CALCULATED, CONSTRAINED, AND CO-OPTED: EXPLAINING AGRICULTURAL DECISION-MAKING OF MALAWIAN SMALLHOLDERS IN THE NEW AFRICAN GREEN REVOLUTION

by

JOSEPH WILLIAM LANNING

(Under the Direction of Bram T. Tucker)

ABSTRACT

In the last 70 years, Green Revolution technologies, such as inorganic fertilizer and improved seed, have been promoted globally as a means to achieve higher agricultural yields, and reduce poverty and food insecurity. Using long-term ethnography, qualitative and quantitative survey data, and experimental risk games, this dissertation research investigates agricultural decision-making among rural smallholder farmers in the Ntcheu District of central Malawi, a country in the vanguard of the new African Green Revolution. The vast majority of Malawian are rural smallholders who experience chronic and seasonal food insecurity, and their decisions about whether and how to intensely use agricultural technologies are therefore important to understand. This research draws upon 16 years of continued engagement and 15 months of fieldwork with rural Malawian communities exploring the issues smallholders face. First, it explores why rural farmers facing uncertain prices for agricultural inputs, constrained market opportunities, and limited arable land, choose either to use local seed and soil amendments, or to purchase improved seed varieties and expensive inorganic fertilizer. By examining indicators at community and household scales, it demonstrates that input choices are influenced by material wealth and that intensive input use, in communities with economic, political, and social inequality, may lead to greater disparity between rural households. Next, results of a real-rewards risk experiment reveal that when facing chronic and seasonal risk, farmers demonstrate a "safety first" decision-making model that reduces their downside risk, thus they select investment options with a higher probability of obtaining low or negative returns. It further focuses on the cognitive aspects of decision-making, showing that peoples' self-reported experiences of food insecurity are subject to response shifts that reflect changing perceptions of their own food insecurity relative to that of other members of their community across two seasons. By factoring in ecological, economic, and cognitive aspects of people's decision-making, this dissertation illuminates the heterogeneity of smallholders' material, social, and physical constraints, demonstrating that unequal access to the productive resources limits wide-scale or pro-poor growth through Green Revolution strategies.

INDEX WORDS: Agricultural decision-making, Risk, Food insecurity, Smallholders, Agricultural intensification, Green Revolution, Malawi

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DEDICATION

To the Mlongoti family for our many jolly walks.

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Any rights or responsibilities that are conferred to me upon completion of this dissertation are deserved to a far greater extend by the many Malawians who have listened to my broken Chichewa, directed me when I was lost, fed me when I failed at farming, and above all gave of their knowledge and experience with forgiveness and infinite patience. The households in the communities around Gowa form the foundation of this study and, in many ways, compose the community in which I grew up. My liminality in Malawi remains. However, any “coming of age” or hint of maturity of I’ve developed in the last 16 years is owed to the people of Gowa.

The dissertation would not exist without my family. My brothers introduced me to risk taking and compassion, two of the forces motivating this study. They’ve never questioned my wanderlust, but inspired it as I chased after them throughout my childhood. My father made me value intelligence. He is wary of mediocrity; this spirit led me to seek a terminal degree. Our countless hikes together instilled in me a sense of appreciation for the environment and adventure. My mother built the foundation of my being and supported the many educational endeavors that are behind this dissertation. I, and it, would not exist without her. As a college student, she studied abroad. I would argue it is one of her greatest memories and her excitement when speaking of it inspired me to study abroad. I would not have gone to Kenya without wanting to be like her. Kenya led me to Peace Corps, which led me to Malawi.

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CHAPTER 1

INTRODUCTION

Prologue

The heat is inescapable on an October afternoon in central Malawi. Avoiding the sun and hoping for a breeze, we reclined in the shade on the village headman's front porch. I listened as he explained his anxiety over whether the rains would arrive at the right time for planting his fields. The 80-year old man's gaze drifted between me, sitting on a mat a few paces from his chair, and the dusty plaza just beyond the house. As we chatted, the plaza hosted its weekly market. In it, women showcased tomatoes, precariously stacked in pyramid-shaped piles on recycled fertilizer bags in order to protect them from the dust. Older men feverishly fanned flies from dried fish delivered by bicycle over 50km of unpaved road from the lakeshore. Young men, with fresh haircuts, gathered around a vendor's recently butchered hog. We'd speculated about the rains many times before and the headman had often mentioned feeling pressure to grow improved maize varieties to mitigate what he perceived to be increasingly unpredictable rainfall. "Last year the rains stopped quickly," he said with slow intention. "They used to start in November, but last year it was not until late December. We must grow more hybrid than local seed in the future because it will be hard for our children. The farmland is short. The rainfall is short."

As had become customary during our chats, we paused as his wife delivered us a plate of roasted groundnuts in a worn metal bowl, rusted along the rim where the paint had flaked. In this pause, I asked what might happen if the government's program to subsidize fertilizer and improved seed technology is discontinued. The Malawian government's Farm Input Subsidy Program (FISP) distributes coupons to be redeemed for improved seed and fertilizer inputs at a reduced price. The objective of FISP is to encourage farmers to incrementally intensify production in order to simultaneously increase yields and incomes, and it is just one iteration of more than a decade of national programs designed for this purpose (Dorward and Chirwa, 2011).

As the headman of the community, he plays a significant and sometimes controversial role in the distribution of the coupons for subsidized fertilizer and seed. Several community members believe those in leadership positions unfairly and inconsistently distribute the coupons, favoring family, friends, and native residents of the community over the intended recipients- the imprecisely defined "vulnerable." He shook a handful of groundnuts, as if preparing to roll a pair of dice, and continued, "Even now, with the subsidy coupons we have, we are not sure we will get the fertilizer and seed we need. It is so scarce. With no subsidies I will buy expensive seed and fertilizer with money sent from my children in town. Others will have hunger and big problems growing enough food."

Groundnuts in hand, I was tempted to naïvely juxtapose the diverse display of food in the plaza with the headman's dystopian prediction of increasing food insecurity, climate uncertainty, input scarcity, production risk, and the shortage of arable land. He was not. For the headman and most Malawians, "maize is life" (*chimanga ndi moyo*) (Smale et al., 1995) and achieving food security and increasing wealth is inexorably linked to maize yields.

In the second half of the twentieth century, due in part to the increased use of agricultural technology, the economies and food production of many Asian and Latin American countries experienced periods of transformative *aggregate* growth in the face of growing populations. However, similar growth over the same period has not been achieved in Africa (Pingali, 2012).

The headman's stance echoes that of manifold private-public development partnerships, such as the Alliance for Green Revolution in Africa (AGRA), advocating for a uniquely African Green Revolution to address food insecurity and poverty across the continent through large–scale adoption and intense use of improved seeds and inorganic fertilizer (Altieri, 2009).

The failure of the Green Revolution to take hold and sustain growth in Africa is commonly blamed on a combination of inappropriate seed varieties and a lack of development of Africa's human and institutional capacity to exploit advances in agricultural technology (Binswanger and Pingali, 1988; Evenson and Golin, 2003; Denning et al. 2009). Despite decades of stagnant and declining agricultural yields in much of Africa, AGRA, with support from the Gates Foundation, the Rockefeller Foundation, and others, has rebranded the tactics of the first Green Revolution and claimed Africa as the new frontier of technologically driven agricultural growth:

> AGRA is not seeking to replicate food production strategies from Asia, Latin America, or anywhere else in the world. We work with our partners to provide assistance that is closely aligned with Africa's unique farming conditions, dietary preferences, and to developing an agriculture sector that is economically inclusive and environmentally sustainable. African farmers also produce a wider menu of staple crops than farmers elsewhere in the world and that diversity must be preserved.
>
> But perhaps the biggest difference is that Africa's Green Revolution is being powered by millions of small family farms, many run by women. These farms face unique challenges in gaining access to financing, land, inputs, and appropriate machinery and technology. Yet they are singularly capable of sparking a transformation in food production that could deliver benefits broadly across the continent, particularly in rural regions that have been bypassed by Africa's recent economic expansion (AGRA Frequently Asked Questions, n.d.)

From this vantage point, Africa is simultaneously "a region of vast untapped agricultural potential, a zone of capitalist agricultural expansion, and the final pocket of global hunger to be conquered" (Moseley et al., 2015). This rebranding of the Green Revolution is based on an ideal type of African farmers, that describes them as discerning, wealth-maximizing economic agents who simultaneously recognize and act towards environmental sustainability in their pursuit of food security and poverty reduction. AGRA's vision of the new Green Revolution continues, "We have found that, like farmers around the world, African farmers often prefer hybrid varieties to saved seeds if the hybrid's superior yield and quality is worth the annual investment," but, "We seek to limit agriculture expansion into natural lands by increasing yields in existing fields. This 'sustainable intensification' is possible because many African farmers can double or triple yields simply by planting high quality certified seed and adopting basic soil management practices." At first glance, the new African Green Revolution is a panacea. It is more than just effectively using technology, it is an ideological movement; conscious of gender disparity, accessible to the poorest farmers, environmentally sustainable, and adapted to local conditions and preferences, while simultaneously addressing climate change, population growth, and land shortage. At its core, AGRA and its partners frame the new Green Revolution as one of choices: "AGRA simply wants African Farmers to have more choices on the varieties they cultivate" (AGRA FAQs, n.d.).

I use this vignette and these excerpts from AGRA's "Frequently Asked Questions" webpage as an introduction to the overarching question of this dissertation: *how do smallholders make agricultural decisions in rural Malawi, a country in the vanguard of the new African Green Revolution?* In this study, I focus on the interaction between rural livelihoods, risk, and food insecurity and their influence on the choice to intensify farming using Green Revolution technology through the lens of economic and cognitive anthropology. Specifically, I examine why farmers who suffer from chronic and seasonal food insecurity, as well as uncertain prices for agricultural inputs and limited arable land, choose either to use local seed and soil amendments, or to purchase improved seed varieties and expensive inorganic fertilizer. I argue that the decision to invest in modern agricultural technology is both materially and cognitively costly to smallholders and I do not assume that technology use is an all-or-nothing choice. Therefore, I ask:

1) Whether the intensity of use of Green Revolution technology (e.g. kilograms of inorganic fertilizer per hectare) by Malawian smallholders varies in relation to different attributes of producers, such as material wealth, age, gender, education, and available labor, as well as access to arable land, remittances, and credit?
2) How may modern agricultural technology may simultaneously improve and reduce wellbeing in communities with pre-existing inequality, as experienced by many rural households in the first Green Revolution in Asia and Latin America (Pearse, 1980)?
3) Do farmers choices, in the face of risk, reflect normative preferences for maximizing the cumulative expected value of outcomes or do they aspire to reduce the variability of outcomes? How do previous successes or failures influence subsequent choices?
4) With specific focus on the social-comparative nature of rural agricultural livelihoods, is the experience of food insecurity associated with technology use and, if so, how?

My analysis of agricultural decision-making in the context of the new Green Revolution is supported by qualitative and quantitative data collection among smallholder farming communities in the Gowa Catchment Area in Ntcheu District of central Malawi, Africa. Malawi is a fitting site for this research as smallholder farmers constitute 80 percent of the adult population, many of whom chronically cope with impoverishment, arable land scarcity, malnutrition, ill-health and food insecurity (National Statistical Office, 2012:36). Farmers in the Gowa area focus their farming on the cultivation of maize, using assorted combinations of local and improved seeds, as well as conventional methods, such as irrigation and chemical fertilizer.

Further, faced with a single growing season and one of the highest rural population densities in Africa at 2.3 person per ha, only 10% of Malawians smallholders are net sellers of maize, while more than 60% are net buyers are incapable of producing enough maize to last a full year (SOAS, 2008, Holden and Lunduka, 2010). Cultivation in the study area is directly influenced by the private-public seed subsidy program (i.e., FISP) that encourages farmers to intensify production with modern inputs. Area farmers perceive that the volume and frequency of rainfall is increasingly erratic, both arriving later and suffering from periods of dryness followed by periods of excessive precipitation. Farmers face constrained access to formal credit schemes and off-farm employment opportunities.

Study Area

The Gowa Catchment Area (GCA) is located in Ntcheu District of central Malawi, nearly equidistant between the capital city of Lilongwe to the north and the major commercial center of Blantyre to the south (Figures 1.1). The GCA is an unofficial designation, defined locally as the roughly 37 communities served by the Health Surveillance Assistants employed by the Malawi government and stationed at the local Churches of Christ mission health center.

This study was conducted with smallholder farming households selected from eight communities surrounding the mission health center. A portion of the study area falls within the former boundaries of the Baptist Industrial of Scotland, established in the area in 1895 on “1,000 acres of wooded, undulating bush in the foothills of the Kirk Range” (Gray, 1987 p. 6).

While the history of the study area prior to colonization is undocumented, shifting swidden agriculture, combined with tilling and broadcasting of seeds, was commonly practiced throughout pre-colonial Malawi (Mulwafu, 2011:24; McCracken, 2012:13). Cultivation concentrated on rain-fed dry-land areas, supplemented by dry-season gardens located along rivers, streams, and moist low-lying *dimba* gardens (Morris, 1998:51; McCracken, 2012:13; Mandala, 2005:165). Multiple staple crops are grown including finger millet (*Eleusine coracana*), sorghum (*Sorghum bicolor*), and cassava (*Manihot esculenta Crantz*), as farmers routinely intercropped their fields (Tew, 1950:38; Pachai, 1972:96–97; Mulwafu, 2011:26–27; McCracken, 2012:13). The history of the arrival of maize is unclear. However, maize likely arrived via Arab and Portuguese trade with East and South Africa in the mid-1500s (McCann, 2005: 97-98). By 1859, missionary Dr. David Livingstone found maize, interspersed with fields of rice, tomatoes, groundnuts, sugar cane, and cocoyam (Morris, 1998:52)

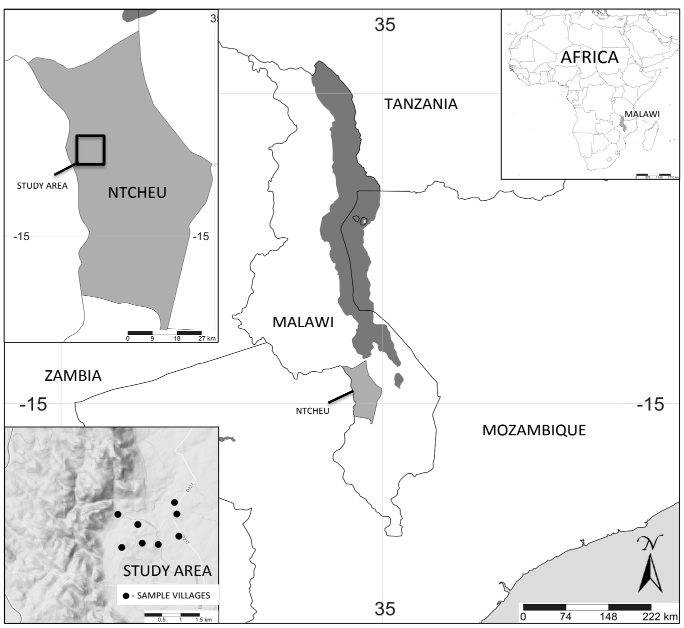

Figure 1.1: Map of the study area and sample villages in the district of Ntcheu, Malawi

Between 1895 - 1914, the industrial pursuits of the Gowa mission station and its surrounding agricultural estate, were focused on the production of coffee *(Coffea arabica)* and various types of peppers *(Capsicum)* as well as the rearing of cattle and pigs, employing 100 – 300 local residents. Further, the mission produced butter and milk for sale in Blantyre and

Zomba, commercial centers to the south. Coffee production reached its peak in 1900 with more than 2,000,000 lbs of coffee exported from the 1,000 acre estate. Through the 1910s, coffee production declined and the estate endeavored to cultivate cotton. Due to climate fluctuations, the high cost of transporting cotton to the Mozambique coast, and the effects of crop disease, from 1920 -1930 the estate shifted to growing tobacco achieving early success, but ultimately low returns. During the 1930s the Baptist Industrial Mission handed over control of the mission station and estate to the Churches of Christ. Management of the station was officially transferred to Malawian residents of the area between 1968–1970 (Gray, 1987).

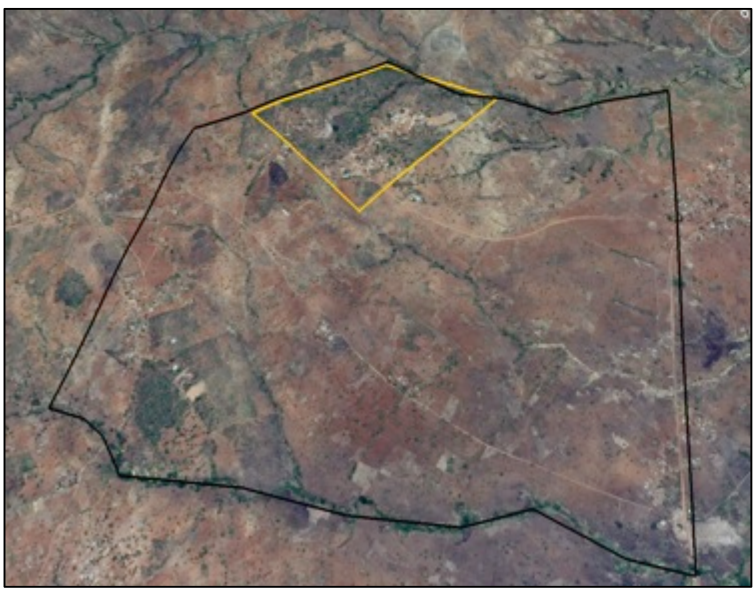

Figure 1.2: Map of the original Gowa estate boundary from 1895 in black and the current Churches of Christ Mission boundary from 2013 in yellow. Note: Forested area resulting within the yellow boundary results from a prohibition on tree removal compared to clear-cut and cultivated areas within the remaining black boundary.

During the agricultural and industrial period of the missions' work in the Gowa from 1895 – 1970s, nearly half of the arable land in the area of this study was inaccessible to local Malawian producers. The modern landscape of the Gowa area shows its history of mission and estate management. While some households have settled within the former estate boundaries, the borders of several modern communities have been shaped by this colonial history. Modern cultivation continues in areas with significant deforestation, formerly the estates' fields of cotton and tobacco, while the remaining tree cover is concentrated within the modern mission boundary, where members of the surrounding communities are prohibited from removing trees (Figure 1.2).

Farms and fields in the study area range between 940 and 1060 meters above sea level, with cultivation occurring on the eroded slopes of the Kirk Range and on the plains below. Malawi's climate is semi-arid, with three distinct seasons: a cooler dry season from mid-April to mid-August, a hot dry period August and mid-November, and a period of tropical rains between November and April, referred to as the rainy season (Figures 1.3). During the rainy season, residents regularly cope with impassable roads, a high incidence of malaria and water-born disease, and the daily struggle to maintain their dwellings, which commonly consist of roofs with layered recycled plastic and grass thatching and sun-dried mud brick walls and foundations.

Figure 1.3: Southwestern view of the landscape of the study area. The border with Mozambique is located on the far side of the hills of the Kirk Range in the background (May 2013).

The households in the study area produce a portion of their daily needs on-farm or by exchanging resources with neighboring households and kin. Despite popular misrepresentations of self-sufficient smallholders, a majority of households rely on access to the larger markets and services along the main road connecting Lilongwe and Blantyre. Market engagements, specifically in the small commercial centers in Ntcheu, Biriwiri, Tsangano, and Mlangeni, integrate these peripheral smallholders into regional, national, and international markets- especially as the study area is less than 10km from the border with Mozambique. Although these commercial areas are located along paved roads, boasting electricity, daily markets, bus access, and several shops for purchasing food, clothes, building supplies, and agricultural inputs, the households in the study area are between 8-21 km away by a network of seasonably passable dirt roads. Residents regularly carry goods by hand or transport harvests by bicycle, climbing more than 400m to reach these markets or to access transportation to the Ntcheu District hospital and bus depots for travel to other locations in Malawi or Mozambique. As crops mature, residents also sell harvests to mobile vendors and to the government owned Agricultural Development and Marketing Corporation (ADMARC). Selling to mobile buyers has advantages, as they come directly to a farmers' home during the maize harvest from April - June. However, vendors buy harvests at unpredictable prices and, based on farmers' frequent complaints, tamper with the scales used for assessing the value of produce. Uncertainty pervades the process of selling harvest and buying inputs at the local ADMARC as well. ADMARC's non-negotiable low buying prices and consistent lack of purchasing funds during the harvest season are countered by relatively consistent availability of maize for purchase during the lean season, from January – April, when rain-fed maize has not fully matured (Chirwa, 2005).

Households frequently employ non-local inputs in their agricultural production. Acquiring agricultural inputs requires cash, accumulated through various combinations of off-farm income, harvest sales, remittances, and credit, or a combination of cash and access to government seed and fertilizer subsidy coupons. The transaction costs involved in sourcing inputs, purchasing them, and shipping them from towns to rural areas on rented vehicles or piecemeal over several bicycle journeys, or on foot, constrains large-scale intensification. Households in the study area lack access to electricity and rely on sporadically functioning boreholes and local streams and rivers for domestic and irrigation needs.

Area households practice mixed livelihoods, focused on small-scale farming of maize (*Zea mays*), while augmenting incomes and harvests with off-farm employment such as formal salaried jobs, informal temporary day labor (*ganyu*), engagement in small-scale tobacco cultivation, producing charcoal, or with remittances from non-resident relatives. The area is representative of national and southern African regional dynamics as smallholder agriculture and the cultivation of maize (Figure 1.4) is the main source of livelihood for 80% of Malawian households who, on average, own only one hectare of land (Chirwa, 2004).

Figure 1.4: Recently harvested maize in a locally produced winnowing basket (July 2013).

Ganyu labor may include daily, weekly, or seasonal contract work in the fields of another farmer. In addition to agricultural labor, ganyu may include work on road repairs, transporting water for domestic use or brick making, and small-scale construction, sponsored by the government, NGOs, or local village development committees. Ganyu is temporary and, while one may be employed in the same ganyu several times in a year and may rely on the same neighbor or organization for employment, there is never a guarantee that jobs will be available. When ganyu jobs are available, it is an employers' market in which laborers have little control over hours and wages. Ganyu may mitigate shortages for food insecure households and those seeking to secure farming inputs for the following planting season, with payment varying between cash, surplus maize from an employer's harvest, and packages of fertilizer and seed from development organizations. However, residents note that ganyu may have deleterious effects on one's own fields, as labor is siphoned away from maintaining crops in the search for supplemental resources. This substitution of own-farm for off-farm labor, differently impacts those with smaller pools of available household labor.

Income generation via charcoal production is associated with a household's proximity to the few remaining forested areas in the Kirk Range to the west of the study area; households in the valley lack trees for charcoal production. Occasionally, entrepreneurs from the valley may purchase trees from other households for making charcoal, but the business is waning as the supply of raw materials, trees, are increasingly scarce with no formal local reforestation activities and an aversion, among local residents, to planting trees in their agricultural fields for fear of shading maize crops and potentially reducing yields. Approximately 18 percent of sample households reported producing and selling charcoal in 2013. While Malawi's primary export is unprocessed burley tobacco (UN Comtrade, 2010:1), supplementing one's income and harvest by engaging in tobacco production is notoriously unstable due to the unpredictable nature of tobacco markets and pricing (Mkwara and Marsh, 2014).

The Malawi government employs approximately 25 residents as teachers and staff in the local Community Day Secondary School (CDSS) and primary school, as well as four policemen and two agricultural extension workers, one specializing in livestock care and the other on cultivation and field management. The remaining salaried employment is affiliated with the Churches of Christ mission and health center. A Pastor, three nurses, five agricultural laborers, an accountant, and a small group of women, who gather fuel wood and water for the pastor, fill the mission-related salaried positions in the study area. The health center further employs eight health surveillance assistants who work, but do not reside, in the study area.

Population pressures coupled with rising costs for modern agricultural inputs, inconsistent distribution of agricultural subsidies, and changing climate affect cultivation and the experience of food insecurity for area households. District-wide there is evidence of a significantly growing population. The Ntcheu district experienced a 28% population increase from 1987-2008, resulting in increased population pressure on arable land (National Statistical Office, 2008, 2012).

