: co-PI for $1.1 million in program activities in Nigeria and Burkina Faso

2. Malaria, Productivity and Access to Treatment: Experimental Evidence from Nigeria
Economic and Social Research Council: PI for $334,000

3. Millennium Challenge Corporation contract for Impact Evaluation of the Alatona Irrigation Project in Mali, 2008-2013, via Innovations for Poverty Action. Co-PI over $2 million in total resources.