Methodology

This dissertation draws on data collected during 15 months of fieldwork in the study area during 2012-2013. Throughout the year, I employed participant observation, semi-structured interviews, formal surveys, experimental decision-making games, and participatory mapping to examine how households and individuals navigate the decisions that define an agricultural livelihood in central Malawi. When the formal research for this dissertation commenced in 2012, I had previously spent more than 35 months living and working the study area, first as a Peace

Corps volunteer (2000 – 2002) and subsequently as the instructor for an anthropological research methods field school for undergraduates (May – July, 2003 – 2012). I further conducted pre-dissertation exploratory studies, from 2009 – 2011, examining the validity of an existing cross-culturally validated food insecurity survey (Pérez-Escamilla et al., 2004) in a rural Malawian context, investigating local perceptions of disease prevalence, frequency, and severity, and assessing the challenges of equitable water management in a small-scale rural irrigations system (Lanning et al., 2010).

Throughout this research, I lived with and participated in the daily livelihood activities of a local farming family. In addition to assisting in cultivation and food preparation within the household, I engaged in communal activities such as weddings, funerals, religious activities, and sporting events throughout the study area. My long-term residence in Malawi afforded me the opportunity to train two Malawian research assistants in anthropological research methods who assisted me throughout this study. Brothers Geoffrey and Alinafe Mlongoti have worked alongside me in each phase of my experience in Malawi. During my time as a Peace Corps volunteer, they trained me in the local language, Chichewa, and I tutored them in English and worked as Geoffrey's biology teacher at Gowa CDSS. Further, they assisted me in several small-scale farming experiments around my home and in compost making demonstrations with area farmers during my extended stay as volunteer in the community. On all subsequent trips to Malawi, after completing Peace Corps, I have temporarily resided with their family, sharing their home with their father, two sisters, and two nephews.

This research began, between July and August 2012, with an exhaustive census of households (n=392) among eight communities in the Ntcheu District. The census was used as the sampling frame for the random selection of households (n=85) included in this study. Due to missing data, some elements of this study address fewer than 85 households. The random selection process identified heads of household, who acted as the primary study participant. As this study spanned 15 months, on some occasions the head of household was unavailable due to various circumstances, including illness, migratory work, or various bureaucratic responsibilities in the community. When this occurred, I approached either the head's spouse or another adult household member. In the case of the food security survey, which I conducted in multiple seasons, the same household member was surveyed on each occasion. I describe the basic structure and challenges of the methods used in this study below and elaborate in detail on the methods of data collection, sampling, and analysis in the methods section of each chapter.

Permission to conduct this study was granted by Traditional Authority Njolomole as well as the village headman of each community included in the study area. Each study participant gave oral consent before data was collected in each stage of collection detailed below.

Participatory mapping

With the assistance of two trained local researchers, detailed maps were constructed with each farmer in the sample to examine both the total arable land area managed by each household and the proportion of cultivated area planted to local and improved maize varieties. The participatory mapping exercise was completed between January and March 2013, after the crops in participants' rain-fed fields had germinated and before harvesting began, to increase the accuracy of locating field boundaries and observing planting portfolios (Figure 1.5). The total hectares of cultivated and fallow land managed by a household were measured using a Garmin Rino 130 GPS device (95% accuracy of 3-5 meters) by walking the perimeter of each field with the field owner. Smaller areas within fields were mapped to determine the area planted to different crops. By participating in the mapping process, farmers identified and explained both the technical and cultural significance of their planting decisions. Mapping provided data on the proportion of the total area planted with non-maize and cash crops as well as fallow areas.

Figure 1.5: Research assistant Alinafe Mlongoti mapping a boundary between two maize fields

In designing this research, I naïvely believed the process of creating maps using a handheld GPS would consume limited time and would simply consist of explaining the mapping exercise, gaining consent from the participating farmers, walking a short distance from a farmers' home to her maize garden, spending a few minutes explaining how the GPS receiver worked, and taking a walk around her field. In reality, 84 of 85 farmers in the sample managed multiple small fields scattered in various locations across the landscape requiring walking several kilometers to access and map each field; the furthest field was more than 10 km from the sample farmers' home. This activity routinely occupied multiple days to complete both the cultivated and fallow areas. Further, the boundaries of each field were commonly difficult to distinguish on a landscape dominated by maize. With few exceptions, such as with elderly farmers or those with difficulty walking, participants paced alongside me as we marked the perimeter of each field as well as the smaller areas within fields. Nearly every mapping exercise concluded with both me and the farmer spending several minutes removing the barbed awns of the black-jack (*Bidens pilosa),* a species of flowering plant in the aster family, from our clothing.

Risk experiment

To examine participants' attitudes towards risk, I designed a novel multi-round experimental game that offered farmers the chance to invest cash to reduce the variability of outcomes. The experiment was presented without any explicit framing, but was designed to mimic agricultural choices in the context of Green Revolution agricultural technologies (Figure 1.6). These technologies are intended to provide farming households with increased and more reliable yields. However, these outcomes are achieved at high-cost. The multiple rounds of the game simulated the sequence of annual decisions farmers make as they harvest one crop, consume and sell their yields, and prepare for the next season.

Figure 1.6: Research assistant, Geoffrey Mlongoti, explains the rules of the experimental risk game to sample farmer

The experimental game consisted of random draws of one ball from a bucket containing different ratios of winning and losing balls. Participants were presented with the choice of three different lotteries. Across the three options, an increased probability of winning corresponded to an increased investment cost. Participants risked over-investment upon losing the lottery with the highest probability of winning and highest investment cost. The experiment was kept as simple as possible and involved practice rounds. Participants played three practice rounds of the experiment with hypothetical rewards and four rounds with real rewards. After making a lottery choice in each round, participants were asked to explain the reasoning behind their choice. After the experiment was finished, I asked farmers to talk about their experience and emotions, to explore whether participants saw analogies between the experiment and risky choices faced in farming.

Using a real-rewards economic experiment as a research method among impoverished populations was itself a risky endeavor. The aim of this game was not to evaluate or define a farmers' static risk preference to label individuals as "risk-averse" or "risk-prone" The value of this interactive method was its ability to elicit explanations of decisions under risk in ways that a stand-alone survey or semi-structured interview may lack. There is obviously a fundamental difference between real-life and experimental conditions (Chibnik, 2011). However, the experimental method allows for analysis of how subjects understand the context of the decision-making exercise and react to parameters and payoffs of particular situations (Gintis, 2000). By mimicking the type of choice farmers make when investing in agricultural inputs in real-time, the game was an effective prompt for farmers to speak in-depth about decision-making, luck, nervousness, and loss. While this was a time consuming method, as the explanation and practice rounds commonly took more than 30 minutes to complete with an additional 30 – 45 minutes for playing the four real-rewards rounds, farmers frequently expressed their enjoyment, asking me to return on another occasion so they could play the game a second time with their own money.

This method faced expected limitations. First, farmers did not play with their own money. They invested money to reduce risk in the game using a windfall of cash provided by the experimenter. By design, the game attempts to overcome this limitation by incorporating multiple rounds of play so that the potential for investment in rounds two through four are based on a participants' decision in round one, rather than a subsequent windfall from the experimenter's purse. Second, at the start of round four of the real-rewards game, farmers were told it was the final round. Awareness that the game was concluding may have biased decision-making, driving participants to invest more conservatively to reduce the chance of losing monies gained in previous rounds, commonly referred to as the endowment effect (Kahneman and Tversky, 1979).

Food Insecurity Survey and Livelihoods Interview

Preliminary research (Lanning et al., 2010) revealed the necessity for seasonal livelihood interviews to account for temporal variation in hunger, access to agricultural inputs, poverty, and cultivation decisions due to climatic conditions, seasonality of market based incomes, and challenges faced in storing foodstuffs. An adapted version of the Household Food Insecurity Access Scale module (HFIAS), used to measure participants' self-perceptions of food insecurity (Coates, 2007; Knueppel et al., 2010), was iterated seasonally, capturing variation in coping strategies and expereince between the rainy and dry season. The HFIAS survey examines three focal domains representing the experience of food insecurity: *anxiety and uncertainty* about the amount of food available to household (3 questions), *insufficient quality* of food (3 questions), and the lived experience of *insufficient food intake* (4 questions).

After the initial field-testing of the adapted HFIAS instrument with non-sample households in 2013, I began to question the data from the Likert scale survey (Figure 1.9). Several farmers I specifically knew to have chronically low maize yields, limited available labor and arable land, and constrained access to technological inputs were reporting low levels of food insecurity. This led me to evaluate the social-comparative nature of self-reported food insecurity responses in an effort to examine evidence of the “better-than-average” effect. This phenomenon exists when people perceive themselves to be higher achieving when asked to compare their abilities to those of others (Alicke et al., 1995). Therefore, sample farmers answered the 10 question HFIAS survey twice in each season: first answering for themselves and secondly, answering the same 10 questions about an “average” member of their surrounding community. I expand on this adaptation to the survey instrument and address the social-comparative nature of responses in Chapter 5.

Livelihood interviews capturing relevant information for exploring decision-making models, also allowed the opportunity to contextualize the varied ethnographic details gained through daily immersion in the lives of Malawian farmers. Livelihood interviews identified participation in labor and commercial markets (Godoy, 2001), access and command over various types of capital and wealth (Ellis, 2000, Scoones 1998; Bourdieu, 1986; Hulme and Shepherd, 2003), livelihood diversity (Ellis, 1998), access to government input subsidy coupons, and cultivation strategies. The questionnaire was used to understand what combination of human, natural, material, and financial capital, under certain socio-ecological conditions and constraints, result in the ability to pursue strategies and achieve certain outcomes (Scoones, 1998). Data collected during these semi-structured interviews included household demographics and socioeconomic characteristics of farming households as well as farm-specific variables, including the intensity of use of inorganic fertilizer as well as access to FISP. In addition to the measured variables of producers and their farms, participants, currently or ever using improved seeds, reported the year of improved seed adoption and the primary reason for initial use. Farmers also free-listed and ranked problems and challenges faced in their annual cultivation.

Upon reflecting on the use of the HFAIS survey and semi-structured livelihood interview, it is worth noting the potential for respondent fatigue influencing the validity of data. I approached each sample household at least twice in this phase of data collection, in addition to calling on them to participate in the risk game and participatory mapping exercise. I was only turned away one time in the duration of my fieldwork, likely reflecting my longstanding relations with residents in the study area. However, farmers were commonly annoyed at answering the same questions multiple times through the year. While I attempted to conduct interviews and surveys without family or neighbors interfering and potentially biasing responses, it was common that small children, spouses, or curious children encroached on these conversations. On one occasion, a female participant actually grabbed my notebook and pantomimed my behavior as a researcher, walking around to her children and other residents, who had gathered nearby, and asking them questions in Chichewa and pretending to record their responses. This was accompanied by excessive laughter by all involved and was a stark reminder of the inherent intrusiveness of anthropological research.

Structure of the dissertation

The collection of articles derived from this dissertation research is organized as follows. Chapter 2 provides a brief review of the literature on agricultural decision-making. I begin by reviewing agricultural intensification both broadly and in the specific context of Malawi. I then review risk and decision-making, examining the role of biases and heuristics as well as the use of experimental games for assessing farmers' attitudes towards risk. I then examine the relationship between intensification and food insecurity, noting the shifting approaches to measuring food insecurity over time. I rely on these bodies of literature for the body of this dissertation in chapters 4, 5, and 6.

Chapter 3 provides an ethnographic overview of life among smallholders in the Ntcheu District of central Malawi. Using selected fieldnotes from my long-term fieldwork and analysis of social situations, I attempt to frame the lived experience that influences the agricultural decision-making of rural Malawians.

Chapter 4 assesses factors influencing adoption and intensity of use of Green Revolution technology among rural Malawian smallholders. Specifically, this chapter examines the predictors of households' investment in improved maize seed and inorganic fertilizer, addressing how different factors drive the decision to invest in each technology. This chapter explores how disparate rates of use intensity among rural households are both cause and affect the local level of economic and social inequality in rural communities. Findings unsurprisingly indicate that material wealth is a key factor determining the use of inorganic fertilizer. Those who have the ability to accumulate household assets likely have enough cash or ability to liquidate assets for the purchase of fertilizer at the non-subsidized price. In contrast, improved seed use reflects the divided aim of producing for subsistence, early maturity, and income generation as well as storability and cultural preferences for taste and memory. Seed choice is primarily driven by human capital and access to exogenous resources such as credit and remittances. These analyses suggest that, when the cost of modern input use is prohibitive and the capital needed to secure inputs is derived from sale of surplus yield or access to exogenous sources of capital, the promotion of Green Revolution solutions to food shortage and poverty may simultaneously demonstrate benefits at the macro-scale through aggregate national yield increases while contributing to increased inequalities at the micro-scale within rural farming communities.

Chapter 5 reports the results from the multi-round risk experiment designed to simulate agricultural decisions and contextualizes experimental choice with farmers' narratives of their decision-making process under risk. It addresses two key aspects of the agricultural decision-making process. First, how do farmers trade-off between maximizing cumulative rewards versus reducing variability of potential outcomes? Second, how do farmers employ heuristics and cognitive shortcuts when making materially and cognitively costly experimental and real-life agricultural decisions? The findings demonstrate that farmers choose to spend money to reduce outcome variability in the experiment and that outcome history (previous win vs. loss) influences subsequent choice in sequential lotteries. Beyond the experimental setting, these results suggest that, in the face of repeated confrontation with risk and the challenging computations involved in accurate cost-benefit analyses for farmers, reliance on simple heuristic rules, such as win-stay, may satisfy many farmers' livelihood aspirations. "Safety-first" decision-making to reduce downside risk seems to drives choices, demonstrating that low rates of modern input use may reflect both farmers' material constraints on investment and their desire to maintain reliable yields over maximum yields.

Chapter 6 explores the social dimension of food insecurity, comparing how individuals perceive their own food insecurity relative to that of others in their communities. When cultivation, exchange, and coping with food shortage occur in a highly social environment, they invite comparison between households. These comparative analyses demonstrate a well-documented bias in social psychology in which an individual consistently ranks himself better than an unspecified average individual. This pervasive "better-than-average" effect may reflect self-enhancing behavior in reporting household food insecurity that distances one from the discourse of hunger and unskilled traditionalism that permeate the global perception of rural African livelihoods. Therefore, biased self-reports may result in systematic and predictable underreporting of food insecurity reflecting a motivational reaction of farmers coping with food insecurity psychologically, in the absence of material means.

Chapter 7 provides a summary and synthesis of the major findings from the analyses presented in the preceding chapters. I then describe the significance of these findings to interdisciplinary debates of agricultural decision-making. I discuss the implications of these insights as well as suggest relevant directions for future research in the context of Malawi's continuing debate on the future of agricultural input subsidies, rising input prices, and increasing population pressure and rainfall uncertainty as farmers encounter the new African Green Revolution.

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CHAPTER 2

LITERATURE REVIEW

Introduction

This dissertation draws upon and integrates aspects of decision-making, food insecurity, and economic and agricultural anthropology literature. It addresses a current debate in anthropology over the role of individual constraints and social comparison on perceived food insecurity and the adoption and persistence of agricultural behaviors. It also explores how attitudes toward risk influence farmers' investments in modern agricultural inputs. This study begins with the premise that decision-making is driven by combinations of individual experience and socially learned norms and practices. It aims to make a theoretical contribution by not only demonstrating that both individual experience and social comparison influence agricultural decision-making, investment, and perception of food insecurity, but also explaining the mechanisms driving individual strategies in the atmosphere of local and global pressure to increase yields. It also examines the prevailing claim in agricultural economics, and debate among anthropologists, that smallholder farmers are risk averse due to poverty.

Since 2005, Malawi's effort to solve problems of hunger with subsidized inorganic fertilizer and hybrid maize seed has led to what is commonly called the "Malawi Miracle." The strategy follows a "Green Revolution" model for agricultural intensification, asserting that subsidized technologies are the most prudent solution to hunger (World Bank, 2007, Denning et al., 2009). The model assumes farmers are profit-maximizers who experiment with technology and sacrifice potential rewards of alternative planting behavior to maximize maize yield. It prioritizes the aversion of short-term economic risk over long-term ecological risk. This strategy, promoted by the Malawi government, is considered a model for other African countries (Dorward and Chirwa, 2011). However, Olivier De Schutter, UN Special Rapporteur on the Right to Food, states that for agricultural solutions to food production, the question is "not how much, but how," suggesting that agricultural decision-making should go beyond maximizing maize yield, to address equity, environmental sustainability, and self-sufficiency (UN Human Rights, 2010). In this chapter, I review literature covering agricultural intensification among smallholders, literature exploring farmers' attitudes towards risk and their use of heuristic shortcuts in decision-making, and describe the current state of food insecurity studies with a particular focus on the role of social comparison on our understanding of the experience of food insecurity.

Agricultural intensification

Studying the ways in which growing populations feed themselves is central to the social sciences. Famously, Thomas Malthus argued that as the geometric growth of population was greater than the power of the earth to provide adequate subsistence, the world would succumb to misery and vice without social checks on the growth (1789). In the Malthusian model, as population increases, production expands to more marginal land resulting in declines on the return of labor. Even when yield increases, from improvements in production techniques, it is canceled out by further population growth (Carswell, 1997). In contrast, Boserup (1964) argued that Malthus had inverted the problem. She believed population determines changes in agricultural methods and that necessity would induce positive adaptations in technology use leading to improved productivity. In her model, population pressure leads to increased cropping intensity, shorter fallows, and land saving techniques.

For decades the Malthus-Boserup debate has been central to the public discourse surrounding the plight of farmers globally. Naylor (1996: 100) argues that, as global food supplies are threatened, “no question is more important for the future of humanity than whether growth in agricultural production can keep pace with the increasing population- and income driven demand for food.” The anti-Boserup literature argues that the population pressure on resources is not the only factor driving changes in agricultural practices and use of technology (Kalipeni, 1994) while the “Beyond-Boserup” literature (Turner and Ali, 1996; Stone, 2001) finds the arguments of Malthus and Boserup more complementary, noting that over longer temporal scales, both Boserup’s endogenous intensification and Malthus’ exogenous thresholds may occur in the same environment. Farmers facing food shortages, who are dependent on the environment and are in close proximity of other farming communities, have been shown to engage in a suite of indigenous livelihood options that may not require technological intensification of farming. Yet, as Stone (2001) explains, population pressure remains a key driver forcing farmers to alter their behaviors and use of technology.

The principle focus in much of the history of agricultural anthropology is explaining how farmers meet their food needs by adapting to local environments, adopting various local and exogenous industrial technologies, and reacting to economic conditions in ways that variably degrade or sustain local ecological conditions (Blaikie, 1989). Industrialized agriculture and “sustainable” indigenous methods are frequently described as the polar alternatives available for answering questions about the human need to produce adequate food for growing populations in limited space. Anthropologists have challenged this reductionism by explaining how farmers adapt and respond to local and global conditions in unique ways (Brookfield and Padoch, 1994). Barth (1956) found that the subsistence strategies of groups sharing the same limited geographical space might be symbiotic when another can exploit areas marginal to one group. Using an ecological framework to understand cultural distribution over an area, he determined that groups exploit ecological niches based on their economic and political organization. Chayanov believed that peasant farms operate in a different realm than capitalist farms, noting that the "drudgery" of farm labor will limit labor expenditure, as there is no incentive to work beyond the subsistence needs of the household (1986[1925]). Without a change in the consumer-producer ration, there is no need for additional inputs to production (Turner and Ali, 1996). Using an inductive approach to demonstrate that farmers do not always discount future utility, Netting (1993) found that the behavior of farmers demonstrated an adaptive common sense.

The work of Robert Netting (1993) is central in challenging the idea that modern industrial farming is the only pathway to meeting the worlds growing need for food. Using ethnographically rich examples, he demonstrates how smallholder households in diverse environments may often achieve intensive farm production in the absence of costly modern methods. His work highlights the diversity of smallholder responses to population pressure, food shortage, and environmental and climatic change, such as market engagement, migration, intercropping, and non-farm small-scale industry.

Some scholars have historically argued that farmers' adoption of innovations to improve productivity follow predictable evolutionary stages of initial knowledge, persuasion, decision, implementation, and confirmation (Ryan and Gross, 1943). The work of Rogers (2003) further developed this linear adoption cycle, noting that once farmers learn of innovations and are encouraged to adopt, broad scale adoption hinges on the individual experimentation of new technology and production performances. Barlett (1980) calls for recognition of the heterogeneity among smallholder farmers and challenges the mainstream theory of the adoption of technological innovations that sees farmers in a static state when innovations arrive and that innovations are invariably an improvement on this static condition. Farmers look to the affect of innovations on both production and exchange. Structural arrangements of the economy and the feasibility of using new technology guide the adoption cycle, not a general state of peasant conservatism or ignorance (Yapa and Mayfield, 1978; Netting et al., 1989). Farmers have dynamic and active responses to prices, markets, and access to credit and technology, which often result in the choice to not adopt modern technologies when the costs of modern inputs are higher than the returns from market sales (Barlett, 1980; Goldman, 1993; Turner and Ali, 1996). Following these ideas, Netting et al. (1989) importantly argue for a more nuanced, critical, and holistic interrogation of the linear predictions of agricultural adoption and innovation pathways. While introducing many anthropologists to and championing the ideas of Boserup, Netting asks about the environmental limits of technology (Cleveland et al., 1994). He finds that smallholders intensify agricultural production with limited use of modern agricultural technologies and often manage resources for a common good (Netting, 1993).

However, while Netting and others have demonstrated the breadth of smallholders' responses to population pressure and food shortage, many modern agricultural development initiatives rest on a "diffusionist assumption" that food shortages are caused by the lack of appropriate technology and that the spread of capital, knowledge, and innovations will lift communities, with uncertainty in the food supply, into a less vulnerable state (Yapa, 1993: 259; FAO, 2010). In Malawi, while historical evidence suggests diverse responses to population pressure and food shortage (Nurse, 1975), this development focus has led to promotion of the use of inorganic fertilizer and improved seeds at large scales (Denning et al, 2009). Nurse present evidence that Ngoni farmers in central Malawi commonly used migration as an adaptive strategy in the past. She found that when population surpassed available food, males migrated for alternative labor opportunities, which in turn resulted in food surplus as there were fewer mouths to feed with no real loss in labor, as Ngoni women commonly do the majority of agricultural work. This migration is interpreted as both an adaptive strategy for combating hunger and a way to reproduce cultural norms of male solidarity, lost through the colonial disbanding of Ngoni armies. However, recent efforts to address the problem of chronic hunger and poverty in Malawi have closely followed a Green Revolution model for agricultural intensification (World Bank 2007, Denning et al. 2009). Modern incarnations of this model in Malawi, such as the promotion of technology use through the Fertilizer Input Subsidy Program, retain key aspects of colonial and post-colonial policies and practices (Mulwafu, 2011:1), specifically a focus on using improved technology, such as synthetic fertilizer and hybrid seed, to increase the national food supply through high-input monocropped farm systems (Bezner-Kerr, 2010). Proponents of development and modernization in Malawi describe successful farmers as those who individually experiment with and cultivate inorganically fertilized hybrid maize to maximize yield and avert short-term economic risk; farmers who do not follow this model are considered "inefficient" or "stagnant" farmers (Tchale, 2009; Dorward and Chirwa, 2011).

Cultural anthropologists and development practitioners generally agree that mitigating uncertainty in the food supply requires efficient management of natural resources, and that traditional agro-ecological knowledge is a driver in sustainable resource management in vulnerable rural settings (Baro and Deubel, 2006). However, growth of agriculture based on technological innovation may affect the way households strategically pursue livelihoods, potentially altering or eliminating indigenous methods of intensification based on traditional agro-ecological knowledge (Yapa, 1993: 262). Traditional agro-ecological knowledge is the shared body of knowledge, practices, and belief about the relationship of living things to their environment that have evolved by adaptive processes and have been shared between generations by cultural transmission (Berkes et al., 2000). Lansing's research in Bali found that interruptions in the traditional planting schedule occurred when farmers where induced to adopt GM rice varieties through government subsidy. This led to water shortages, increased pests, and accelerated environmental degradation, supporting the finding that agricultural production in the absence of biotechnology can outperform the modern interventions of the "Green Revolution" (Lansing and Kremer, 1993:112). Social scientists have long demonstrated the unintended consequences resulting from technologically based intensification, noting that existing social and economic inequality may lead to disparate effectiveness of inputs among segments of societies and the potential for environmental degradation from an overuse of chemical fertilizer (Yapa, 1993; Kumbamu, 2009).

Yapa (1993) argues that while modernized seed technology can provide high yields for smallholders it also creates scarcity by destroying the productive base of subsistence and replacing sustainable reproductive capacity with non-renewable industrial inputs. Erosion of social structure, and soil, may result from increased competition for expensive industrial inputs as farmers run out of land to expand on. Subsidizing industrial inputs may reduce the cost of intensification for households in the short-term while degrading soils in the long term (Brookfield and Padoch, 1994). The need for market dominance among industrial farm supply companies has led to a rush of technology that address short-term challenges, while masking the depletion of soil quality and erosion (Barlett, 1987).

For many smallholder farmers, industrial agricultural methods consume resources faster than they are replaced, requiring constant innovation and new knowledge to stay ahead of changing markets and environments (Stone, 2004). For others, industrialized intensification is a reflection of conscious labor saving when alternatives like composting are constrained by high labor costs and limited access to organic matter (Holden and Lunduka, 2012). Farming behavior may also be driven by cultural preferences for particular cropping patterns that, while detrimental to the environment, display both the need to maximize yields in constrained spaces and a desire to maintain the cropping patterns of ancestors (Clay and Lewis, 1990). Farming behavior also reflects variation in taste preferences, food preparation preferences, risk reduction, and constraints on seed availability (Ferguson, 1993; Ohna et al., 2012).

Agricultural anthropologists have emphasized that research and development applications should begin and end with farmers and that answers to the incongruence of population, food, and technology requires interdisciplinary approaches that include farmers in the identification of both the problem and the solution (Rhoades and Booth, 1982). Alleviating population pressure is certainly not the only reason for intensification of agriculture, and applied research needs to account for economic goals of smallholders who may intensify because of desire to engage in the cash economy and meet demands from a global market (Brookfield, 2001; Stone, 2001; Beckford, 2002). Alternative approaches to smallholder agriculture should “seek solutions that deal with extant problems as they arise but also develop solutions that ultimately prevent those problems from arising in the first place” (Vandermeer, 1995). Approaching these solutions requires a complex balance, as gender politics (Cliggett, 1997; Schroeder, 1999), property rights (Peluso, 1996; Beckford 2002), and social impacts (Altieri, 2009) may result in unintended consequences when local power relations are not adequately accounted for in the design phase of interventions.

In Malawi, uncertainty remains between the perceived success of modern agricultural technology for the improving farmer yields (Dorward and Chirwa, 2011) and its potential effects on knowledge, food insecurity (Kumbamu, 2009), risk perception, and the evolution of decision-making of smallholder farmers. Chapter 4 addresses the economic and environmental drivers of intensification among Malawian smallholders, examining investment in modern agricultural inputs and their affect on yields and wealth.

Decision-Making

Recent research by social scientists has enhanced our understanding of the conditions that shape and distort the linear adoption cycle of agricultural technology. A key assumption of mainstream economic theory is that individuals are rational actors who aim to maximize utility, or wealth, in an environment of scarce resources (Friedman and Savage 1948, Becker 1962, Kuznar 2002). Ethnographic analyses demonstrate that maximizing the satisfaction of individual needs with scarce resources is not the only driver of decision-making, citing cooperation, reciprocity, and social norms as additional influences (Mauss, 1967[1925]; Sahlins, 1972; Polanyi, 1977). Therefore, variation in the use of technology may reflect differences in social and economic conditions and aspirations. Farmers may have similar decision-making strategies that lead to very different responses to the same challenge (Gladwin, 1989; Goldman, 1993).

Formalists argue that while social constraints influence decision-making and behavior, they do not limit individuals from working to strategically maximize their utility. Substantivists believe that individual decisions work to reinforce the social bonds and that decision-making is driven by social interaction (Dalton, 1961; Sahlins, 1972; Wilk & Cliggett, 2007). Ethnographic observations in Chiapas, Mexico provide evidence that social networks may have a stronger influence than knowledge gained through the observation of seed production performance, suggesting that seed selection is based on the ethnolinguistic relationships of two groups, citing in-group seed choice similarity (Perales et al., 2005). Boyd and Richerson (1985) also note the social influence on decision-making, suggesting a social and environmental distinction, describing the difference as one of imitation (social) versus cost benefit analysis of potential payoffs (environmental). Sperber and Claidaire believe that the distribution of knowledge among human populations is limited by ecological forces and driven by psychology, suggesting both individual and "cultural" learning include socially acquired elements (2008).

Normative decision-making models of economists are often adequate at predicting the behavior of experts with complete knowledge of options and potential outcomes, but experimental and cross-cultural evidence demonstrates that most humans are novice decision-makers at best (Thaler, 1980). The rationality of novices and their decisions is contingent on knowing the context of their decision-making process, which rarely consists of perfect knowledge (Kahneman and Tversky, 1979). Sufficiently simple decisions often confirm to normative models of rational decision-making while more complex situations often violate normative models (Thaler, 1980). Furthermore, ethnographic and experimental evidence suggests that many economic decisions are not shaped by the overall maximization of wealth, but by small stakes gains and losses (Laury et al,. 2009; Holt and Laury, 2002).

Economic anthropologists have used game theory and experimental economics to test whether decision-making flows from the rational calculations of individuals. They have explored how humans mobilize scarce resources in areas beyond the market setting and how decision-makers are coerced and influenced by groups, examining how people often fail to conform to the normative economic model of the self-interested and outcome oriented decision-maker who is guided solely by personal (or familial) consumption and wealth (Axelrod and Hamilton, 1981;

Boyd and Richerson, 1992). While there is obviously a fundamental difference between social interactions and experimental conditions, the experimental method allows for analysis of how subjects understand the context of the decision-making exercise and react to parameters and payoffs of particular situations (Gintis, 2000a). Anthropologists have demonstrated how punishment, fairness, cooperation, and social norms shape economic decisions (Boyd and Richerson, 1992; Gintis, 2000b; Gurven, 2004) even resulting in neurologically detected emotional response (Sanfey et al., 2003). The evolutionary implications of interacting models of decision-making and variations in cultural norms and the social transmission of rules varies across culture (Trivers, 1971; Axelrod, 1981 Boyd and Richerson, 2001; Gurven, 2004; Boyd et al. 2011; Gigerenzer, 2010; Henrich, 2000; Henrich et al., 2001a)

Bounded rationality aims to understand the cognitive processes and ecological conditions that lead to particular behaviors, assuming humans make decisions using a low-cost and realistically attainable amount of information that is often shared by interconnected groups (Simon, 1955; Selten, 2001). Such boundedly rational decisions, based on socially acquired information, often lead to behaviors that meet individual objectives (Gigerenzer and Gaissmaier, 2011). In the case of a farmers' decision to invest in new technology, the individual objective may be to avoid or reduce risk by increasing yield (Ellis, 1998; Binswanger, 1980). Henrich and McElreath (2002) provide evidence that a farmers' attitude towards risk may range from risk averse to risk seeking and that these attitudes may represent the accumulated experiences of individuals into socially transmitted norms. Henrich and McElreath (2002) used choice experiments to show that prestige bias can drive decision-making by providing low-cost cognitive shortcuts to acquiring the costly information needed in agricultural decisions. Prestige bias, when farmers imitate strategies of others they perceive as prestigious regardless of production performance, and conformist bias, when farmers copy the majority strategy, define the social learning process because environmental learning and experimentation are too costly (2002). Boyd et al. (2011) demonstrate that in addition to imitating those perceived as prestigious, there are benefits to imitating those who achieve success in a similar livelihood. Boundedly rational decision-making may also be maladaptive under certain circumstances such as stochastic environmental and economic conditions or when the enforcement of norms is so high that it inhibits innovation (Henrich, 2001). The recent work of Stone, on the adoption of scientifically enhanced cotton seed in India, argues that making distinctions between social and environmental learning in decision-making "is contrived because the two forms of learning contribute to each other to varying degrees" (2007:71).

Chapter 5 uses risk experiment to examine two threads agricultural decision-making under risk. The experiment first explores the mechanics of decision-making, asking how decision-making shortcuts and biases, such as repeating the same experimental choice after a successful outcome, are employed by smallholders. Second, it explores the measurement of risk preferences by examining how participants select from risky prospects using both hypothetical and real, rewards.

Food insecurity and social comparison

Food insecurity is commonly defined as uncertain access to a reliably sufficient amount of preferred food for an active and healthy life (FAO, 2004). This definition aims to encompass both nutritional necessity and temporal exposure to vulnerability (Barrett, 2010). A household's food security represents the outcome of its members navigating a constellation of economic, political, social, and environmental constraints and challenges while striving to meet their food needs (Drewnowski and Specter, 2004; Hadley et al., 2011; Mkandawire and Aguda 2009; Aggarwal et al. 2012; Jones, 2014; Misselhorn, 2005).

Household food insecurity is commonly conceived as hierarchical, such that availability of food is a prerequisite to access to it, and access precedes a household's ability to utilize food in a preferred way (Webb et al., 2006). Due in significant part to the work of Amartya Sen (2001), the dimension of access reflects disparity within and between communities. While foodstuffs may be available, not all households have secure economic, social or political means to secure the food they require. Adding the dimension of utilization to the concept of food insecurity illuminates the importance of assessing whether households who have overcome the availability and access hurdle are able use food in safe, preferred, and nutritious way. Utilization is commonly measured by examining dietary diversity rather than generic calorie intake.

Measuring food insecurity is an evolving practice. Assessment instruments commonly tradeoff depth and breadth, efficiency and cost, and each addresses the dimensions of availability, access, and utilization differently (Barrett, 2010). Anthropometrics, such as weight for height or mid-upper arm circumference, expose undernutrition and insufficient caloric intake. Food availability measurements are less costly and provide broad national and regional estimates of availability, but neglect the disparate access within and between households and communities. These objective measurements, even after the pivotal work of Sen (2001), remain popular for their ability to provide efficient low-cost estimates at large scales. Perception and experience-based surveys offer an important alternative to these objective measures.

The nature of experience-based measures of food insecurity, which ask about the frequency of individual and household experiences, has long been qualified as a subjective presentation of the self (Maxwell, 1992; Webb, Coates et al., 2006;Jones, Ngure et al., 2013).

For example, the 18-question Household Food Security Survey module (a precursor to the Household Food Insecurity Access Scale or HFIAS) asks informants to self-report feelings of anxiety and perceptions of food adequacy as a companion to more objective recording of constrained food intake (Kennedy, 2003). Food insecurity may be seasonal and episodic, reflecting droughts, floods, and other disasters (Barrett, 2010). Thus, perception and experience based measures commonly report levels of food insecurity that are vary significantly from national or regional availability estimates. Scholars contend that assessing feelings, experience, and perception of food insecurity is also subject to biased responses, as informants' internal standard of measurements and values are dynamic, and may shift in relation to their social interaction with others in their community (Maes et al., 2010).

Shifts in the way informants respond to experience-based food insecurity instruments reflects both changes in physical and biological reality (i.e. season, climate, soil fertility) and changes in the degree to which individuals are aware of the relative food insecurity of others around them. Social psychologists have long recognized that social interactions influence people's attitudes about themselves and their relative standing in their community, in a variety of given parameters. Social comparison theory is a framework for understanding people's perception of themselves relative to other individuals in their surroundings (Festinger, 1954). Social psychologists assert that the perception of self exists as both a unique and a socially compared phenomenon. Humans rely on social interaction for survival and these direct and indirect social interactions shape our view of the self (Decety and Sommerville, 2003; Festinger, 1954).

In the context of these social interactions, substantial evidence suggests that people commonly perceive themselves to be higher achieving when asked to compare their abilities to those of others, referred to as the better-than-average effect or BTAE (Alicke et al., 1995; Alicke, 1985; Weinstein, 1980). For example, in a study of 1 million Scholastic Aptitude Test takers in the U.S., 70% rate themselves above the median in leadership ability and 85% perceive themselves to be above the median in their ability to get along with others (College Board, 1976-1977). Cross-culture evidence of the better-than-average effect is demonstrated in a study of American and Swedish college students (Svenson, 1981). When asked to rate their driving safety, 88% of Americans and 77% of Swedes rate themselves above the 50% percentile. Among surgical residents, self-perceived surgical skill fails to correlate with achievement on standardized board examinations; surgeons think they are better than their scores report (Risucci, Torolani, & Ward, 1989). The strength of the better-than-average effect is associated with the degree to which a comparison target is individuated. When the source of comparison is specific rather than an aggregated *other* or *average individual* the better-than-average effect is present, but evidence suggests it is reduced (Alicke et al., 1995; Klar & Giladi, 1997).

While experience-based food insecurity instruments aim to capture self-perception and the experience of worry, coping, and food shortage, the social-comparative nature of these measurements and assessment of food insecurity at the community scale has received little direct attention. In a longitudinal investigation of food insecurity among community health workers in Ethiopia, Maes et al. (2010) found evidence of potential social comparison influencing survey responses. Improvements in self-reported levels of food insecurity, across three surveys, were partially explained by a “response shift” in which respondents change their self-reported food insecurity in relation to their interaction with others in their community. The researchers conclude that social interactions lead to a reassessment of the “internal standard” for food insecurity for health workers as they interact with others suffering from more pronounced food insecurity.

Chapter 6 examines the relationship between seasonality, food insecurity, and social-comparison in rural Malawi. It attempts to distinguish the "noise" in experience-based food insecurity measurements created by these variables and explores to what degree response-shifts are predictable phenomena.

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CHAPTER 3

"IT MAY LOOK TO YOU THAT I AM PROSPERING": ETHNOGRAPHIC OBSERVATIONS FROM SIXTEEN YEARS IN THE GOWA CATCHMENT AREA

Introduction

This chapter is an attempt to frame and contextualized the results found elsewhere in this dissertation by reflexively interrogating my long-term immersion in a Malawian community. Over the last sixteen years, I spent three years full-time and made 13 one or two month visits during which my ethnographic inquiries were guided by my interest in the opportunities and constraints that influence agricultural decision-making in rural Malawi. I also got my hands dirty at every opportunity. I farmed alongside Malawians and maintained my own small garden, attempting to produce a nominal quantity of produce for my own consumption while experiencing the activities at the foundation of an agricultural livelihood. Here I present typical examples of my field data, consisting of the detailed notes of selects events that connect my presence as a participant-observer with larger social, cultural, political, and environmental realities that influence the agricultural decision-making of smallholders in Malawi. I do not attempt to summarize 16 years of immersion in rural Malawi, but rather to present the drivers that lead to the diverse livelihood strategies of smallholders and a sample of the experience that shape my own interpretation of the questions and conclusions in this dissertation.

When I first arrived in Malawi in June of 2000, I had recently completed my undergraduate training in anthropology. However, my skills as an ethnographer were limited and research was not the primary objective of my visit. I was assigned to Malawi by the Peace Corps and stationed in the community of Gowa in the Ntcheu District as a "Community Health Educator" with the primary task of working with local counterparts at the Gowa Health Center designing HIV/AIDS prevention lessons. I was inexperienced, optimistic, eager, and more immature than I knew at the time. I did not choose Malawi. Through some alchemy of my previous experience as a student in Kenya, my undergraduate public health coursework, and a desire to return to sub-Saharan Africa, Malawi chose me.

Gowa is a small community of approximately 35 households, centered around a Churches of Christ mission, with a primary and secondary school and a rural health center serving the residents of 37 surrounding villages. Initially, I lived alone in a small brick house about 450 m from the health center. The porous iron sheets of the roof, the lack of electricity and running water, the broken glass of the windows, and the cement-floored pit latrine behind the house put my standard of living equal to other residents of Gowa, but significantly different from that of my neighbors in the surrounding communities.

For the first several months in Gowa, I approached my days as any diligent fieldworker in a new site should. I drew community maps with local farmers, I attended weddings and funerals of neighbors, I sat through four hours of church each Sunday, and I accepted many invitations to eat meals with strangers. I resisted hiring domestic help so I could make the walk to the bore hole with my bucket each morning to get water and meet community members while practicing my Chichewa language skills and staying up to date on the news and gossip of the village. I also resisted doing any formal public health related work. I was naïve, but smart enough to know I had more to learn than I had to share as a new arrival in Gowa. Therefore, much of my day was spent sitting on a cement bench in the admitting ward of the health center observing patients as they waited for consultations and treatment from the nurse. Gowa health center lacks a physician. The "Sister In-charge," as the head nurse is titled, accommodated my questions each day and never made me feel like the nuisance I knew I was.

After six months, the daily routine of sitting in the health center, struggling to cook rice and beans by candlelight, and rereading the few books I'd brought from home, wore thin. In December, the rains arrived and I asked my neighbor if he would help me to secure a hoe and shovel so I could start a garden. Shamefully, I admit that my farming experience up until December of 2000 consisted of begrudgingly filling a watering can with some Miracle-Gro to water my mother's flower garden and doing my best to look like I was pulling weeds while my father cut the grass on the weekend. In Gowa, I was committed to finding seeds, tilling the soil, and applying compost from the pile I started with my kitchen scraps. I used every contact I had in Malawi to find medicinal plants, fruit tree seedlings, and local varieties of maize and vegetables. The Peace Corps trained me in the basics of permaculture, an agricultural system that attempts to simulate patterns and features of natural ecosystems to achieve sustainable harvests and self-sufficiency. I imagined my "alternative" garden as an educational resource for farmers, acting as a seed bank for locally adapted plants and a place where health workers could move the conversation about farming beyond the volume of yields to a focus on nutrition and health.

By January, I had 30 different types of plants growing on a 100 m^2 plot. I placed small signs with plant names written in Chichewa and hired three young neighbors to find stones to make a pathway through the garden so the potential tours of my Malawian neighbors would bring the pages of *Better Homes and Gardens* to life. Then the waiting began.

As I had done at the health center, I sat on the cement steps of my house with my eyes darting from my garden to the road and back in hopes that someone might want a tour. I continued to visit the health center for my assigned duties, such as helping to record the weights of children under the age of five at the weekly clinic or to distribute soya flour to malnourished mothers and their underweight children. However, my new objective was to learn about and participate in agriculture.

Knowing smallholders

In the dry season, the hills of the Kirk Range are a yellow-golden color with a few sprinkles of green. The mangos are really the only trees I notice; everything seems to be cut, buried, and slow-burned to make charcoal. Today I hiked up the hill behind Chauluka with Fulagombe to visit the agricultural extension office and see if we could get some vetiver grass for the irrigation project. We carried two empty maize sacks on our three-hour walk towards the M1. On the way, Fula pointed out different plants and showed me my first real bananas still growing on a tree. We also saw some baboons playing in a small pool up near the spring that feeds the irrigation project. I was excited and he tried to be too, but it was clear he was more annoyed by them than enamored. He mentioned that they sometimes come down to the irrigation project and destroy the maize.

We passed about 10 people on the path. Most were carrying something back that they'd purchased at the market by the main road. Some were transporting baked goods to sell in different villages in the valley. I feel terrible because a young boy was scared when he saw me coming towards him and actually dropped the winnowing basket full of samosas he was carrying.

We reached the road a little after noon and found that the extension station was closed for lunch. We waited in the shade next to the building. I offered Fula some sunflower seeds that I got in a package from home. He declined several times and I couldn't understand why so I pressed him until he smiled to remind me he didn't have teeth. I felt like an idiot and stopped eating them for the rest of our wait. He told me a story about how he'd had constant headaches and the local sing'anga (African doctor) had given him medicine that made all his teeth fall out.

When the office finally opened, the extension worker told us we could take as much vetiver as we wanted for free, so we filled up both our sacks and headed quickly back down the hill to Chauluka. I still had another hour to walk back to Gowa after we returned. We explained to the extension worker that the vetiver was going to be used to line the sides of the irrigation canals to reduce erosion since we didn't have any cement. The amount we carried back was barely enough to cover 30 m of the canals, so this will be planted in a nursery until we can grow enough for any real impact.

-Fieldnotes, March 2001

To reach Gowa from the M1 highway, the main north-south road through Malawi, one descends approximately 250 m of dirt roads through the Kirk Range. The road is seasonably passable by vehicles and is lined by hand dug trenches for redirecting water and reducing erosion of the road along the slopes of the plateau, which forms Malawi's western border with Mozambique.

Each year that I've returned to Malawi, my hosts have noticed me age. Jokes about my weight increasing and my hair decreasing are a common greeting when I reach Gowa after the two-hours walk from the roadside drop-off point. In tandem with my own aging, the landscape in the area surrounding Gowa increasingly shows signs of "male-patterned baldness," as farmers extend maize fields up the steep slopes of the range. The commensurate reduction of the tree cover, as gardens are established further up the hillside, is symptomatic of the combined pressures of increasing population relative to arable land and the need to maximize cash income from farming and charcoal production. From my small garden, I am able to look back up the slopes of the plateau. On several occasions in the last sixteen years, my neighbors in Gowa have commented that the "rocks are growing" on the hillsides, as cultivated areas erode during the rainy season, exposing the rocks beneath.

In February of 2001, after a few months spent establishing my small demonstration plot, one of the more vocal and observant neighbors brought my waiting for an agricultural counterpart to an end. Early one February morning, Wexton Fulagombe knocked on my door asking for a tour of my garden. One of the workers at Gowa Health Center had told him about the volunteer living nearby who was planting fruit trees and making compost piles. Wexton was born in Chauluka village in 1954, during the last decade of British colonial rule in Malawi. From 1970 to 1984, he migrated to South Africa to work as a supervisor on mining projects. Upon his return to Malawi he was employed in the northern region of the country, working for a British agricultural company. He worked in several locations in the northern districts of Malawi until

1994 when the British company closed its doors, leaving him unemployed. He then returned to the village of his birth.

Wexton's initial interest in seeing my garden was to secure fruit tree seedlings for the Chauluka irrigation project. When he arrived, I aggressively led him through my small plot, taking time to explain every detail of the plants, including their Chichewa names, where I had sourced them, and how best to plant each seed. He graciously followed me around, nodding to assure me he was listening. In the excitement of giving my first garden tour I failed to ask his name, his background, or even his purpose for visiting me. A popular, development-focused retelling of this encounter has the volunteer teaching the impoverished rural Malawian about a "better" way of farming. In reality, the young inexperienced *mzungu* quickly learned that explaining farming to a knowledgeable, experienced, and well-traveled Malawian elder was like explaining water to a fish. However, Wexton was struck by the number of medicinal plants I was growing, repeatedly explaining that many of the plants were ones he had not seen since he was a child. I'd brought many of the medicinal plants from the gardens of friends across Malawi.

The following day, I accompanied a colleague from Gowa Health Center on a visit to Wexton's home to see his work on the Chauluka Irrigation Scheme. Wexton lives with his wife and two children in a small four-room house made of dried mud brick and a grass thatch roof lined with plastic sheets to reduce leaking in the rainy season. His homestead consists of the main house, a small detached kitchen, a pit latrine, and an empty house across a small dusty courtyard that a sibling used to live in where he now stored his maize harvest.

The chance to assist and collaborate in the early days of the Chauluka Irrigation Scheme was ideal to me. It was my opportunity to do my work as a volunteer while participating directly in Malawian farming. My role was limited. I helped dig canals, alongside the 13 founding members of the project, which ran from the hillside spring that fed the scheme down to the gardens in the valley. I commonly gave presentations on building and maintaining compost piles and I helped to source seeds, vetiver grass, and tree seedlings from other parts of Malawi.

In 2001, membership in the scheme ballooned from 13 to 65 individuals. The initial success of Wexton's innovation led many households to join in the scheme. The membership quickly grew to over 150 farmers at which point the available land was too little to meet the needs of the scheme. In 2007, "Station B," also called the Mbiribiti Scheme, was opened on a hillside of the plateau.

At the end of my tenure as a Peace Corps volunteer, a Danish development agency got wind of the budding success of the project in Chauluka. Within three-months of my August 2002 departure from Malawi, the agency supplied Wexton and the scheme's membership with cement and plastic pipes to establish permanent water canals on the project. However, the funding for these supplies was discontinued before the cementing of the water channels was complete, leaving half the fields with cement channels and half with the original hand-dug canals (Figure 3.1).

In December of 2002, I made my first return trip to Malawi as the leader of a group of 10 college students and administrators to Gowa as part of an "Alternative Summer Break" volunteer program. My intention in leading the group was to return to Gowa to see my friends. The groups' intention was to learn about Malawi and provide some service in aid to our hosts. Within a few days of our arrival, I led the group to Chauluka to check-in on Wexton's work. It was immediately clear that the vetiver grass I'd hoped would be used to control erosion along the canals had been abandoned. The half-cemented scheme now faced a new challenge of maintaining an income high enough to expand the cemented area while repairing the cement work started by the Danish organization.

I've returned to the Chauluka and Mbiribiti irrigation schemes each June from 2002-2016. Wexton's role as a manager has waned over the years as the conflicts surrounding management of the project funds has increased. In 2012, he stopped farming a garden in the project, citing increased conflict between members of the project and a lack of consistent and adequate access to water. He believes that as farmers have extended gardens further up the slopes of the Kirk Range, the deforestation from the newly established fields has reduced the flow of water in the scheme. He explained that he was losing money and food security as the water became increasingly unreliable. Aware of the decreasing flow of water towards the end of the 2000s, he attempted to shift from local maize varieties to early maturing hybrid seeds. However, by 2012, he decided that it was no longer profitable to pay rent for a field in the scheme and purchase hybrid maize and inorganic fertilizer with the increasing probability of the irrigation canals drying up before crops were fully matured.

Figure 3.1: Abambo Fulagombe and a cement canal on the Chauluka Irrigation Scheme

On risk

It's early October and the rains are still a few months away. Residents of Gowa and the surrounding communities have started to run low on their stored maize. The maize is increasingly stored inside rather than in the woven silos in the courtyards of the village houses. Today we took the pathway to walk to Kasirya's home rather than the main road. He had mentioned that he'd be working in his dimba garden by riverside and I hoped to observe him watering his sugarcane, maize, and sweet potatoes that he'd planted to help carry his family through the hungry season, from December to April.

The walk was exhilarating because it was different. I'd used the main road to walk to Galeta village and past Kasiyra's home more than 30 times in the last three months. Today, the path took me along the edge of Linkhue River. For a while, I jumped from boulder to boulder in the riverbed before climbing the banks and up through weeds that taken over a maize plot to the spot that overlooks Kasiyra's dimba garden. From the top of the bank, I could see down to his plot and noticed it was quiet so I pulled the blackjack spurs from my pants and continued on the path leading to the backside of his homestead. In total the walk took 30 minutes.

Kasiyra invited me in immediately. We'd planned to continue our conversation after our last talk concluded with him saying, "I need others to lose if I want to survive." He's a pastor and farmer who is well respected in Galeta village. Hearing this Christian leader tell me he needs his neighbors gardens to do poorly required a deeper explanation. We sat at the table in the front room of his home. The door in the next room opens to a small shop from which he sells soda, candles, sugar, salt, and other sundries. He shouted to his daughter, telling her to watch the shop, and began to explain why he'd said he needs others to lose.

"If the rains come well and people have enough fertilizer, I suffer. I have maize and no one to sell it to. If others have a surplus, no one is willing to work for maize. The problem is, these days, the land is scarce and you need to rent more pieces of land from other people. That is an expense. And you have to apply more of a labor force to work in those fields, another expense.

"Now if it happens that farmers who spend less on fertilizer and seed, with little pieces of land, have done better from good rains and they are reaching the next rainy season with a good amount of food, I will suffer. When that happens I cannot even sell a single bag of maize. Why? Because maize is then at a very low price. So, I am always hunting for high cost and high sales at high prices so I can continue to buy labor and inputs.

"It may look to you that I am prospering. But I am not. I am a pastor and I am a Christian, but I am living in an environment where I have to pay high costs to live and sustain myself in order to keep living into next year. I pay to rent land like an ordinary man. When I go to my fields I need someone to work for me like every other man. Although I am a pastor, the worker expects to be paid. The workers and the inputs are the same for me, so I may meet the same tragedy as any man. If I come down on my prices I will lose. I must match my selling price to labor and input costs. A person cannot eat money. This paper, this money, is only an exchange. The costs reflect our environment. If I don't' make a profit I can't succeed."

-Fieldnotes and transcribed recording, October 7, 2013

My experience working with Wexton Fulagombe sparked my interest in understanding the conflicts and cooperation between rural households and highlighted the complexity of the constraints facing farmers. Observing his decision to abandon his work with the irrigation scheme because it was unprofitable surprised me. In the early days of my time in Malawi, my naïve perspective viewed irrigation as an obvious solution to relying on a single rainy season for one's food security. I thought that if you can farm twice in a year, you should have twice as much food. By talking with and observing Wexton, the reality of the risks encountered by Malawian farmers' relying on costly inputs and a stable climate became increasingly clear. I had witnessed the boom and bust cycles of the irrigation scheme, seeing how they were influenced by short-term price changes in inputs and labor as well as by longer-term deforestation and changes in climate. Farmers without access to irrigation faced even greater constraints, relying on what many perceived to be shorter and more erratic rainy seasons and declining soil fertility.

These experiences, in the years leading up to my dissertation fieldwork, led me to study agricultural decision-making. Kasiyra, the pastor-farmer in the vignette above, came to my attention during a community census I completed in June of 2012. Like Wexton, he had experience working in other parts of Malawi as both a pastor and a foreman for road construction projects. I was interested in speaking with him after he told me that many of his farming practices were learned by observing the different behaviors of smallholders around the country during his days as a road builder. He had accumulated a list of best practices that guided his decision-making and investments.

During the census and in our in-depth conversations that followed, Kasiyra explained that he had fully abandoned the "local" seed in favor of expensive improved varieties of maize. It was common for him to comment on the uselessness of my "alternative" permaculture garden as he rapidly listed the various improved maize varieties and their specific response to different fertilizer applications and planting styles. He would tell me the local seeds were "finished" meaning that, although they had been adapted to the local environment over the last century, they were no longer a viable choice for Malawian farmers. In his experience, local varieties don't mature quickly enough to handle the shortened rainy season. They also don't respond as well as improved seeds to the inorganic fertilizer he deems a necessary requirement for his infertile soil. I would try my best to remain the objective scientist, but found myself defending the need for biodiversity and building up of microorganisms through the use of compost and manure. I consistently questioned him, asking why people no longer grew sorghum and millet as staple foods. Both were crops I had grown in Gowa with some success after hearing that *nsima* (hard porridge), which is now made with only maize, used to be made from these more drought-tolerant crops.

Kasiyra is always quick to point out that, in modern Malawi, a farmer needs cash to survive and that the only pathway to sufficient income was through "modern" farming of hybrids. Sorghum and millet had no market value beyond the few local women who use them to make beer. Further, sorghums and millets were risky to grow because they mature slower than maize. Now that maize dominates the landscape, the control of livestock is tied to its growing season. Once maize is harvested, the chief allows farmers to graze livestock freely, resulting in the trampling of later maturing crops.

The broader shift to hybrid maize and Kasiyra's specific preference for it echoes a common finding from my interviews and observations. Farmers consistently mention that while local maize is preferred by many for its taste and grain-to-flour ratio, it fails to produce sufficient yields for marketing. A need to enter the market and gain the cash necessary to purchase inputs for the following season leads many households to pursue a strategy that favors the use of improved seeds and inorganic fertilizer.

However, as in Kasiyra's story above, the success of this strategy at the local level is premised on there being winners and losers. Those with high yields need those with low yields to purchase their maize to make a profit. The "winners" need the "losers" to be in need of maize enough that they are willing to work for them (*ganyu)* in their fields. The excess harvest of the winners is used to pay their workers. If everyone has an excess, the labor supply disappears, the selling price of maize drops, and the farmers heavily invested in modern inputs fail to achieve the returns necessary to continue their current strategy.

When I returned to Galeta in summer of 2015, I again took the river bank path to visit Kasiyra in his field. This time I noticed him bent over, reaching into an old fertilizer bag. As I approached and he came into clearer view I could see that he was spreading manure on his field in preparation for the upcoming year (Figure 3.2). He laughed out loud when he saw me and said he'd finally been priced out of modern farming as the cost of fertilizer had spiked and his access to the fertilizer subsidy coupon had ceased.

Figure 3.2: Abambo Kasiyra speading cow manure in his garden in preparation for maize planting

<u>Coupon day</u>

Geoff and I started out the morning intending to follow-up with Rhoda since she had been unable to talk with us yesterday. I woke up when I heard him listening to music with Nafe in the *kitchen. They were boiling water for tea and mandazi (fried dough). After we ate, Geoff and I packed up our bags and filled our water bottles. I grabbed the clipboard and Geoff grabbed a fresh copy of the food insecurity survey for the interview with Rhoda.*

We took the short-cut to Gomonda, passing the bore hole. About 50m beyond the bore hole, we started to notice there were large groups of 10-15 people on the path in front and behind us. This was unusual as we'd only see one or two people on a normal walk to Gomonda. I asked Geoff if he knew if something was going on today. Was there a funeral? He had no idea, so we caught up to the group in front of us and asked. When we caught up, I noticed that Amayi Hara was with them so we went straight to her. She told us that the agricultural extension worker had passed the message around the Gowa area early in the morning that they were planning to distribute the fertilizer and seed subsidy coupons today.

When Geoff heard this he leaned close to tell me that we had to go back to the house. I argued that no, we had to go to the coupon distribution event. He looked at me, shook his head, and said of course we were going, but that he needed to get his father's ID card first. His dad was in Blantyre working and if he wasn't at the coupon distribution, or apparently if at least his ID card wasn't there, then Geoff's family wouldn't get a coupon.

We raced back to the house, after I took a minute to joke with Amayi Hara about whether or not mzungu could get a coupon. When we got back to Gowa, Geoff and Nafe searched for the ID card and I grabbed my camera. We were back on the road toward Gomonda which is the same road to Likhumbo, the location of the coupon program. It took about 30 minutes to reach Likhumbo. I was worried that Rhoda was going to be wondering where we were when we didn't show up for the scheduled interview. Geoff assured me Rhoda would not be doing any interviews today, but that she would also be in Likhumbo with everyone else from the area.

When we got to Likhumbo, it was unclear whether we were late or early. Some household heads formed long lines in front of their respective Village Headman. Others were seated in small, crowded clusters on the dirt around their Headmen, who sat on wooden benches. Each Headman had a stack of papers with them and their Secretary next to them. Geoff and I headed over to talk with our friends from Daudi village. I sat down next to a farmer we had interviewed only a few days before and then Geoff walked away to find Abambo Hara, the Secretary for Phonya, to hand over his father's ID card. Geoff told me that by giving Hara the ID he was sure that his family would get a coupon since his father had followed the proper registration process for Phonya village a few months before. Without the ID, the Chief and agricultural extension worker could argue that Geoff's dad didn't want the coupon anymore. It was imperative that Geoff get the coupon in the right hand to avoid forfeiting the discounted bags of inorganic fertilizer and seed that the coupon provided access to.

When Geoff returned we chatted casually with our friends from Daudi. We must have been there for about an hour when we first started to hear some complaints. The cluster of people we were with had shifted every few minutes to try to stay under the shade of a tree, but people were getting hot, tired, and annoyed that nothing was happening. The Village Headman had come and gone a few times, moving between us and the agriculture extension agents that were sitting in a group about 30m away. I could tell there was tension in the group when people started saying that the government had not sent as many coupons as they were supposed to. The Headman had registered the names of people a few months before and everyone who was registered expected their name to be on the list.

As the morning turned into afternoon the coupons finally started to be distributed. The residents of Daudi debated why certain names were left off of the initial registration. Some felt *that the Headman should declare that coupons should be divided so that everyone who was registered got an even portion. Ultimately, the list was cut and several farmers did not get the coupon they'd expected. Within our cluster of Daudi farmers, there were arguments. A few clusters away there was pushing and shoving, with a few men ultimately being restrained by others. I never saw Rhoda.*

-Fieldnotes, November 1, 2013

After finishing Peace Corps, I lived with Geoffrey Mlongoti and his family during each short-term visit and during the year of my dissertation fieldwork. Living with a family in the community is a daily reminder of the complex strategies rural Malawians employ in making a living. A Malawian smallholder is rarely only a farmer. Through the weeks, months, and years as a guest in Gowa, I watched as Geoff's family participated in activities representative of the mixed livelihoods of many rural households in Malawi.

When I first arrived to Gowa in 2000, Geoff's father was employed in Blantyre, Malawi's second largest city and a commercial center, as a radio engineer. In my first two years in the village, I only saw him twice. However, I was frequently reminded of the money he was sending from his paycheck. Bricks were molded and iron sheeting was purchased to repair and remodel the rural home. New plastic buckets would almost magically appear to replace the worn and leaky metal ones. School fees were paid for Geoff, his brothers Nafe and Phil, and for his sisters, each wearing their newly purchased school uniforms to class.

Geoff's mother maintained the rural home and managed all of the households' agricultural pursuits while caring for her three teenage sons and two young daughters. An older daughter also lived in the household with her two small children as well. I quickly took to calling Geoff's mother, *Amayi*, commonly relying on her cooking, bringing her grand total of household members to care for to 10, including herself. Amayi and *Abambo* (father) pushed their children to excel in school and to contribute to the household. From the time they were young boys, their sons learned the basics of radio repair and electronics by watching their father work, allowing them to contribute to the households' resources. It was common for them to be summoned to a neighbor's house to repair a diesel generator for a small fee. As the years passed, their skill set included taking apart cellphones and laptops and reconstructing them, installing solar panels, and repairing the broken boreholes that provide Gowa with potable water. Most recently, the knocks at the door are frequently people who want to create a profile page on Facebook.

As with the Mlongoti family, many residents supplement their harvests with various income generating activities. Some women brew beer that they sell at the weekly market. Others bake mandazi, trying to corner the markets on breakfast snacks for students as they arrive to Gowa Secondary School each morning. I've met a few men who travel to Mozambique for a few months each year to work in the mining industry. In the course of interviewing households for my dissertation, I encountered women whose husbands had migrated to Lilongwe or Blantyre to seek formal employment, like Geoff's father. The husbands of a few women have moved to South Africa to find jobs, sending money back every few months. Some women have not seen their husbands in person for years at a time.

Ganyu is another strategy employed by many households at some point in the year. Ganyu may include working for another farmer, helping with planting, weeding, harvesting, and preparing fields for the following season. Occasionally ganyu employment is provided by the government or NGOs. They hire rural people to repair the roads, digging out the accumulated soil that has filled the gullies and check-dams intended to reduce erosion. Ganyu is commonly paid in cash or food. Occasionally, over the last 10 years, it has been paid in small allotments of fertilizer and seed.

Gaining access to fertilizer and seed drives many of the decisions and behaviors of farmers in the Gowa area. While ganyu may help secure some miniscule amount of modern soil amendments and improved seeds, the focus of many smallholders in the area is ensuring that they receive the Fertilizer Input Subsidy Program (FISP) coupon before the planting season. The evolution of FISP is described in greater depth in later chapters, but the essential details are that each year the Village Headman registers the names of community members and submits those names to the agricultural extension worker. The extension worker sends the list up the bureaucratic chain to the central government. The list then boomerangs back to the village headman accompanied by coupons that are to be distributed to farmers. The coupons are redeemable at fertilizer and seed distributors, allowing the recipient to pay a reduced price for inputs. Officially, Headmen are supposed to register names of the most vulnerable, poorest, and food insecure households. However, as the farmers in the Gowa area explain, a list of 100 names may return less than 50 coupons. Many believe the reduction in coupons is due to corruption. They tell me that at each level, from the central government to the district government, to the agricultural extension worker, and all the way to the Headmen and their secretaries, that coupons disappear. I am unable to corroborate these stories and have no direct evidence of corruption, but I have witnessed those who expected to receive a coupon not actually receiving one. I've also witnessed a market for the buying and selling of coupons by recipients.

The FISP program is a defining feature of life in Malawi. Farmers plan their cultivation strategy around the expectation of receiving the subsidy coupon. They are angry when the don't acquire the coupon they feel they were promised when their name was registered. Those who do receive the coupon are further frustrated by the unreliability of the timing of the coupon distribution. The fieldnote excerpt above reflects the immediate frustration present at the event. More broadly, people in the Gowa area and throughout Malawi have no concrete idea of when exactly the coupon distribution day will occur.

The reality of FISP captures the overlapping risk and uncertainty faced by smallholders. It is a probabilistic event; people know that coupons will be distributed, but they don't know the exact day. It is also an uncertain event; a farmers' name is registered, but there is some unknown chance that they won't actually receive the coupon they expect.

Figure 3.3: Daudi Village Chief announcing names of households that will receive the Fertilizer Input Subsidy Program (FISP) coupon. November 1, 2013

Conclusions and beginnings

During the year of my dissertation fieldwork, I interviewed and surveyed 85 randomly selected households from eight communities in what is called the "Gowa Catchment Area," by the agricultural extension worker and employees of the Gowa Health Center. Gowa has been a second home to me for much of the last two decades. My conversations and observations, as well as my direct participation in daily life, centered on agricultural decision-making and intensification, risk, and food insecurity. My questions asked how the social interaction and seasonality shapes farmers' perception of food, how farmers make and discuss risky choices, and how the drivers of input investment ameliorate poverty and hunger.

The process of framing questions, collecting data, and completing the subsequent analysis and write-up of findings is obviously iterative when one completes long-term anthropological fieldwork. Each year that I've returned to Gowa, and each day I walk to a nearby village with Geoff, a pen, and a notebook, I encounter new information that leads to more interesting lines of inquiry. What is less obvious is what it takes to put all this information into a cohesive and somewhat comprehensive package.

Putting together the chapters that follow was a bit like putting together a puzzle, but with one important difference. Like most people, when I put a puzzle together I like to have the box top with the picture to look at nearby. In the case of this project, I had an idea of what the picture would look like. However, in this particular puzzle, the individual puzzle pieces in the box don't exactly fit together to make the "picture on the box."

The selected fieldnotes and analyses above, as well as the chapters that follow, do not come together to create a picture of a Malawian smallholder. They come together to show a variety of smallholders and the myriad ways in which they mix farming with employment, perceive risk, and perceive and mitigate food insecurity. As you read and interpret the data and analyses in the chapters that follow you may find that the various pieces in this "puzzle" of data could make any number of different pictures than what I present here. Anthropology as a discipline may be just that, interpretive puzzling.

CHAPTER 4

WAITING FOR GROWTH: DISPARITY AND THE DETERMINENTS OF GREEN REVOLUTION TECHNOLOGY USE IN RURAL MALAWI[1]

[1] Lanning, J. To be submitted to *Global Environmental Change.*

Abstract

Much of Africa was bypassed by the first Green Revolution resulting in limited intensity of use of agricultural technology by smallholder farmers. This research assesses the factors influencing adoption and intensity of Green Revolution technology – specifically, improved maize seed and inorganic fertilizer – among rural smallholders in the small landlocked African nation of Malawi. I hypothesize that the intensity of use of Green Revolution technology will be influenced by households' wealth and receipt of remittance, as well as input subsidy and credit access. I argue that this disparity is representative of smallholders' capacity for intense use of exogenous inputs. Beyond the economic predictors, the determinants of use intensity may differ between improved seed and inorganic fertilizer. I further hypothesize that the intensity of improved seed use will be more closely related to the production aims of households beyond yield maximization. Results suggest that differences in Green Revolution input use intensity is indicative of the heterogeneity and local-level economic and social inequality present in many rural communities

Introduction

In Samuel Beckett's *Waiting for Godot*, Vladimir and Estragon endlessly wait under a leafless tree for the arrival of someone named Godot (Beckett, [1956] 1988). Confusion and miscommunication define these characters. While the setting of the story is a barren road, suggesting the potential for an alternative to their present condition, the tramps are immobilized by the hope that Godot will inevitably appear. A reader, interpreting the text literally, may wonder why they fail to take the initiative of looking for Godot rather than aimlessly waiting in their circular absurdity. Similarly, the theme of waiting may describe the modernist reaction to the reoccurring question: why have the predicted outcomes of the Green Revolution largely bypassed Africa? Proponents of the African Green Revolution perpetually wait for increasing technology use to stimulate sustained agricultural growth, relieving the poverty and food insecurity of smallholder farmers (Evenson and Gollin, 2003). While waiting, they continue to seek an explanation for low levels of intensity of use of technology among those needing growth in agricultural productivity the most. However, the explanation may lie in exploring the paradox that technology may generate growth while simultaneously creating scarcity when the capacity to intensely use technology differentially benefits segments of society (Yapa, 1993). This study addresses this paradox by exploring the mechanisms driving differential use of agricultural technology by rural smallholders in Malawi.

Since its formalization in the late eighteenth century, the theory that population growth may outstrip available resources has been central to conceptual models for agricultural innovation. Where Malthus (1798) saw a limit on the potential for growth in food supply to meet demand of a growing population, Boserup (1965) famously argued that population pressure on arable land leads farmers to (1) employ more labor or (2) innovate with new technologies. The Green Revolution paradigm prioritizes a technological solution to the Malthusian crisis of limited growth in food availability relative to population pressure. The macro-scale objective of the Green Revolution is a marked growth in the production of grain yields via a technological package including enhanced agronomic practices, such as the use of inorganic fertilizer, and the cultivation of improved seed varieties (Khush, 2001). The technocratic agenda for combatting global poverty and hunger is broadly premised on the assumption that the value of increased yields outweighs the inherent cost of attaining yield-enhancing technology. The use of improved seed and inorganic fertilizer is intended to increase smallholder income through increased market integration. It aims to overcome food shortages resulting from demographic pressure having reduced the capacity for extending agricultural growth into virgin or marginal land (Roe, 1999; Breisinger et al., 2011). Both technologies are considered scale neutral, such that larger and smaller farms can gain equal benefit relative to farm size (Mosely, 2002). This technological solution to Malthusian crisis is driven by government policies that increase access to Green Revolution inputs (Mosley, 2002; Denning et al., 2009).

However, like other technological engines of industrial agriculture, inorganic fertilizer and improved seed, divorced from human labor and social relations, are not themselves productive (Hornborg, 1992; Yapa, 1993). Additional inputs of energy, from both humans and their environment, animate exogenous technology, turning potential into realized production. These technologies must yield enough to both reproduce themselves *and* support growth. In other words, seed and fertilizer technology must be renewable either in their ability to be replanted (seed) or their ability to be converted into subsequent seed and fertilizer for the following season through the sale of harvests. Otherwise, farmers must have previously accumulated significant material wealth or access to supplementary exogenous resources to afford these technologies in future seasons. Among rural Malawian smallholders, the focus of this research, the availability of and access to these supplements, such as remittances, subsidies, off-farm employment, access to arable land, and access to credit are unevenly distributed.

Aggregate indicators, such as GDP and national agricultural output, suggest reduction of poverty and food insecurity via Green Revolution technologies (Denning et al., 2009). However, disaggregated local-level measurements (Bezner Kerr, 2013) reveal that when rural inequality is high, national level agricultural growth is in fact less likely to result in poverty reduction than in greater marginalization of vulnerable subsets of society. Scholars contend that this inequality attenuates the productivity of the Green Revolution strategies (Negin et al., 2009). In essence, macro-solutions premised on Malthusian crisis narratives may further marginalize smallholders already influenced by micro-scale inequality (Dawson et al., 2015). Rather than continuing to wait for technological solutions to affect positive change – either through "top-down" policies to shape food and input prices (Ruttan and Hayami, 1984) or "bottom-up" responses to population pressure (Boserup, 1965) – it is necessary to first understand the effect of local-level inequality on the capacity for technological enhancement of production.

Measuring and understanding the determinants of the intensity of use of improved seed and fertilizer at the level of local communities already suffering from micro-scale economic and social inequalities may offer a window into closing the gap between expectations and realities faced by communities, when it comes to the rewards of Green Revolution technologies (Peters, 2004; Bates, 2005; Dawson, 2015).

A substantial body of literature focuses on the determinants of adoption and use intensity of agricultural technology both within and beyond Africa (see Feder et al., 1985). Scholars contend that, while population pressure, coupled with government policies that reduce input prices or control market prices of crops, may induce technological innovation broadly, the relationship between input costs and farmers' resource endowments (e.g., financial, human, and physical capital) plays a crucial role in determining adoption and use intensity (Binswanger and Ruttan, 1978; Pingali et al., 1987). In contrast, the priorities and preferences of farmers may better explain differential rates of adoption and use intensity. The divided aims of producing for both consumption and for markets may influence the adoption of technology among households facing climatic uncertainty, environmental constraints, limited food reserves, and constrained market opportunities (Turner and Ali, 1996).

In this article, I argue that we cannot explain the bypassing of Africa by the Green Revolution or the differential intensity of use of agricultural technology by smallholder farmers without first understanding the effect of smallholder heterogeneity and local-level economic and social inequality on the capacity for intense use of exogenous inputs. To this end, this research assesses factors influencing adoption and intensity of Green Revolution technology – specifically, improved maize seed and inorganic fertilizer – among rural smallholders in the small landlocked African nation of Malawi. I hypothesize that the intensity of use of Green Revolution technology will be influenced by households' wealth and receipt of remittance, as well as input subsidy and credit access. However, beyond the economic predictors, the determinants of use intensity may differ between improved seed and inorganic fertilizer. I further hypothesize that the intensity of improved seed use will be more closely related to the production aims of households beyond yield maximization (Smale, 2005). The age and education level of maize producers as well as the size of farming households may reflect differential preference for consuming traditional maize varieties and knowledge of new technology, thus determine improved seed use.

Research Setting

Agriculture is the most common livelihood in Malawi, contributing 90 percent of the national export earnings and 39 percent of GDP (Chinsinga et al., 2011). Maize dominates the farmed landscape, occupying 70 percent of agricultural land in Malawi (Sauer and Tchale, 2009). It is grown by 97 percent of smallholder households on farms averaging 1.12ha and accounts for 60 percent of the total caloric consumption for rural Malawians (SOAS, 2008; Ivanyna, 2015). The preferred staple for less than a century, maize production is presently synonymous with food security. Farmers routinely state that, "maize is life" (*chimanga ndi moyo*) (Smale et al., 1995).

High population density relative to arable land (2.3 persons per ha) constrains the potential of Malawian smallholders extending cultivation into virgin areas, contributing to food insecurity and low levels of productivity in the agricultural sector, particularly in the production of maize (Holden and Lunduka, 2012).

Agricultural technology, namely improved varieties of maize and inorganic fertilizer, is the central feature of the Malawian government's effort to achieve food security and raise incomes and yields among the 90 percent of the nation's citizens whose livelihoods annually rely on a single season of rain-fed cultivation (Smale et al., 1995; Chirwa, 2005; Denning et al., 2009; Ellis and Manda, 2012). Premised on the Green Revolution solution to a growing Malthusian crisis, the government has, in turn, attempted to induce an incremental increase in the use of improved seed and fertilizer through the Farm Input Subsidy Program (FISP). FISP is intended to provide under-resourced farmers with access to technology at a reduced price. Targeted producers receive two coupons entitling them to procure two 50kg bags of fertilizer as well as improved maize seed (open-pollinated or hybrid varieties) at a discounted price. Despite population pressure on arable land and the introduction of FISP, as well as evidence that agricultural technology may increase maize yields Denning et al., 2009), raises incomes, and reduces food insecurity in the population dense nation, the adoption and intensity of use of improved maize varieties and inorganic fertilizer in rural Malawi remains low (Kumwenda et al., 1997; Simtowe, 2006).

Sampling and Data Collection

This study was carried out in the Ntcheu District, central Malawi between January and December 2013. It is based on data collected through a structured questionnaire and participatory mapping of fields from a cross-section of smallholder farmers from eight communities. Data collection was completed in the national language of Chichewa using instruments field-tested in central Malawi between July 2010 and 2012. These analyses address data collected by the author and two Malawian enumerators who assisted with translation and field mapping.

A random sampling technique was used to select 85 sample farmers from an exhaustive census of 365 households from eight communities in the study area (Figure 4.1). Due to missing data, a total of 74 households are included in these analyses. Data collected during the structured interview included household demographic and socioeconomic characteristics of farming households as well as farm-specific variables, including the use of improved seeds and inorganic fertilizer as well as access to FISP. In addition to the measured variables of producers and their farms, participants, currently or ever using improved seeds, reported the year of improved seed adoption and the primary reason for initial use. The participatory mapping exercise was completed between January and March 2013, after the crops in participants' rain-fed fields had germinated and before harvesting began to increase the accuracy of locating field boundaries and observing planting portfolios. The total hectares of cultivated and fallow land managed by a household were measured using a GPS device by the author by walking the perimeter of each field as well as within fields to identify the boundaries of areas planted with different crops alongside the field owner.

Description of the study area and sample

Sample households in the study area manage an average of 1.18(±0.7) hectares of land and have an average household size of 4.4 (±1.7) members. The small average land holding is slightly larger than the national average of 1.12 ha (SOAS, 2008). Households in the study area face notable population pressure on arable land with 3.71 persons per ha. The major crops grown by sample households include maize, tobacco, beans, cassava, pumpkin, pigeon pea, tomatoes, and sweet and Irish potatoes. Maize covers 74% of the total area managed by sample farmers (64.18 maize ha/87.30 total ha). The altitude of agricultural fields in the sample ranges from 940 and 1060 m above sea level. The climate is semi-arid and agricultural productivity is greatest during a single rainy season between November and April.

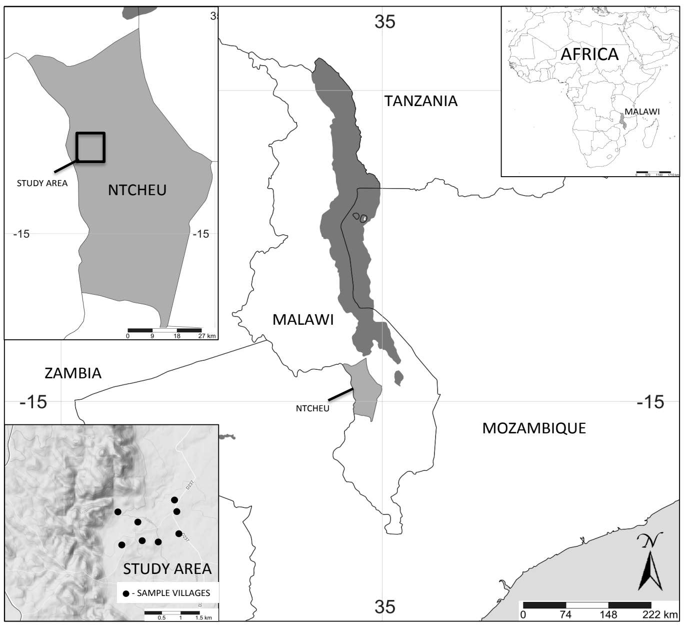

Figure 4.1: Map of the study area and sample villages in the district of Ntcheu, Malawi

Table 4.1 displays selected demographic characteristics of sample producers and their households discriminated by the total hectares of cultivated and fallow land held by households. During the 2012-2013 rainy season, study participants purchased an average of 137.1 kg (0 min, 590 max) of inorganic fertilizer, including both fertilizer purchased at the market rate and through the Farm Input Subsidy Program (FISP). Ideally, FISP targets resource poor farmers, providing them with a coupon to be redeemed at a local fertilizer and seed wholesaler for 50 kg of urea and 50 kg of NPK (Nitrogen-Phosphorus-Potassium) (Dorward and Chirwa, 2012). Area-specific recommendations for fertilizer application suggest farmers in the study area should apply 100 kg of NPK and 150 kg of urea per ha of maize (Benson, 1999). However, in this study fertilizer type is not defined.

Table 4.1: Sample household summary statistics discriminated by total ha of farmland

	Total area cultivated (ha)			
	0.0-0.74	0.75-1.49	1.50+	Total
# of HHs	21	34	19	74
Mean age of HH head	41 ± 19	44 ± 16	43 ± 12	43 ± 16
Mean # of HH residents	3.3 ± 1.7	4.3 ± 1.3	5.7 ± 1.5	4.4 ± 1.7
Mean years of HH head's formal education	4.8 ± 3.2	4.9 ± 3.4	7.6 ± 3.5	5.6 ± 3.5
Mean material asset score	4.4 ± 2.6	10.1 ±11.4	21.61 ± 16.19	11.41 ± 12.95
Mean total area cultivated (ha)	0.51 ± 0.16	1.10 ± 0.20	2.06 ± 0.64	1.18 ± 0.68
% of HHs in category w/ male head	48	71	100	72
% of HHs in category w/ credit access	24	53	68	49
% of HHs in category renting land	9	27	26	22
% of HHs in category w/ formally employed adult	19	32	26	27
% of HHs in category w/ informally employed adult	71	59	53	61
% of HHs in category receiving input subsidy coupon, 2012-13	57	50	47	51
% of HHs in category receiving remittance, 2012-13	10	27	21	20
% of HHs in category that were net maize buyers, 2012	48	29	47	39
Mean % of total cultivated area planted with non-maize crops	18 ± 18	21 ± 13	30 ± 21	22 ± 17
% of HHs adopting improved maize seed, 2012-13	86	91	95	91
% of HHs adopting inorganic fertilizer beyond FISP, 2012-13	64	94	100	91
Mean kg total fertilizer per maize hectare, 2013-13	155.66 ± 65.96	152.49 ± 104.40	182.93 ± 97.51	161.21 ± 92.90
Mean kg of unsubsidized fertilizer per maize hectare beyond FISP, 2012-13	32.38 ± 48.36	111.10 ± 117.76	148.54 ± 95.92	98.38 ± 105.65
Mean % of total maize area planted with hybrid, 2012-13	47	44	54	47

Values are percentages or mean ± standard deviation.
Note: Variables are defined below

Among the 74 sample households, 35 received the subsidy coupon and 80 percent of coupon recipients shared half of the subsidy (50kg of fertilizer) with another household in the community (not necessarily with another sample household). Of the remaining 39 households that did not receive the subsidy, 32 either received gifted shares of other people's or purchased small portions of the fertilizer received by another household in the community. Only seven sample households received neither the FISP coupon nor were shared or purchased a portion of another households' subsidy. Neither a households' material wealth nor the size of its landholding predicted receipt of subsidy coupons among sample households.

Seventy-six percent of sample farmers purchased fertilizer either in addition to a received or shared subsidy or in the absence of receiving the FISP subsidy coupon. Ultimately, 100% of sample households used some amount of inorganic fertilizer and 91 percent of households (n=67) dedicated some portion of their productive land to improved maize varieties in 2012-2013.

Empirical procedure and explanation of variables

Following Smale et al. (1995), the decision to use improved seed and inorganic fertilizer in Malawi may be characterized as a series of interrelated choices. Farmers first decide to adopt one or more technologies of the package. Next, they decide the extent to which they will allocate land to any improved maize variety they have chosen. Finally, they decide on the level of use per hectare of either improved seed or fertilizer, or both inputs. The intensity of use of improved seeds is, therefore, measured as the proportion of a households' productive agricultural land planted with maize that is devoted to improved maize. The intensity of use of inorganic fertilizer is defined as the amount of inorganic fertilizer applied per hectare of area planted with any maize variety.

Adoption studies commonly employ maximum likelihood estimation techniques including tobit (Adesina and Zinnah, 1993; Nkonya et al., 1997) and probit (Negatu and Parikh, 1999; Kaliba et al., 2000) models. These models are more appropriate than OLS for analyzing the adoption and intensity of technology use (Feder et al., 1985). Maximum likelihood models have a more discrete range of values. In the case of probit, the dependent variable is binary (0=no adoption, 1=adoption). For tobit models, the dependent variable may take any positive value but is censored, having a lower bound of zero (Kennedy, 1998).

Due to the nature of the dependent variable, different estimation techniques are used in the analysis of adoption and intensity of use. Commonly used is the Double-hurdle model, formulated by Cragg (1971), which assumes that the adoption and use intensity decisions are distinct and independent. The first hurdle is the adoption equation estimated by using a probit model, where 1 means the respondent is reporting improved seed or fertilizer intensity greater than 0, and 0 means otherwise. The second hurdle involves an outcome equation, which commonly uses a tobit model to determine the intensity use of the technology. In this stage, only observations from farming household heads reporting positive technology use are included. However, as described above, 91 percent (n=67) of sample farmers adopted improved seed and 100% used some amount of fertilizer. Therefore, due to the ubiquitous adoption of fertilizer and near complete adoption of improved seed and the small sample size, the first hurdle is not modeled.

To examine the factors influencing the intensity of use of improved seed, a fractional response probit model was employed due to the proportional nature of the dependent variable (proportion of maize area planted with improved maize). A Tobit (or censored regression) model was used in the analysis of the inorganic fertilizer intensity per hectare of maize area, as fertilizer use may not take on a negative value.

Explanatory variables influencing intensity of use of improved seed and fertilizer

The explanatory variables used in this study are suggested by the literature on adoption and intensity of use of agricultural innovations (Feder et al., 1985; Smale et al. 1995; Chirwa, 2005). The variables may be classified into three broad categories: (a) producer characteristics (age, gender, and education level of the household head, household size); (b) farm characteristics (total farm hectares, proportion of farmland planted with improved maize seeds, intensity of fertilizer use, renting farmland); (c) economic characteristics (material wealth, receiving remittance, formal and informal employment, access to credit, and receiving farm input subsidy). Expected signs for the effect of each explanatory variable on the intensity of improved seed and fertilizer use are presented in Table 4.2 and are described in detail below.

Table 4.2: A priori expectation of explanatory variables on use intensity

		A priori expectation of use intensity	
Variables	Variable definition and measurement	Seed	Fertilizer
Improved seed/ha	Proportion of maize area planted with improved maize varieties		+
Fertilizer/ha	Kg of inorganic fertilizer applied per hectare of maize	+, -	
HH size	Number of people who sleep and consume meals in HH	+	+
Education	HH head's years of formal education	+	+
Wealth	Weighted sum of seven material assets owned by the HH	+	+
Total area	Sum of HH's cultivated and fallow land in hectares	+, -	+
Gender	Gender of HH head (Binary 1 if male)	+	+
Credit	Access to credit from bank or club (Binary, 1 if yes)	+	+
Rents land	HH rents land for cultivation (Binary, 1 if yes)	+	+
Formal Job	HH head received consistent monthly pay (Binary, with 1 if yes)	+, -	+
Informal job	HH head engages in short-term labor (ganyu) (Binary, 1 if yes)	-	-
Remittance	HH received a remittance from non-HH resident (Binary, 1 if yes)	+	+
FISP coupon	HH received or was shared the FISP coupon (Binary, 1 if yes)	+	+, -

Note: Shaded variables act as both dependent and independent variable in the models that follow

Producer characteristics

In this study, both age and education level of the household head may be indicative of farming experience. They are expressed respectively as years of age and the number of years of formal education the household head has completed. Agriculture is a required subject in government secondary schools in Malawi. Gender of the household head is captured as a binary variable with gender taking on a value of 1 if the head is male. Household size is measured as the number of people who both sleep and regularly consume meals in the sample household.

Education is commonly expected to positively impact the adoption of agricultural technology (Wozniak, 1984; Feder et al., 1985; Doss et al., 2003). Feder and Slade (1984) model the decision to adopt agricultural technology on human capital and land constraints, suggesting that farmers with more education have greater knowledge of improved farming techniques and a higher probability of rapidly adopting technology. In contrast, Zeller et al. (1998) and Green and Ng'ong'ola (1993) do not find a significant association between education level and technology adoption in Malawi. Doss and Morris (2001) further note that improved seeds are a relatively simple technology, requiring little deviation from the normative planting behaviors of smallholders. However, inorganic fertilizer requires detailed knowledge of the response relationship of different seed varieties and to various application rates, as well as knowledge of the appropriate timing of fertilizer application. In addition to education, age may be expected to influence the probability of technology adoption and use intensity. Older farmers may have a greater likelihood of favoring existing technology over innovation (Chirwa, 2005). Further, the use of technology, specifically fertilizer application, may increase seasonal labor demands on a household. Labor shortage among smaller households may be expected to decrease the capacity for intense fertilizer use (Feder et al., 1995), while larger households may be more likely to adopt and use fertilizer technology more intensely (Zegeye and Haileye, 2001; Doss et al., 2003).

Farm characteristics and factors of production

The variable for total farm size, measured in hectares, includes farmers currently cultivating land, both owned and rented, and any fallow land controlled by a household but excludes land a household may have rented out. Renting land is included as a binary explanatory variable in the intensity of use models. Twenty two percent of sample households rented farmland in the study area. Previous studies suggest that tenure insecurity among poorer farmers may reduce technological innovation (Faure 1995), while farmers renting additional land are more likely to employ agricultural technology more intensely (Chirwa, 2006).

As previously described, the intensity of use of improved seeds is measured as the proportion of a households' total maize area planted to improved varieties and the intensity of use of inorganic fertilizer is defined as the amount of inorganic fertilizer applied per hectare of maize. While production is greatest when seed and fertilizer technology are adopted as a package, Chirwa (2005) notes that adoption and use rates of each are likely to differ among smallholders in Malawi. Zeller et al. find that although yields of improved maize are higher than those of local varieties, local maize continues to be cultivated by half of Malawian households. Smale (1995) and Takane (2008) note that local maize varieties are commonly preferred for consumption, helping to explain the allocation of land area between improved and local seeds. Local maize seed is also preferred for its storability and pest resistance, as well as its high grain to flour ratio relative to improved varieties (Smale, 1995).

Economic characteristics

Feder et al. (1985) note that the desire to use technology may be equally high between small and large farms, but the capacity of smaller farms to intensely use inputs may be limited by financial constraints. Adesina and Djato (1996) adds that households with limited income and access to credit have a lower capacity to purchase costly inputs and are less likely to accept the downside risks of agricultural technology. In contrast, off-farm household income may offset credit constraints allowing a greater capacity to accept the risk associated with technology use (Feder et al., 1995).

Non-farm income may be derived from multiple sources. In this study, I examine three sources of households' non-farm income as binary variables taking on a value of 1 if accessed by the household. First, I measure whether a household head is formally employed. For the purpose of this study, formal employment includes working in the study area for the government as a teacher, policeman, health professional, or agricultural extension worker. Also included in formal employment are household heads regularly buying and selling produce, timber, fish, or other goods or who are employed as groundskeepers for the local Christian mission station.

The second binary variable measures a household heads' informal employment working on daylong or short-term arrangements for another household in the study area or on small-scale development projects such as road repairs. This category of employment, locally referred to as *ganyu,* may draw a farmer away from working on her own land at critical moments in the farming cycle influencing the effectiveness of technology aimed at improving agricultural productivity (Moseley, 2000).

The third source of non-farm income measures whether a household has received a remittance in the last 12 months from a relative not residing in the household or local community. Relatives living in commercial centers such as Lilongwe, Blantyre, or Mzuzu primarily sent remittances received by sample farmers. Mochebelele and Winter-Nelson (2000) examined the impact of labor migration on efficiency in agriculture, finding that remittances may facilitate production rather than substituting for subsistence or market production.

Household material wealth was calculated by transforming the total number of units of seven assets owned by a household into a Household Asset Score (HAS). Household assets measured for these analyses include bicycles, radios, solar panels, cell phones, television, batteries, and plastic buckets. HAS is calculated by assigning each item from the asset list a weight equal to the reciprocal of the proportion of study households who owned one or more of the item. The weighted value is then multiplied by the total number of units of the asset owned by the household and the products are summed to derive HAS. The process of weighting assets is based on the assumption that the higher an items' monetary value, the less likely a household is to own it (Morris et al., 2000).

HAS is a proxy of household wealth and consciously omits three important variables arguably related to rural Malawian wealth: 1) the number of livestock owned by a household, 2) the quality of materials used in home construction, and 3) the value of land controlled or owned by a household. The HAS household wealth proxy was previously compared with the total monetary value of the same assets owned by households in rural Malawi (Morris et al. 2000). Morris found the HAS was highly correlated with the total value of assets when both variables are expressed on a log scale ($r=0.83$, $p<0.001$). When livestock were included in both the HAS and the valuation of assets, the correlation was notably reduced ($r=0.53$) suggesting that including the limited management and ownership of livestock in a measurement of household assets reduces the reliability of the HAS overall in the context of rural Malawi (Morris et al.

2000). While the housing quality may be correlated with wealth status (Adams et al. 1997), homes in the study area are built using a varying combination of found and purchased materials (e.g. mud, fired bricks, grass thatching, corrugated metal sheeting). Determining the monetary value of a home is further complicated by the lack of a formal housing market in rural areas from which home values may be derived. Determining the value of land holding is complicated by variability in the quality of land, including productive natural capital such as timber or water access for irrigation, as well as variability in soil structure and soil health. While monetarily valued land transactions have occurred in the study area, they are rare.

Two additional binary variables measure a participants' receipt of the seed and fertilizer input subsidy coupon (FISP) for the 2012-13 cultivation season (1 if coupon was received or a portion of the inputs derived from the coupon was shared with the participant) and whether households reported having reliable access to credit from a bank or organized credit club.

Results

Descriptive statistics

Table 1 displays selected demographic characteristics of sample producers and their households discriminated by the total hectares of cultivated and fallow land held by households. These measurements reveal some of the disparities present among smallholders in the study area. Sample households with smaller landholdings tend to have fewer material assets and resident members, and a higher probability of being headed by a female with fewer years of completed education. These small landholders have a lower rate of formal off-farm employment and a higher rate of informal employment, as well as constrained access to credit in comparison to medium and large landholders.

The sample mean use intensity of unsubsidized inorganic fertilizer is 98.38 kg/ha. When examining fertilizer use intensity by farm size it is clear that households cultivating smaller areas use fertilizer less intensely (F=7.67, p=0.001). The sample mean measurement of intensity of use of improved seed (percent of maize area planted with improved maize) is 47 percent. The difference between the mean proportion of area planted to improved maize for households between landholding size categories is not significant (F= 0.58, p=0.5624).

Improved seed adoption

Figure 4.2 displays farmers' stated reason for the initial adoption of improved maize seed varieties. The results show the proportion of the 72 ever-adopters in the sample stating each listed reason for the use of improved maize. Fifteen percent of farmers described observing both higher yields and greater wealth of farmers using improved varieties as the reason for initial use of improved maize. The dominant reason for improved maize adoption among sample farmers was the potential for higher yields. The next most frequently stated reasons for adoption of improved maize were the traits of early maturity and drought tolerance. The earliest adopter reported using an improved maize variety in 1970 and two farmers report experimenting with improved maize for the first time in 2012, the year of the study. Two farmers stated that they have never attempted to plant improved maize. Three farmers planted improved seeds only once with the intention of taking advantage of its early maturity in order to sell it before other households had begun harvest. However, each felt the improved maize spoiled quickly and discontinued planting it after only one year.

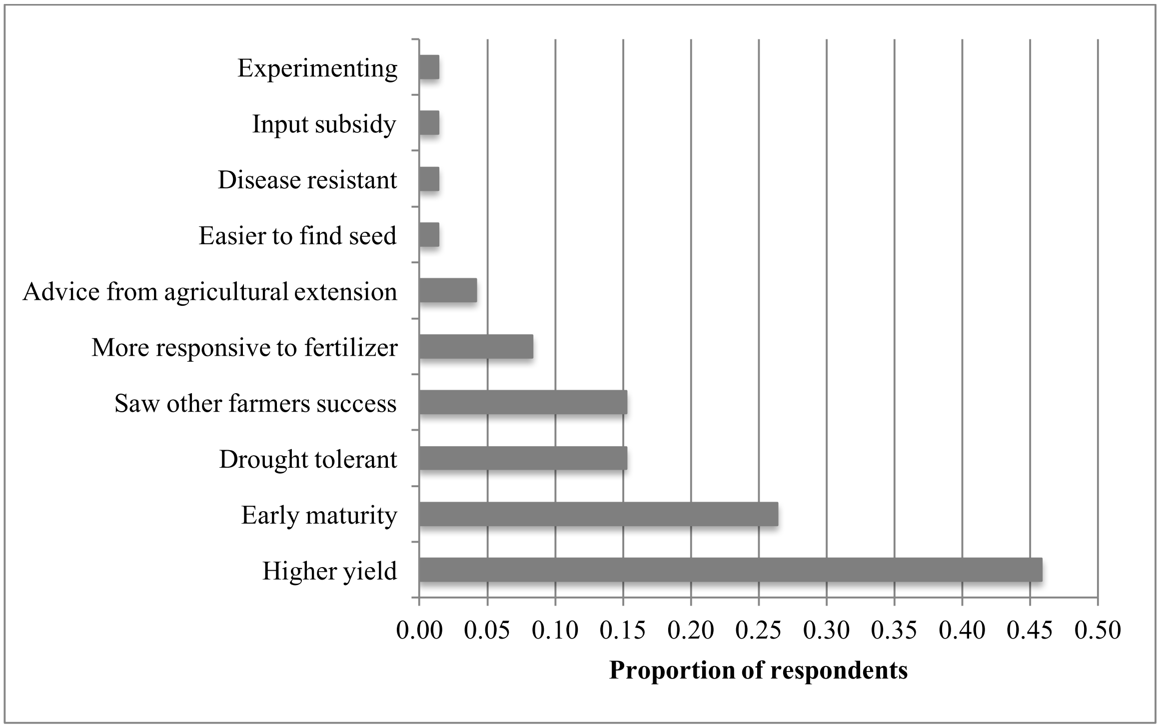

Figure 4.2: Reasons for adopting improved maize varieties (n=72 ever-ever adopting respondents)
Note: Two sample respondents have never used improved seeds.

Intensity of use

Table 4.3 presents the fractional response results assessing the predictor of intensity of use of improved maize varieties. Model 1 displays the marginal effects of all measured explanatory variables. As expected, access to exogenous sources of financial capital, including credit and remittances received from non-resident family members, is significantly associated with larger proportions of maize area planted with improved seed. However, households' material wealth has a remarkably small and negative effect on improved seed use intensity.

The level of education of the household head is associated with a significant but small increase in use intensity of improved maize. A positive association exists between an increase in the number of household residents and an increase in improved seed use intensity. Interestingly, the amount of fertilizer per maize hectare is not significantly associated with the proportion of land planted to improved maize suggesting that the decision to use improved seeds intensely is not associated with fertilizer use intensity. The results effectively indicate that larger households with more educated heads with access to credit, who rent land and receive remittances plant a greater proportion of their area in improved maize varieties with small tendency to decrease fertilizer inputs.

Table 4.3: Factors affecting the proportion of maize area planted with improved maize varieties

Dependent variable	Fractional Response Probit Model Proportion of maize area plant with improved varieties					
	Model 1			Model 2		
Explanatory variables	APE	Sig.	p-value	APE	Sig.	p-value
Age	.00094		0.715			
HH size	.07930	***	0.001	.06731	***	0.001
Education	.02347	**	0.047	.02255	**	0.033
Wealth	-.00346		0.270	-.00781	**	0.002
Total area	-.05038		0.521			
Gender	-.01545		0.879			
Credit	.16415	**	0.022	.16348	**	0.015
Rents land	.15369	**	0.041			
Formal Job	.02024		0.788			
Informal job	.09317		0.245			
Remittance	.23964	***	0.003	.22257	***	0.008
FISP coupon	.07341		0.274			
Fertilizer/ha	-.00073	*	0.054			
Number of observations	74			74		
AIC	1.303			1.129		

Note: *** P<0.01, ** P<0.05, * P<0.10

A backward-selection model (2) retained household size, education level, material wealth, credit access, and receipt of remittance, each having positive marginal effects. This suggests that the proportion of maize area planted with improved varieties is greater among larger households whose head of household is more educated. Access to exogenous source of financial capital, credit and remittances, further increases the area devoted to improved maize.

I further evaluated a possible source of bias that could have resulted in spurious correlations. It is plausible that the inclusion of the few farmers who stated a specific reason for not using improved seeds could result in inflated negative correlations. I therefore repeated the analyses after excluding the five farmers who reported either not wanting to plant improved seeds or that they had previously adopted improved seed but found them ineffective. The conclusions drawn from the original analyses were unaffected and the same explanatory variables were identified by backward selection. The results, therefore, appear to be robust in relation to the exact analytical methods and the quality of the data used. In no case did the addition of the five non-adopters improve the fit of the model, suggesting that household size, education level of the household head, material wealth, access to credit, and receipt of remittance were sufficient to explain the proportion of maize area planted to improved seed.

Table 4.4 presents the tobit regression results assessing the predictors of intensity of use of inorganic fertilizer, both subsidized and fertilizer purchased at retail prices. The complete model (1) of use intensity of inorganic fertilizer demonstrates that both material wealth and renting additional farmland have a significant positive association with greater intensity of fertilizer use. The proportion of land allocated to improved maize seeds has a negative, but non-significant, influence on both intensity of use of inorganic fertilizer. The negative sign of the APE is an indication that farmers allocating more land to improved maize varieties use marginally less fertilizer per hectare. Thus, the intensity of use of inorganic fertilizer is not significantly influenced by the intensity of use of improved maize seeds.

Table 4.4: Factors affecting the use intensity of inorganic fertilizer

	Tobit Model					
Dependent variable	Kg inorganic fertilizer/ha					
	Model 1			Model 2		
Explanatory variables	APE	Sig.	p-value	APE	Sig.	p-value
Age	.21437		0.711			
HH size	1.04498		0.871			
Education	.77490		0.704			
Wealth	2.99987	***	0.000	3.60471	***	0.000
Total area	-18.89716		0.191	-25.51737	**	0.028
Gender	-26.25994		0.123			
Credit	10.74539		0.504			
Rents land	59.97180	***	0.007	62.20758	**	0.019
Formal Job	-7.73074		0.669			
Informal job	-24.85328		0.185			
Remittance	4.57311		0.838			
FISP coupon	-5.76232		0.695			
Proportion Impr. Maize	-9.65193		0.757			
Number of observations	74			74		
Pseudo R^2	0.0420			0.0366		

Note: *** P<0.01, ** P<0.05, * P<0.10

A backward- selection model (2) retained wealth and land rental, each having positive marginal effects. In Model 2, and increase in households' total hectares of cultivated and fallow land negatively impacts the fertilizer use intensity.

It is important to note that the sign on the APE for the variable capturing the receipt of the FISP coupon is negative, suggesting that receiving FISP reduces the intensity of fertilizer use among sample farmers. Therefore, I further estimated the tobit model (Table 4.5) with the intensity of use of non-subsidized, purchased fertilizer as the dependent variable to disentangle the affect of FISP on fertilizer use intensity. To create this variable I first subtracted the kilograms of subsidized fertilizer received by a household from the households' total fertilizer and then divide by the total maize hectares.

Table 4.5: Factors affecting the use intensity of *non-subsidized* inorganic fertilizer

	Tobit Model					
Dependent variable	Kg Non-subsidized inorganic fertilizer/ha					
	Model 1			Model 2		
Explanatory variables	APE	Sig.	p-value	APE	Sig.	p-value
Age	.48633		0.406			
HH size	6.92806		0.222			
Education	1.76783		0.520			
Wealth	2.20602	***	0.006	3.70231	***	0.000
Total area	9.97630		0.457			
Gender	-6.86714		0.730			
Credit	32.39001	*	0.057			
Rents land	66.57950	***	0.003	62.76014	***	0.008
Formal Job	3.47597		0.847			
Informal job	-20.50219		0.267			
Remittance	30.28603		0.179			
FISP coupon	-9.33479		0.568			
Proportion Impr. Maize	-40.81665		0.109			
Number of observations	74			74		
Pseudo R^2	0.0656			0.0525		

Note: *** P<0.01, ** P<0.05, * P<0.10

A comparison of the results of Model 1, between Table 4.4 and Table 4.5, demonstrates a few potential influences of FISP on fertilizer use intensity. While not significant in association, the marginal effect of age, household size, education, wealth, credit access, and receipt of remittance on use intensity is reduced. Further, the marginal effect of total farm size and employment are reversed.

In the backward selection model, the direction of the relationship and marginal effect of wealth (APE=3.702318, p=0.000) and renting land (APE=63.76014, p=0.008) remain similar to the previous results (see Table 5 Model 2 for comparison). However, total land is no longer significantly associated with fertilizer use intensity.

While the explanatory variables for formal and informal employment do not significantly impact the intensity of fertilizer use among sample households in the tobit model, a Wilcoxon Rank Sum test indicates that those who participate in informal day labor use significantly less fertilizer per hectare (median=122.85 kg/HA) than those who are not employed as day laborers (median=201.61 kg/HA), (Z=2.94, p=0.0033).

Discussion

By disentangling the determinants of technology use intensity, this study highlights the polarizing potential of agricultural technology on rural smallholders in Malawi into asset rich households and those with limited capacity to follow a technological pathway to growth. Results of this study reveal that Green Revolution technology is generally used more intensely by sample farmers with larger households who are 1) wealthier, 2) more educated, 3) able to access credit, 4) receiving a remittance and 5) able to cultivate larger areas. Additionally, models demonstrate that the intended purpose of FISP differs from the reality. These analyses suggest that FISP does not significantly increase the intensity of fertilizer use among sample farmers. This may be an artifact of redistribution of subsidized inputs, such that when the expected beneficiaries share or sell portions of the subsidy package, the effectiveness of FISP is muted.

In comparison, the intensity of use of improved maize seed and inorganic fertilizer by farmers is associated by distinctly different factors. These results demonstrate that human capital and access to exogenous resources that loosen financial constraints, such as remittance and credit, are associated with using improved seed more intensely. In contrast, the intensity of use of inorganic fertilizer is significantly associated with households' material wealth, with evidence suggesting that those who rent land apply more fertilizer per hectare. Further, while inorganic fertilizer and improved seeds are distributed as a packaged input with the intention of benefitting each other, these models suggest that in reality the intensity of use is unrelated.

These results may be looked at from multiple perspectives. First, from the perspective of demand, increasing domestic fertilizer prices coupled with currency devaluations and high inflation rates mean that vulnerable smallholders are often unable to purchase the recommended dose of inorganic fertilizer (Uttaro, 2002). Although the fertilizer market is liberalized, few private traders operate in rural areas, leaving the bulk of the fertilizer supply to be handled by parastatal institutions, resulting in higher retail fertilizer prices, thus reducing use intensity for poorer farmers (Tchale et al., 2004 p.4). The evidence of lower levels of intensity of fertilizer use among relatively more impoverished households is not a startling finding. As Chirwa (2006) finds, it may not be economically efficient for sample smallholders with smaller areas of cultivated land to use fertilizer with higher intensity. The relationship between renting land and more intensely using fertilizer is less straightforward. Efforts to more intensely use fertilizer may reflect renters' concern that improving both soil structure and long-term soil fertility are labor and capital-intensive risks (Chirwa, 2006). If a landowner perceives improvements in soil fertility they may reclaim the area, thus renters look to fertilizer as a short-term yield maximization strategy directed toward generating commercial returns.

In contrast, taking Sen's (1981) perspective, farmers' capacity to intensely use improved seed more broadly reflects not only wealth, but also the full bundle of endowments held by households. Thus, households coping with chronic poverty and previous food shortfalls with an inability to enrich their resource base through credit and remittance are further marginalized. That human capital is associated with technology may be expected in light of the fact that seven institutions released a total of 43 maize seed varieties between 2000-2009 (Banda et al., 2010 p. 33). While not all seed types are equally available to farmers in all regions of the country in all years, the pace of seed development presents significant financial and cognitive costs. Smale et al. (2005) found that the mean area devoted to improved varieties reflects strategy of growing local maize varieties for consumption and improved varieties for the traits of early maturity and higher yields. Early maturing improved maize acts to smooth consumption shortfalls as households wait for traditional varieties to mature. Further, when potentially higher yields from improved maize are realized, harvests may be sold or used to pay ganyu labor. The results of this study suggest similar reasons for improved maize adoption.

As is the case among sample farmers in this study, Ricker-Gilbert et al. (2014) have suggested for areas with high population density that agriculture may no longer be a viable livelihood for under-resourced farmers. This proposition makes sense when these determinants of technological intensification are considered in relation to rising cost of inputs (Denning et al., 2009), shrinking of landholdings (Snapp et al., 2014), and shifting of farming strategy from income generation towards securing a minimally sufficient maize harvest through increased monocropping (Ricker-Gilbert et al., 2014).

The approach taken in this study demonstrates how economic inequality may suppress and distort smallholder strategies for achieving growth. Barrett and Carter (2000) offer a useful frame for interpreting the relationship between inequality and technology use: “While it is often recognized that poverty breeds insecurity, the reverse is also true. Insecurity breeds poverty by suppressing and distorting strategies of accumulation by the poor.” (p.4). Informal labor, or ganyu, is a striking example of the marginalizing effects of economic inequality on agricultural technology driven growth. Malawian households suffering from previous food shortage and chronic economic and land constraints, typically engage in short-term low-return employment in the fields of other farmers (Whiteside, 2000). Low wages or payments in food coupled with ganyu detracting labor from farmers’ own cultivation, suggests that the polarization between vulnerable and wealthy farmers is exacerbated by informal employment arrangements (Mosely, 2000). While informal employment was not a significant determinant of technology use intensity among sample farmers, those engaging in ganyu use significantly less fertilizer overall and households with smaller landholdings disproportionally engage in ganyu labor.

In short, the Green Revolution pathway to growth is like the classic chicken-and-egg scenario. Which comes first, the technology use or the resource endowments? Although incremental growth over time is the aim of inducing the use of Green Revolution technology, the differential access to exogenous supplementary resources may further marginalize the most vulnerable households in rural Malawi.

Conclusion

This study was undertaken to identify the key factors in the adoption of improved maize seed and inorganic fertilizer as well as the intensity of use for each technology among a rural Malawian smallholders. Descriptive statistics and models unsurprisingly show that material wealth is the key factor determining the use of inorganic fertilizer. Those who have the ability to accumulate household assets likely have enough cash or ability to liquidate assets for the purchase of fertilizer at the non-subsidized price. Further, renting land plays a significant role in fertilizer use intensity. Those renting land distribute wealth to other members of the community; however, renting also consolidates landholdings under the temporary control of the wealthiest farmers with the greatest capacity to intensively use fertilizer. While beyond the scope of this study, this suggests that over time, the benefits of increasing farm sizes for the wealthiest farmers may lead to net economic loss to those renting out land. In contrast, improved seed use reflects the divided aim of producing for subsistence, early maturity, and income generation and is driven by human capital and access to exogenous resources such as credit and remittances. The lack of association between wealth and seed use may further reflect the practice of recycling hybrid seeds for multiple seasons. While fertilizer is an annual purchase, seed purchases may be less frequent. While beyond the analysis of this study, the relationship between remittances, credit, and improved seed use suggests that an exogenous influx of cash may require surplus yields to send to urban relatives or to repay loans.

Macro-indicators of the effectiveness of Green Revolution technologies are commonly cited to promote poverty reduction and reduce food insecurity. This micro-analysis suggests that the outcome of induced technology use in communities with human, natural, and economic inequality may be further entrenchment of disparities in wealth and yields as resource constrained households are also those least capable of intensely using inputs.

Green Revolution policies continue to be foundational in the Malawi governments' strategy to achieve agricultural growth and reduce poverty and food insecurity among rural populations (Dorward and Chirwa, 2012). The positive moments of growth such as 2006, when aggregate yield increases reduce reliance on the importation of maize, have been heralded as the "Malawi Miracle" (Bourne, 2009). Proponents stress that, with more donor and government on subsidies to induce an incremental increase in technology use, "In time, stimulating agricultural productivity will likely increase commercial activity in rural areas and extend new opportunities for agricultural input suppliers" (Denning et al., 2009 p.6). However, for the most vulnerable farmers, time may be an enemy rather than an ally (Barrett and Carter, 2000).

The Green Revolution paradox may continue to exist as long as macro-policy is driven by yield maximization while household decision-making prioritizes achieving food security through diversification and risk reduction rather than maximizing output and incomes (Smale et al., 1995). Returning to Beckett ([1956] 1988), the confusion driving the endless wait for Godot induces the main characters to continue their unsettling life of mediocrity. Just as Vladimir reminds Estragon that the "inspiring prospects" of an alternative strategy must be ignored and that they must persist in their waiting, the wait for sustained economic growth from Green Revolution technology continues in Africa. Yet, in this persistence, the differential capacity to conform to growth strategies founded on costly and complex technology may create scarcity and exacerbate local economic inequity.

By moving beyond the macro-growth indicators of Green Revolution proponents and exposing these systemic differences in use intensity at a micro-scale, this study informs the design of effective policies to improve agricultural production that are sensitive to both the differential capacities for innovation and diverse motivations of marginalized farmers living in resources stratified communities.

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CHAPTER 5

"FARMING AS GAMBLING": A MIXED METHODS ANALYSIS OF MALAWIAN FARMERS' ATTITUDES TOWARDS AGRICULTURAL RISK[2]

[2] Lanning, J. To be submitted to *Economic Anthropology*

Abstract

Farmers face an annual choice to purchase expensive inputs to mitigate both probabilistic risk and unmeasurable uncertainty. In this study, I synthesize the quantitative analysis of a multi-round risk experiment with qualitative narratives from 85 households in rural Malawi to examine how farmers choose between a set of risky prospects and explain their choices. Experimental results reveal that farmers choose to spend money to reduce outcome variability and that outcome history (previous win vs. loss) influences subsequent choice in sequential lotteries. Participants perceived the similarities between the experiment and real farming decisions, where people make investment choices to reduce risk of crop failure. Post-experiment discussions reveal that farmers tend to ignore the amounts they spent to reduce risk in the game, so that they confuse net rewards with gross rewards. This suggests that farmers may base real-life agricultural investment decisions on successes and failures in previous years without accounting for the costs of yield enhancing technology.

Introduction

Agriculture is central to achieving sustained economic growth and food security in sub-Saharan Africa, where it is the primary source of both employment and subsistence (Johnson, 1990; FAO, 2000; Ehui and Pender, 2003). Agriculture is also a risky and uncertain enterprise. The essential nature of farming entails making choices in the face of repeated encounters with risk and uncertainty, ranging from volatile input costs and market prices to erratic rainfall patterns and changing technology, which together impact yield. As this dynamic process determines agricultural output, farmers form attitudes toward risk and uncertainty, and beliefs about their expected return on investment (Hill and Viceisza, 2010).

Among smallholders in sub-Saharan Africa, increasing population pressure and declining soil fertility have resulted in an increased demand for food, creating significant challenges for farmers who face a high degree of chronic poverty and annual income uncertainty (Timberlake, 1990; Pretty, 1995; Barrett et al., 2001, Heady and Jane, 2014). With population growth exceeding commensurate gains in agricultural yields (World Bank, 1996; Ray et al., 2013), the combined impact of erratic rainfall, degraded soils, and stagnant economic growth paints a risky and uncertain picture of sub-Saharan Africa's agricultural future. While the full impact of climate change remains uncertain (IPCC, 2014), farmers relying largely on adequate rainfall are particularly vulnerable to the projected extreme weather events and seasonal anomalies that place stress on water resources (UNECA, 1999; Washington et al., 2006; Li et al., 2009).

For some, hope for increasing agricultural productivity springs from increasing the use of inorganic fertilizer and improved seed varieties, perceived to be the requisite pathway to combat this risky and climatically uncertain scenario (Bourlag, 2000; Denning et al., 2009). Quinones et al. (1997) argue that "mineral fertilizers, when properly used, are not only beneficial for productivity enhancement but also are environmentally friendly by permitting production on the same land, and thus prevent the migration of farmers to marginal soils in search of plant nutrients" (p. 93). However, over the last half-century, low adoption rates and low intensity use of yield enhancing technology suggest that the innovations of the Green Revolution have bypassed sub-Saharan Africa (Evenson and Gollin, 2003; Morris, 2007; Sanchez, 2015).

A commonly cited explanation for the uneven and limited use of agricultural technologies in sub-Saharan Africa is that farmers are risk averse decision makers, preferring options with lower average outcomes but less variability when selecting between risky prospects (Feder et al., 1985; Cornejo et al., 2002). Researchers have explored the influence of farmers' attitudes toward risk on the use of yield enhancing technology using experimental economics (Binswanger, 1980; Giné and Yang, 2007), researcher-led and participatory farm trials (Kamanga et al., 2010), and econometric analyses of risk preference models (Smale et al., 1995; Chirwa, 2005; Simtowe, 2006). These varied approaches, as well as the results presented in chapter two of this dissertation, cite resource endowment and access to credit as pivotal factors for explaining farmers' limited adoption of agricultural technology.

While the constraints on intensification may be material, choosing to adopt technology and determining the intensity of use in the face of risk and uncertainty is also cognitively costly. Shifting input and output prices, variable climates, interaction between seed choice and fertilizer dosage, and inconsistent government policies make the search for strategies that reliably meet materially constrained farmers' aspirations difficult (Smale et al., 1995, Uttaro, 2002). Evidence increasingly suggests that individuals use heuristic tools in predicting and interpreting outcomes when faced with probabilistic and unknown prospects (Tucker, 2007; Tversky and Kahneman, 1974; Charness and Levin, 2005; Rabin and Vayanos, 2009; Eiser et al., 2012). Such decision-making shortcuts provide a cognitive discount to the complex computations needed to evaluate risky and uncertain outcomes. Smale (1995) finds that Malawian smallholders may follow a safety-first model of decision-making, allocating resources to yield-enhancing technology to minimize their downside risk, or the option that minimizes the chances of falling into the lower range of net returns, even when another option provides higher probabilities of large profits.

In this study, I report results from a multi-round risk and investment experiment designed to simulate agricultural decisions, conducted among farmers in Malawi. Farmers' choices in experiments and narratives are contextualized by my long-term ethnographic research among Malawian smallholders. The results I report address three related questions. First, do farmers' choices reveal a normative preference for maximizing the cumulative expected value of outcomes or do they aspire to reduce the variability of outcomes by choosing a higher probability win even when accompanied by lower net gains? In other words, do farmers prefer to win the most money over several rounds (or seasons) or simply to achieve positive gains in each individual round (season) of the game? Second, in the context of the experiment, how do previous wins and losses and their associated changes in wealth influence subsequent choices? Third, using the experiment to elicit narratives of risk, I ask how participants interpret the relationship between the abstract risk experiment, which offers the choice of investing an endowment toward risk reduction, and the risky and uncertain prospects of investing in the adoption of improved seeds and fertilizer? If agricultural decisions are materially and cognitively costly, do participants' narratives reveal the use of heuristics that simplify their agricultural decision-making under risk and uncertainty?

The structure of this article is as follows. In section two, I frame the adoption and intensification experience of Malawian farmers facing repeated exposure to both probabilistic risk and uncertainty. Section three describes the ethnographic background and agricultural strategies of rural Malawians in the study sample, setting the stage for a detailed review of both the experiment and cognitive interview design, described in section four. Section five presents results of the risk experiment and corresponding interview data. The paper concludes with a discussion of participants' experimental behavior and the implications in context of Malawi.

Background

Risky if you don't, risky if you do: Yield enhancing technology in Malawi

Agriculture employs between 78 - 84% of the national labor force in the small land-locked country of Malawi (Chirwa, 2004; Republic of Malawi, 2006). Self-sufficiency in maize production has been the priority of successive Malawian governments since independence in 1964 (Ellis and Manda 2012) and, while maize has been the dominant staple crop for less than a century, the exclamation that “maize is life” (*chimanga ndi moyo*) is a common mantra of Malawian smallholders (Smale et al., 1995). Maize is grown by 97% of rural Malawian households on farms averaging 1.12ha. Faced with a single growing season and one of the highest rural population densities in Africa at 2.3 person per ha, only 10% of Malawians smallholders are net sellers of maize, while more than 60% are net buyers (SOAS, 2008; Holden and Lunduka, 2010). The high population density per hectare of arable land limits the potential for fallowing or extending plots into virgin land.

Low adoption rates for improved seed varieties coupled with low intensity use of inorganic fertilizer among farmers is considered the primary reason for the failure of households to subsist on maize yields (Government of Malawi, 2003; Simtowe, 2006). According to Smale et al. (1995), “In the short term, in Malawi the land-saving technological change that is necessary to sustain a growing population can only be achieved through adoption of seed/fertilizer technology” (p.352). In contrast, Simtowe (2006) states that, “In the case of Malawian farmers, although adopting hybrid maize is plausible, in times of drought or water stress, the yields are much lower than those of the traditional varieties. In addition, it is widely believed that in the absence of fertilizer, local maize performs much better than hybrid maize” (p.2).

Owing much to reinstatement of fertilizer and seed subsidies by the Government of Malawi in 2005 (Sanchez et al., 2005), some farmers have increased the intensity of use of fertilizer and improved maize varieties in Malawi (Holden and Lunduka, 2012). However, a national trend of low adoption of improved seed and low intensity of fertilizer use remains the norm (Smale and Jayne, 2003; Chirwa, 2005; Giné and Yang 2007).

Malawi is highly dependent on adequate rainfall for maize production. More than 80 percent of farmers' production is rain-fed. In seasons with adequate rainfall, improved maize produces a yield superior to that of the local seed variety, if accompanied by the recommended dose of inorganic fertilizer (Simtowe, 2006). Malawian smallholders also look to improved maize to buffer the impacts of the hungry season. Early maturing hybrid are favored in the time period during which stored maize from the previous harvest is depleted, market prices for purchasing maize are prohibitive, and local maize is not yet mature enough for consumption (Lunduka et al., 2012). Malawi's climate is highly variable with 40 weather related disasters impacting crop yields between 1970-2006 (ActionAid, 2006). Within this time period, the volume of precipitation on days with extreme rainfall has increased, while the overall number of days with heavy rainfall has decreased (McSweeney et al., 2008). Diverse topographical characteristics in different areas within Malawi result in a variable rainfall distribution (Uttaro 2002). Simtowe (2006) finds that, "Although hybrid maize is superior in terms of yield, to local maize, in the event of dry spells, local maize produces higher yields than hybrid maize" (p. 5). In seasons of both inadequate rain and of inordinately intense rain, the input package of inorganic fertilizer and improved hybrid maize may result in low harvests and a loss of the premium price paid to employ them.

Other drawbacks to yield enhancing technologies stem from the economics of adoption and use. Researcher-managed farm trials demonstrate that hybrid seed has the potential for superior yields, but only when used with the proper dosage of inorganic fertilizers, which must be purchased (Denning et al., 2009; Snapp et al., 2014; Simtowe, 2006). Currency devaluations and high inflation rates mean that smallholders are often unable to purchase the recommended dose of inorganic fertilizer (Uttaro, 2002). Unfertilized hybrid seed does not produce yields that justify its purchase compared to local varieties due to variability in the distribution of returns on plots exclusively managed by smallholders (Carr, 1997). Furthermore, local seed may be saved and reused, while costly hybrids must be replaced annually to retain their yield enhancing advantage (Uttaro, 2002).

In 2004, UN Secretary General Kofi Annan called for a "Uniquely African Green Revolution," pledging the support of the United Nations in an effort to see improved food crops developed and soil health restored through the use of organic and mineral fertilizer (United Nations). It has been argued that yield enhancing fertilizer complimented with early-maturing hybrid maize improves agricultural productivity and, thus, increases incomes, mitigates climate uncertainty, and improves food security (Smale, 1995; Denning et al., 2009; Katengeza, et al., 2012; Besu et al., 2014). In contrast, it is argued that variability in returns from the investment in costly yield enhancing technology make it a risky choice for rural smallholders in Malawi (Carr, 1997; Zeller et al., 1997; Simtowe, 2006). These two perspectives on yield enhancing technology place smallholders in a confusing situation. Expensive yield enhancing technology is situated as both a solution to and a source of agricultural risk in uncertain markets and climates.

Experiments and decision-making under risk and uncertainty

A key assumption of mainstream economic theory is that individuals are rational actors aiming to maximize utility in an environment of scarce resources (Friedman and Savage, 1948, Becker, 1962; Kuznar, 2000). Sufficiently simple decisions often conform to normative models of rational decision-making while more complex situations often violate normative models (Thaler 1980). These complex situations are commonly examined through the use of risk experiments.

Two threads of theory and practice frame the use of experiments in examining decision-making under risk and uncertainty. The first thread explores the mechanics of decision-making, drawing heavily on experiments conducted by psychologists in laboratory settings (Kahneman and Tversky, 1979; Thaler, 1980; Thaler and Johnson, 1990; Gigerenzer and Goldstein, 1996). Through manipulation of the experimental conditions, this research identifies the common biases influencing the decision-making process as well as the cognitive shortcuts employed by decision makers when sampling all of the possible strategies and outcomes is costly (Simon 1957; Bonawitz et al. 2014). Results from these experiments suggest that many economic decisions are not shaped by the overall maximization of expected value, but by small-stake gains and losses that systematically influence subsequent decisions (Laury et al., 2009; Holt and Laury, 2002). Experiments involving sequential gambles conducted by Thaler and Johnson (1990) find that an initial loss can induce greater risk aversion while after a gain, people may be more risk seeking. This pattern of behavior is referred to as the "house money" effect, referencing casino gamblers who take greater risk after recent wins. An important implication of these results is that gamblers tend to segregate sequential gambles so as not to merge the outcomes of distinct decisions.

In addition to the segregation of sequential gambles, Kahneman and Tversky (1979, 1984) find that when decision-makers face risky prospects, losses are weighted substantially more than gains, relative to a reference point. When the point of reference is a participants' endowment, Thaler (1980) finds that the goods that one owns hold greater value than the goods potentially gained from a risky choice. This "endowment effect" makes losing something one owns a larger loss compared to the prospect of acquiring a gain from accepting a risky prospect.

While the "house money" and endowments effect, in the larger context of loss aversion, may bias decision-making, naïve learning rules may further explain why real-life and experimental decision makers seek satisfaction rather than maximizing their payoffs in iterative encounters with risk (Simon, 1955). Assuming that decision makers have a certain aspiration level, or minimum expected payoff in each round of an experiment, a simple win-stay lose-shift strategy may explain experimental behavior. In a win-stay, lose-shift (WSLS) strategy, a decision maker maintains their current choice until they experience evidence inconsistent with their expected outcome, at which point they respond by sampling choices from the distribution that increases the probability of winning (Bonawitz et al., 2014; Levine, 1975; Restle, 1962). While this learning rule is pervasive and evidence shows it may outperform other behaviors in cooperative games (Nowak and Sigmund, 1995), decision-makers under risk who overweight the probability of a positive outcome and ignore the costs associated with reducing outcome variance may forgo maximum expected payoffs.

Stemming from the work of agricultural economists, the second thread of experimental risk studies focuses on the measurement of risk preference. Researchers such as Kuznar (2001), Henrich and McElreath (2002), Yesuf and Bluffstone (2009), and Tucker (2012) measure risk attitudes with representative samples of experienced decision-makers in international settings. Binswanger (1980) pioneered the use of field-based risk experiments, asking rural farmers in India to choose among hypothetical lotteries with different expected values and variance. Farmers are found to exhibit risk aversion that tends to increase as the payoffs of choices are increased. Risk experiments offer the advantage of examining how participants select from risky prospects using hypothetical, and sometimes real, rewards.

Critics charge that experimental decisions among abstract risky prospects, especially when using hypothetical rewards, are an ineffective proxy for examining how people behave in their daily life (Smith, 2005; Chibnik, 2011). These authors suggest that observation of behavior and interviews with decision makers more accurately account for the complexity of choices between risky prospects. However, asking farmers about their previous agricultural investment decisions necessitates the recall of information about endowments, previous outcomes, expenses, seasonal climate fluctuations, and markets for produce and inputs, and memory may be imperfect and unreliable (Koriat, 1993). Research on memory and recall suggests that 20% of critical details of a recognized event are irretrievable after one year from its occurrence and 50% are irretrievable after five years (Bradburn et al., 1987). The inherent complexity in recalling from memory is a function of time interval between an event and the assessment of the event; the longer the time between the event and recalling the greater the distortion of perception (Margretts et al., 2003).

The potential advantage of experiments is that they do not rely on recall of past decisions, but challenge informants to make decisions in new, controlled environments. Because people's choices in experiments may not always demonstrate the factors or processes that led to the choice, some researchers have relied on a "thinking aloud" protocol (Ericsson and Simon, 1980; Gaboury and Ladouceur, 1987). In "thinking aloud," the researcher asks the participant to verbalize her thoughts during the experiment and to explain her assessment of risky prospects as she encounters them.

The experiment presented here pursues the theoretical goals of the first thread of risk preference experiments championed by Kahneman and Tversky (1979), Thaler (1986) and others, which is to better understand decision-making processes, biases, and heuristics. But while most previous work in this thread has occurred with what Henrich et al. (2010) call WEIRD people (Western, Educated, Industrialized, Rich, Democratic), the research described here was conducted among actual rural farmers in Malawi. Unlike comparable field studies from the second thread, pioneered by Dillon and Scandizzo (1978) and Binswanger (1980), the present study does not attempt an objective measurement of risk preferences nor a determination of whether they tend to be risk averse, risk neutral, or risk prone. The experiment presented here was designed to mimic many of the important features of agricultural decision-making, including multiple rounds and investments to reduce risk, to examine whether known biases such as house money effects, endowment effects, and WSLS guide strategy. A thinking aloud procedure and post-experiment debriefing were used to explore the external validity of the experiment (whether informants intuited the similarity between the experiment and agriculture) and to identify possible heuristics.

Site description and sampling

This study was conducted in the foothills of the Kirk Range along Malawi's border with Mozambique (Figure 5.1). Between September and November 2013, a random sample of 85 heads of household was selected from an exhaustive census of 365 households from eight communities in the Ntcheu District of central Malawi. The experimental game and companion interview were part of a one-year research project broadly examining agricultural decision-making and food insecurity among rural Malawian households. The sample is female-biased, with 50 women and 35 men[3].

Households and farms in the study area range between 940 and 1060 m above sea level. With a semi-arid climate, agricultural productivity is greatest during a single rainy season between November and April. The dominant rural livelihood in the study area is small-scale farming using a combination of local and improved agricultural inputs. Between 1987-2008, the

[3] I attempted to complete the experiment and interview with heads-of-household. Of the 44 women in the sample, 23 females self-identified as the head-of-household while 21 females were interviewed and participated in the experiment due to an absence by the household head during the time of the study.

Ntcheu District experienced a 28% population increase, resulting in increased demand for agricultural production from increasingly small land holdings (Office 2008, 2012). Sample households in the study area manage an average of 1.13(±0.7) hectares of land and have an average household size of 4.4 (±1.8) members. Maize dominates the farmed landscape, occupying 77% of cultivated areas. 88% of sample households report cultivating maize as a staple food and income source. Sample farmers produce an average of 956.74 kg per hectare of maize. Fifty-three percent of households report facing a shortfall in household maize production in 2013. Additional farm area is intercropped or dedicated to tobacco, beans, cassava, pumpkin, pigeon pea, tomatoes, and sweet and Irish potatoes, grown as non-staple food or market crops. Selected demographic characteristics of sample households are presented in Table 5.1.

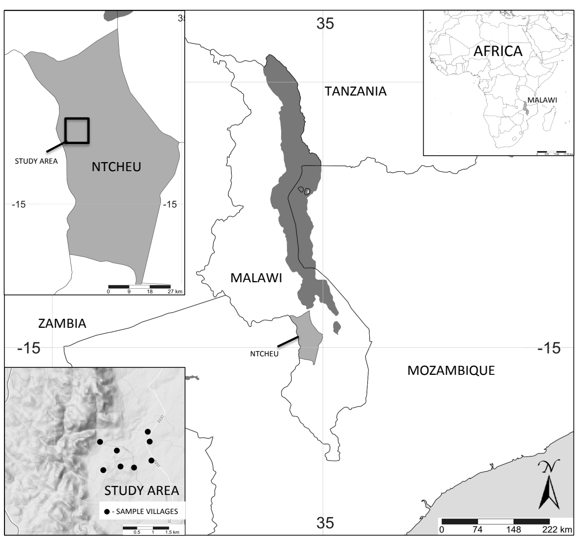

Figure 5.1: Map of the study area and sample villages in the district of Ntcheu, Malawi

Agricultural strategies in the study area are highly monetized. During the 2012-2013 rainy-season, study participants purchased an average of 131.3 kg of inorganic fertilizer per hectare planted to maize (0 min, 590 max) spending an average of 21,677.31 Malawi Kwacha (0 min, 129,200 max). These figures include both inorganic fertilizer purchased at the market rate and fertilizer purchased through the Farm Input Subsidy Program (FISP). FISP provides select farmers with a coupon to be redeemed at a local fertilizer and seed wholesaler for 50 kg of urea and 50 kg of NPK (Nitrogen-Phosphorus-Potassium). Ninety-five percent of farmers purchased fertilizer either in addition to their subsidized amount or in the absence of receiving a coupon.

Table 5.1: Selected sample descriptive statistics

Characteristics (n=85)	Mean ± SD	Min	Max
Age, years	44.2 ± 16.4	19	85
Percent Female	59%		
Household size, # of members	4.4 ± 1.8	1	8
Completed schooling, years	5.5 ± 3.6	0	12+
Landholding, hectares	1.13 ± 0.7	0.5	4.4
Percent land planted with improved maize	38.2%	0	100
Percent land planted with local maize	39.2%	0	100
Inorganic fertilizer purchased 2012-13, kg	131.3 ± 108.7	0	590

Nineteen percent of study participants use gravity-flow and riverside irrigation in the valleys and hillsides along the Kirk range to supplement the main rainy season harvest, either in formally organized community schemes or in private wetland fields (*dimba*), irrigating with foot pumps or watering cans during the 2012-13 rainy season. Community members commonly perceive the frequency and intensity of rainfall to be increasingly inconsistent and unpredictable. 100 percent of farmers in the study sample perceive that rainfall has become more erratic between 2003-2013 while 77 percent feel that soil fertility has declined in the same time period.

Methods

Overview

The experiment consisted of random draws of one ball from a bucket containing different ratios of winning and losing balls. Given that the average years of formal education among participants was 5.5 years (Table 1) and the fact that the participants had little or no experience with experiments, the experiment was kept as simple as possible and involved practice rounds. Participants played three practice rounds of the experiment with hypothetical rewards and four rounds with real rewards. In each round, players could choose among three investment strategies by which players could spend money to increase the number of winning balls in the bucket and thus the probability of winning. The experiment was presented without any explicit framing, but it was designed to mimic agricultural choices in the context of agricultural technologies. The multiple rounds simulated the sequence of annual decisions farmers make as they harvest one crop and prepare for the next. The investment strategies mimic farmers' investments in hybrid seed and fertilizer to reduce agricultural risk.

Participants were encouraged to verbalize their decisions between lotteries using the “thinking aloud” procedure (Ericsson and Simon, 1980). After the experiment was finished I asked farmers to talk about the experiment, to explore whether participants saw analogies between the experiment and risky choices in agriculture. “Thinking aloud” explanations of lottery preference in each round and the post-experiment interview responses were translated to English, transcribed, and thematically coded. The experiment and post-experiment interview lasted between 90 minutes and two hours. All names used in the article are pseudonyms.

Procedure

Experiments were either conducted at the participants’ home or in one of her agricultural fields. Participants were asked not to discuss the experiment with other members of the community. Every effort was made to play the experiment out of view of observers. Young children and spouses were occasionally present during the experiment.

At the start of the experiment, participants were given a laminated copy of the experimental procedure, written in the local language of Chichewa (see English translation of the procedure in Figure 5.2). An opaque empty plastic bucket was placed in front of the participant alongside eight colored plastic balls of equal weight and size (five blue, two yellow, and one orange). Researchers explained that the exercise involved a random draw of one ball from the bucket. Participants were asked to identify the color of each ball by holding it and pointing to the circle of the same color on the laminated instructions. The experimenter explained that if drawn, a blue ball rewards the participant 200 Kwacha, a yellow ball rewards zero kwacha, and an orange ball results in a loss of 200 Kwacha. The participant was then presented with the three investment strategies (options), labeled A-C, summarized below:

A: Pay nothing. Bucket contains one blue ball, two yellow balls, and one orange ball.

B: Pay 50 Kwacha. Bucket contains three blue balls, two yellow balls, and one orange ball.

C: Pay 100 Kwacha. Bucket contains five blue balls, two yellow balls, and one orange ball.

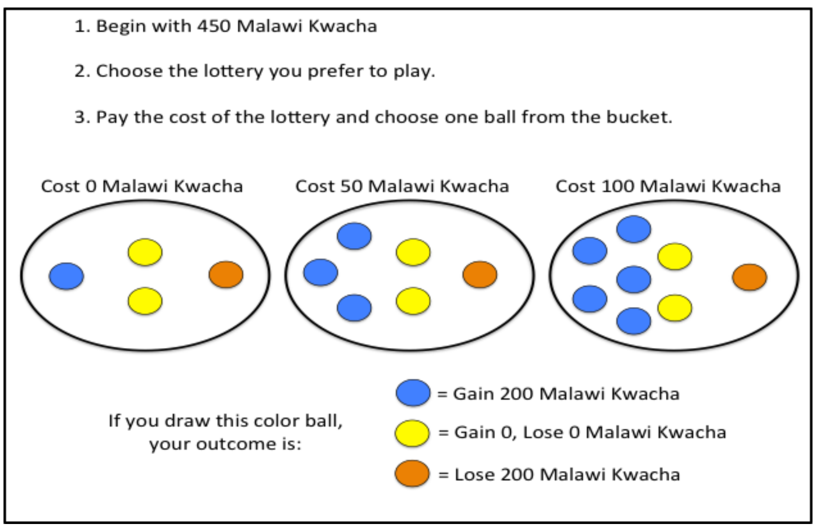

Figure 5.2: English version. Participants were given a laminated Chichewa version at the start of the experiment.

All participants started with an endowment of 450 Malawi Kwacha (≈US$1), which is roughly equivalent to a half-day's wage for both men and women completing day labor such as road repairs or agricultural labor. In the three practice rounds, nine laminated cards with “50MK” printed in bold on each card were used to represent participants’ hypothetical initial windfall endowment, investment expenditures, and rewards. After the three practice rounds, participants counted their remaining 50MK cards and were asked if they had any questions before beginning the four round real-rewards experiment.

The real rewards stage consisted of four rounds of sequential play. In each round, after selecting a preferred lottery, the participant paid the required fee and the experimenter placed the appropriate quantity of each colored ball (1+x blue, two yellow, one orange). Participants looked inside the bucket to confirm that the correct number of balls was placed inside. The bucket was then sealed and shaken for 10 seconds by the experimenter to redistribute the balls randomly. The top was removed and the bucket was held at a height within reach of the participant, but above her line of sight. The participant drew one ball at random. A blue ball was immediately rewarded with 200 kwacha. After each round, the bucket was emptied and all eight balls were displayed in front of the participant before repeating the procedure for subsequent rounds. At the start of round four, participants were informed that it was the final round of the experiment.

The expected value and variability of each lottery is displayed in Table 5.2. The net payouts for each lottery were chosen carefully. The objective was to present farmers with the choice to invest a portion of their endowment to reduce the probability of a loss. Payouts for a win and payments for a loss are equal across all three lotteries. However, since reducing risk came at a cost, the net payouts and probability affects both the expected value and variability of outcomes. Figure 5.3 shows the probability distribution for each lottery.

Table 5.2: Gross and net monetary outcomes as a function of lottery choice and probability for one round of the experiment. Note EV (expected value) is presented for gross and net (gross-cost of lottery choice) outcome. SD=standard deviation, IQR=interquartile range

Choice Outcome Gross *Net (Gross-Cost)* Probability	Blue Good	Yellow Average	Orange Poor	EV	SD	IQR
A (Cost 0MK)	200 *200* 0.25	0 *0* 0.5	-200 *-200* 0.25	0 *0*	163.3	300
B (Cost 50MK)	200 *150* 0.5	0 *-50* 0.33	-200 *-250* 0.17	66.67 *16.67*	163.3	200
C (Cost 100MK)	200 *100* 0.625	0 *-100* 0.25	-200 *-300* 0.125	100 *0*	151.2	200

It was possible for a participant to lose all of her endowment by the end of round two and three if the orange ball was selected consecutively in either the 50MK or 100MK lottery or with a combination of the two. In both the hypothetical and real-rewards version of the experiment, the participant was given the option of taking a loan to purchase a preferred lottery in subsequent rounds of the hypothetical-rewards version or in rounds three and four of the real rewards version. If a loan was taken and the participant drew a winning ball in the subsequent round, they immediately returned the value of the loan. At the end of the experiment, the researcher forgave any outstanding debt; participants were not required to repay out of pocket.

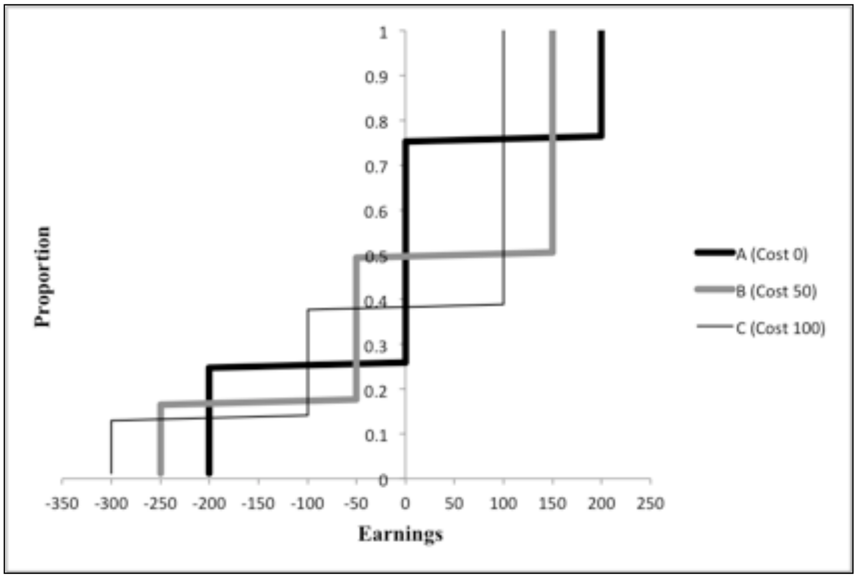

Figure 5.3: Curves measure the cumulative probability distribution for each choice. For example, one can say for those who choose the option A (Cost 0), 25% of them will gain 200 MK, 50% of them will neither win or lose any money, and 25% will lose 200 MK.

Predictions

Normative theory for choice under risk calculates the value of a gamble as its expected value (EV), equal to the probability of each outcome multiplied by the rewards for each outcome, summed across all possible outcomes (Bernstein, 1996). In this experiment, reward amounts (200 MK) are net of the investment cost (0, -50, -100 MK). Thus option A offers an expected value (EV) of 0; option B offers EV=16.67, and option C offers EV=0. A "rational" player interested in maximizing net cumulative profits should prefer option B. A player who is more focused on winning the game (drawing a blue ball) than maximizing net cumulative returns, or who ignores investment costs in her mental calculations, should prefer option C.
If this unframed experiment was interpreted as similar to the risky decisions made in daily life, especially decisions related to farming, the elicitation of narratives of risk both during and immediately following the experiment may reveal cognitive shortcuts used by farmers and

overcome the recall bias present in more abstract discussions of agricultural decision-making under risk.

Post-game Survey

While the objective of the experiment was to elicit preferences and examine the influence of previous outcomes on subsequent choices, the survey aimed to elicit narratives of decision-making under risk. The post-game survey questions are in Table 5.3.

Table 5.3: Post-experiment survey questions

General
1. What emotions or feelings did you experience while participating in the experiment?
2. What do you think was the intended purpose of participating in this experiment?
3. Do the emotions or feelings you experienced while playing this game remind you of emotions or feelings you experience in your daily life? If so, please explain?
4. Have you encountered choices like this in your daily life? If so, please explain?
5. Do you participate in activities in which you invest something with a chance that you will either gain more than you invested or lose something in return?
Farming prompt
6. (if not already mentioned unprompted) Do you think the risk and rewards in this game are similar to the risks and rewards in farming? If so, please explain?
7. How does one win or lose in farming?
8. What do each of the colored balls and their associated outcomes mean to you in the context of farming?

<u>Results</u>

Experiment revealed preference

The first objective of the experiment was to examine if participants' choices reveal a normative preference for maximizing cumulative net earnings versus a higher probability of drawing a blue ball. Figure 5.4 shows the percentage of participants selecting each lottery across four rounds. There is a clear preference for options B and C over option A. The difference in the proportion of participants selecting either option B or C in the first three rounds is insignificant (Two-sample test of proportions: round one z=-0.504, p=0.6146, round two z=-1.114, p=0.2654, round three z=0.9608, p=0.3367). However, round four reveals a significant difference between the proportions of participants preferring option B to option C (z=-4.296, p=0.000).

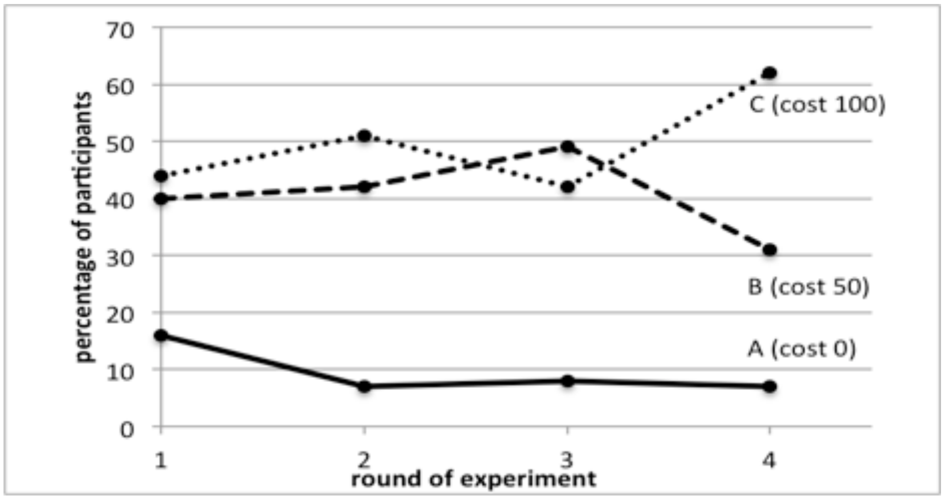

Figure 5.4: Aggregate lottery choices across rounds

Table 5.4 displays participants' average gross and net outcomes of each lottery. As expected, lottery B resulted in the only positive average net outcome for participants. Over the course of the experiment, only 12 participants stayed on lottery B in all four rounds. 66 participants selected lottery B at some point and only 19 participants did not pick lottery B in any round of the experiment. Although net gains from lottery C were negative, it was the preferred choice in three of four rounds. The cumulative proportion of participants choosing option B is significantly different than option C (z=-2.5021, p=0.0123).

The results may be insufficient to delineate farmers' normative motivation for maximizing net earning versus reducing variability across all rounds of the experiment. However, the aggregate results demonstrate that 50 percent of all choices are for option C, the option with the lowest variability. This result is most pronounced in round four, in which participants were made aware the game was concluding and short-term, safety-first decision dominated consistent with the findings of Smale et al. (1995) that reducing yield variance is a primary concern of Malawian farmers.

Table 5.4: Mean gross and net outcomes for each lottery across four rounds

	Mean Gross Outcome (MK)	Mean Net Outcome (MK)	SD
A (Cost 0)	-22.22	-22.22	139.60
B (Cost 50)	74.07	26.79	150.06
C (Cost 100)	87.5	-10.35	150.00

Notes. SD=Standard Deviation

The second objective of the experiment was to examine the effect of previous wins and losses and changes in wealth on subsequent choice. Table 5.5 displays the number of people who chose to stay on the same lottery or shift to a different lottery in both winning and losing scenarios, as they transitioned between rounds. By adding the win-stay column, we see that participants who won a lottery repeated their lottery selection 66 percent of the time. In contrast, investors who lost stayed on the same lottery only 51 percent of the time in the next round. This difference in the proportion of choices to repeat a previous choice of lottery between winning and losing outcomes is significant (Two sample test of proportions, z=2.815, p=0.005).

In the aggregate, winners tend to stay on the same lottery choice more frequently than do losers. However, 41 percent of decisions for both winners and losers in the transitions from rounds one to four involved a shift in choice (104 shifts in 255 decisions). In reference to objective one of the experiment, a detailed examination of the decision to switch lotteries suggests that participants desired to invest in reducing their risk of a loss in the next round. Among participants who chose to change their lottery choice after winning the previous round, 48 percent of choices are shifts to the most expensive, lowest variance option (C). In contrast, 35 percent of shifts are to option B, and 17 percent switched to the free option (A). In the loss columns, 53 percent of shifts are toward the most expensive, lowest variance option (C) while 40 percent of subsequent choices are for B and only 7 percent chose to shift to the free option (A) across all rounds. Thus there is good evidence that the farmers who participated in this study employ a win-stay heuristic even when this is unlikely to enhance earnings, although there was less support for lose-shift.

Table 5.5: Number of participants who repeat or change lottery choice by outcome during the transition between rounds.

Round 1 - 2	Win-Stay	Win-Shift	Lose-Stay	Lose-Shift
Choice A	1	2	1	10
Choice B	7	5	12	10
Choice C	14	4	11	8

Round 2 - 3	Win-Stay	Win-Shift	Lose-Stay	Lose-Shift
Choice A	0	1	3	2
Choice B	20	3	6	7
Choice C	20	9	7	7

Round 3 - 4	Win-Stay	Win-Shift	Lose-Stay	Lose-Shift
Choice A	0	1	2	4
Choice B	12	14	8	8
Choice C	16	7	11	2

Table 5.6 shows the participants with endowments lower than 100 MK entering round three (6a.) and round four (6b.). As previously explained in the research design, participants were offered the chance to take a loan in order to afford their preferred lottery, with immediate repayment if the subsequent choice resulted in a win. Three of six participants with endowments below 100 MK chose to take a loan between round two and three, and three of seven participants

took a loan between rounds three and four. Participants who did not accept the loan offer were limited in their lottery options, accepting higher risk lottery A (cost 0) or B (cost 50) to avoid repaying a loan in the event of a winning outcome. All six participants who took a loan subsequently invested in the lowest variance (and zero average yielding) lottery C. This finding suggests that when risks are greatest farmers attempt to maximize number of wins rather than net earnings.

Table 5.6. Loan Taking and lottery choice a) Round 2 -3, b) Round 3-4

a)

Participant ID	**Endowment After Round 2 (MK)**	**Round 3 Lottery Choice**
GAL084	-50	B (-50)*
GAL033	0	A (0)
DIW100	50	B (-50)
PHO012	50	B (-50)
DAU022	50	C (-100)*
GOM016	50	C (-100)*

b)

Participant ID	**Endowment After Round 3 (MK)**	**Round 4 Lottery Choice**
GAL033	-200	A (0)
PHO012	-200	C(-100)*
DAU022	-50	C (100)*
DAU029	0	A(0)
GAL022	0	A(0)
GOM020	50	A(0)
DIW117	50	C (-100)*

Note. Rows represent individuals with endowments below 100 Mk. after rounds 2 and 3.
* indicates taking a loan to play a lottery with a higher cost than her current endowment.

Risk Narratives

> *Interviewer*: Do the feelings you have while playing this game remind you of anything from your daily life?
>
> *Participant:* This game is like buying fertilizer. You pay 15,000 Kwacha to hope you get back 30,000 from your sales. One year you can win from this strategy and next you can do the same thing and find you have lost from disease or lack of rainfall.

I open with this participant's interpretation of the lottery experiment because it typifies the association made between both experimental and agricultural investments and outcomes. As lottery choices were made in each round, I listened as participants explained their selections. The “thinking aloud” statements and post-experiment discussion (see table 3) of choices provide insights into participants’ perception of probability and their motivation. Since the experiment was presented as an abstract and unframed lottery, it is of note that in the post game interview 31 of 85 participants made an unprompted connection between the experiment and their own agricultural decision-making. There is potentially an unintended framing effect, as I am known in the surrounding area to frequently ask questions about agricultural decisions. Nonetheless, participants’ detailed qualitative explanations of investment decisions and nuanced explanations relating the experiment to farming highlight its external validity.

Motivation and lottery choice

> *Participant:* Farming is *juga* (gambling).
>
> *Interviewer:* How is farming like gambling?
>
> *Participant:* Farming is the best example of winning and losing.

Participants demonstrated a clear understanding of the probabilistic nature of both the experiment and their farming decisions when explaining their choices. Farmers commonly defined the choices in terms of the trade-offs between the investment costs and volatility of outcomes associated with each lottery. One woman stated that, “In the first choice the chance of winning is too low. Lottery 3 is the *big type* of farming. These days you can lose a lot when applying too many inputs because it rains too much or too little.” The “big type of farming” included investment in inorganic fertilizer and modern varieties of maize seed. Another farmer noted that while the lottery C had a high probability of winning, the lottery B was the best chance at a profit. “100Mk truly has more winning balls to choose from. It is true you can win, but you can also still lose. To say the truth, the 50MK is the one where you win the most.”

Figure 5.5 displays participants' description of their choices while "thinking aloud" during their lottery selection. The y-axis presents categories into which coded statements were sorted. Sample statements for each category are presented in Table 5.7. That the majority of choices were made based on evaluation of the cost involved is not surprising as in the aggregate, the two less expensive lotteries were more frequently chosen. Both the probabilistic statements and statements expressing a desire for greater certainty in the final round suggest that, while participants may not have computed the expected value of each lottery, they did understand the probability of winning each draw. In 96 percent of times that probability was mentioned during the decision process, participants selected lottery C.

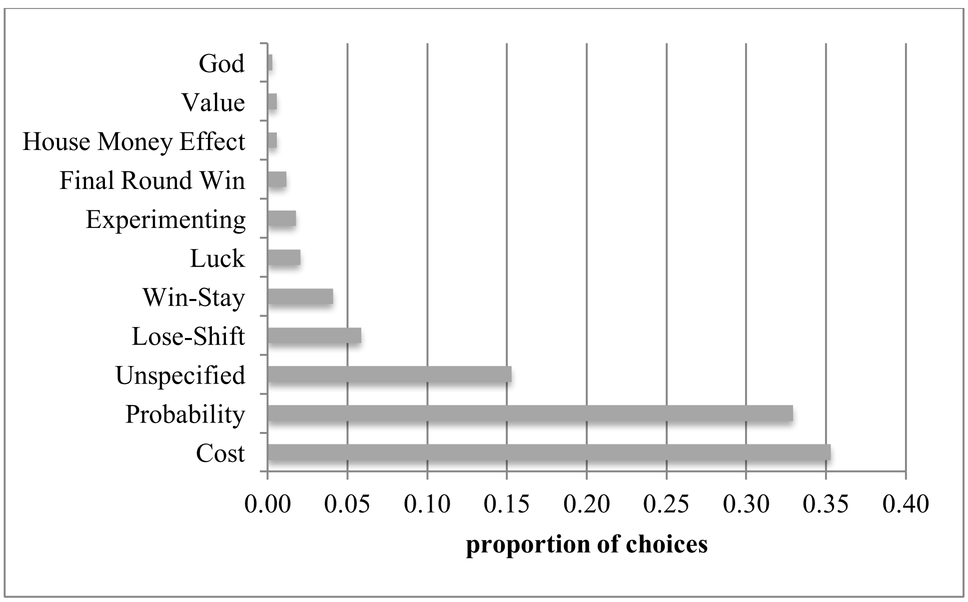

Figure 5.5: Explanations of lottery choice from "thinking aloud" during lottery selection. n=340 discrete decisions (85 participants x four rounds)

Harold, a smallholder who farms along the slopes of the Kirk Range, explained the general avoidance of lottery A, laughing while saying, "Mpechepeche mwa njovu sadutsamo kawiri" or "Under the elephant's belly you can't pass twice." Harold believed that winning on a risky bet is bound to fail the second time and was eager to invest in order to reduce the chance of losing. Another participant explained that the free option was lazy and that you have to pay for better chance to succeed in farming. "You must sweat for your success. If you don't work hard you can't expect to win and working hard includes investing in fertilizer."

Table 5.7: Focal conditions driving lottery choice and sample statements in each category.

Category	Sample "thinking aloud" statement
Cost	"100 kwacha is dangerous because you spend too much. I want to increase my money without spending more.
Probability	"I want to use all the balls. I know it is lowering my money, but it is the best chance to win."
Unspecified	"I'm just choosing anyhow."
Lose-Shift	"I lost with 100. I want more chance to win so I will use 50."
Win-Stay	"It's the one I am winning with. Why should I change?"
Luck	"You can win any option depending how much luck you have."
Experimenting	"I can see that 100 is the most winning, but I want to see the option for winning in 50 to differentiate."
Final Round Win: "Endowment Effect"	"I am running low on money. If this is my last chance I must secure something."
"House Money" Effect	"I now have many wins to play with."
Value	"Others will pick 100, they see it as lots of money. And they are forgetting the losing. People think 100 as it is more capital, but I measure my losses first, others measure their wins first."
God	"God is doing my choosing. I am not the one. God makes you win."

Sitting on the ridges of his small terraced hillside garden, another participant held on tightly to the winning blue ball he had drawn after investing 100 MK. Although he did not win in each round he exclaimed, "Benefits must come from a cost," adding, "This game is the same as when I buy fertilizer and apply it in this field. I buy fertilizer, but I expect to harvest more from it. You can have a big field and a small amount of fertilizer and not win in farming. Too much land with not enough fertilizer is losing."

Another participant, who consistently separated her kwacha between the original amount and her winnings, hesitated after a loss to switch from lottery B to lottery C. When I asked her about why she had divided her money between two piles she said, “You need to know math to be a farmer. Farming only happens once a year and you must always be planning for your harvest and inputs.” Describing her cost-focused decision-making aloud, she added, “You may sometimes put only a little (fertilizer) and expect a lot and sometimes you put a lot, but when you do you must rely on rainfall working for you. Too much fertilizer can be stagnant without rain.”

Farming as a gamble

After farmers completed the experiment, they were asked to relate experimental outcomes to the outcomes of farming. Figure 5.6 summarizes the proportion of participants who mentioned each condition as a necessary prerequisite to achieving a winning outcome in farming. “You should expect to win and lose in games,” a mother of two told me sitting in the shade of a mango tree on the edge of her maize field. While taking a break from making planting ridges to participate in the lottery, she explained, “This game is just the same as farming,” pointing to the laminated page of instructions for the experiment. “What is coming in front of you, you might not know it. You can prepare to plant a certain crop, but rains won’t come. When farming, you expect certain things to happen, but you don’t always know the results. You expect to win, but if you lose you must know these things can happen to you.” Another participant explained that farming investments were essential to success and that the lottery choices mimicked his lived experience. “In Malawi, the agricultural extension worker may tell you what to do but we must choose what we want. You have to be ready to get lucky.” When I asked for clarification he added, “You must prepare well. You must have your seed and your fertilizer purchased and ready to plant with the first rains.”

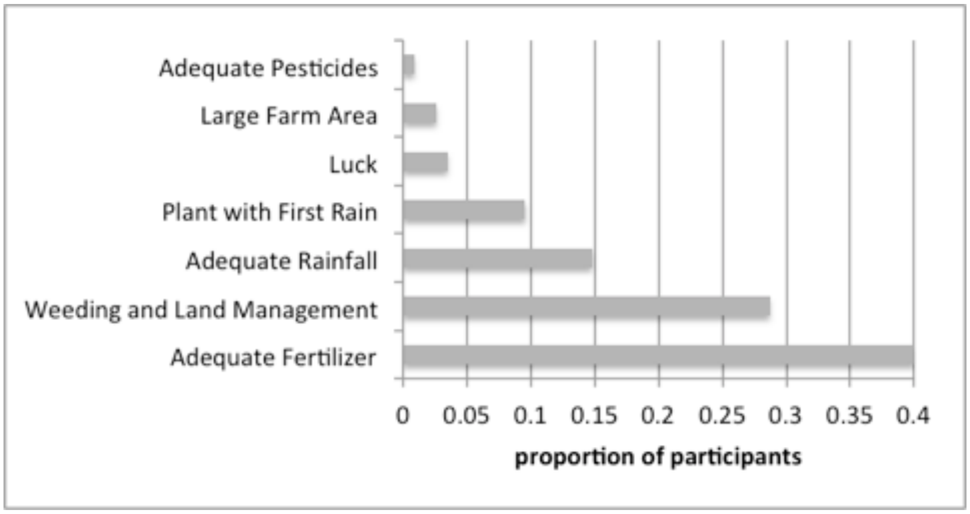

Figure 5.6: Perceived drivers of successful farming outcomes

Figure 5.7 summarizes the conditions leading to losing outcomes in farming and the proportion of participants who mentioned them. A man named Henry, who blamed inadequate rainfall for his previously poor harvest and subsequent inability to purchase enough fertilizer for the upcoming planting told me, "You can win from working with strength and not being sick and then lose with the same investment from a lack of rain, being sick at the wrong time, or having to stay in the hospital." A farmer named Samson, comparing the free option to the two opportunities to invest in reducing risk, added, "You can work hard and make good choices and still lose depending on the rains. You will lose if you don't buy fertilizer and you can win or lose if you do buy it, but the rains fail to come. If you can't buy fertilizer you expect to lose." Another participant shared that even after he had decided which lottery he preferred, the process of drawing a ball reminded him of the risk of losing even after you have invested in inorganic fertilizer, which he believed was a lower-risk strategy. "I lost in farming this year because my wife was sick for 20 days in the hospital and I was forced to apply my fertilizer very late and then rains stopped early.

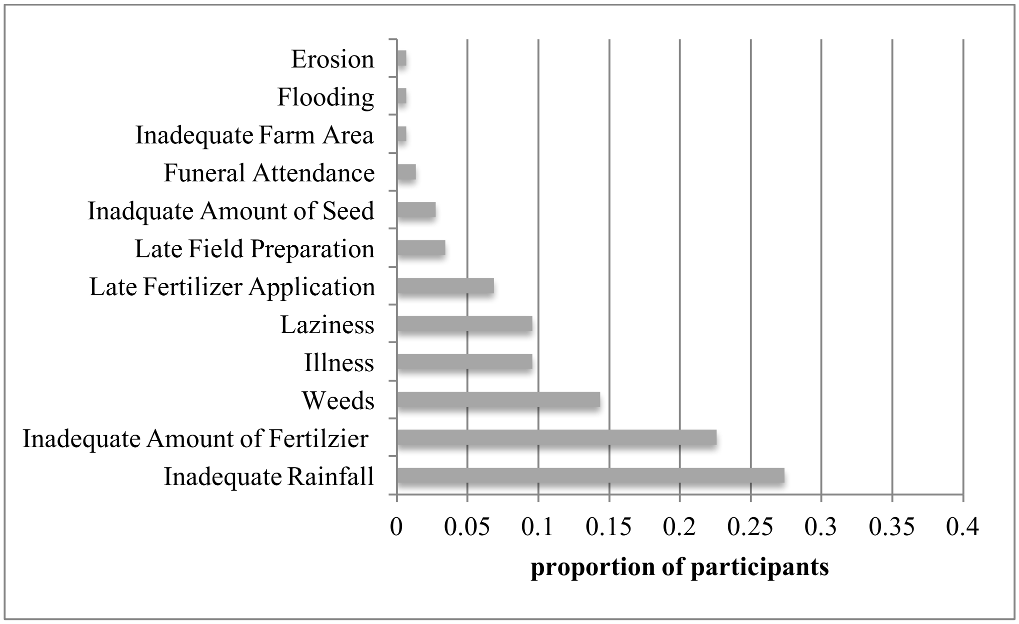

Figure 5.7: Perceived drivers of negative farming outcomes

While the association between the risks faced in the experiment and in farming were common, not all participants connected the game to the probabilistic nature of farming. An elderly woman named Sophia who lived alone in a small two-room house explained how playing this lottery brought back memories of her children. She shared the story of how she had worked hard in both her fields and worked small jobs in the community so she could afford to send her son to school. "This game reminds me of paying school fees," she said. "I invested in my son so when I am old he will make more money to support me." She added, "Farming is similar though. I make rows, plant and expect a harvest in the field. You can do everything, but still not harvest. Sometimes I farm right and don't get a single harvest."

Win-Stay, Lose-Shift Heuristic

In the face of agricultural risk, staying with a winning choice seems an effective and efficient heuristic. James, who invested in a higher probability of winning each round of the experiment, stated, "If I go to this one time and then to that another I will end up in a ditch.

When you make a big change you think your luck will continue with you, but your luck may not transfer. I have been winning so why take a different chance?" This fast and frugal decision-making rule to stay with a winning choice was explained by another farmer named Kaitlin. Overlooking her garden from the weathered front step of her house, she remarked, "If you take this game as real life, whatever crop you stand firm with, that's the crop you can benefit from. If you are winning, stick with it."

Some farmers considered staying with the same strategy after a loss as the most effective strategy. Changing strategies is materially and cognitively costly and may not reduce the volatility of outcomes. A farmer, named Ronda, who maintained her Cost 100 lottery (option C) while losing in two of the four rounds insisted that disappointment in farming is something she must accept. She explained that as the rainy season progresses and stored grain begins to run low she often prays, "God love me so I can finish eating this maize." She believed that using the same strategy each year, as in each round of the experiment, may result in wins and losses, but that persistence is the best choice. "When you are winning and have plenty of yield you feel like jumping like a baby cow. When you are losing you wish you were dead." Asking me to repeat after her she continued, "*Usamulekele wakuba m'munda mwaka chifukwa akukubela koma upithilize chifukwa adzatopa okha"* or "Don't leave your field because of thieves, but continue because they will get tired by themselves." Explaining the true meaning of the proverb and her efforts to buy expensive fertilizer each season, Ronda told me that the thief either may be an actual person who is stealing your crops or inadequate rainfall resulting in lower-than-expected yields. "You must persist in the way you farm, the thief will stop stealing from you one day, and the rains will return." In Ronda's opinion the choices made in the experiment were similar to challenges she faces in farming. "You can take your money, buy fertilizer and maybe still get nothing. You can even sell what maize you did harvest and not get back the money you put into growing it." Even though she has experienced loss from the use of expensive inputs, she described her continued effort to purchase inorganic fertilizer, "The rains may come differently each year. If the rains are good you will lose if you were the one who didn't buy fertilizer." She is willing to forgo the investment cost of inputs to ensure winning when the conditions are in her favor.

Comments on maximizing expected value

As demonstrated in figure 4, the majority of participants favored the low risk strategy, lottery C, regardless of the investment cost and expected value of zero. Some participants, however, followed a normative expectation of attempting to maximize expected value across the four rounds of the experiment, with 12 participants choosing lottery B in all four rounds regardless of the outcome of their choice. With his infant son on his lap, a farmer named Suma, who split his time between working in his fields and repairing old car batteries, explained how he had discerned among the different choices in each round. Suma had a history of gambling, but stopped playing games of chance in 2002 stating that, "Games were eating all of my household's budget." He agreed that the experiment was similar to farming. "Farming is a gamble. If you don't farm well you will lose and this game is about understanding budgets so you can increase your money."

Suma explicitly stated that he recognized both the probabilistic nature of the experiment and cost of investing in each lottery. With a smile he explained *"Chuluke, Chuluke ndi wa njuchi suona imene ya kuluma"* or "The more bees there are, the less chance you can tell which one will sting you." His preference for option B was unchanged because, "The danger is hidden in the crowd. The option C lottery can make you lose more through expenses, but it is hidden among many tempting (winning) balls." Suma described how his actual farming strategy was similar to his experimental choices, "Improved maize seed is from outside. It needs more care and more medicines to grow. It does not solve the problems or hunger of my household. It matures quickly but can fail from too little rain or rot from too much. If it rots in the field, the improved maize actually brings more hunger not less because of the large investment you have made."

Suma's interpretation of the game was echoed by Hemaki, who chose the option B lottery in each round, when she shared that, "To say the truth, the 50 kwacha game is the one you can win the most. The 100-kwacha game has the most winning balls to choose from. This is true, but you can still lose more there." Hemaki believed that most of the other participants who played the lottery would choose to play the expensive Cost 100 option. "They see the most winning balls there. In their minds they are thinking they are winning, but I see that I don't want to spend all my money. I see farming as a business and spending too much money is risky." Hemaki explained that last farming season she had purchased expensive fertilizer and expected that she would have a good harvest, but was still forced to purchase additional maize after harvesting. She added, "This year I am now feeling nervous. This game is like farming and fertilizer purchase. You always must think what may happen and now I am wondering what to do differently to harvest enough next year."

Discussion

These results provide answers to the three research questions with varying level of clarity and precision. The first question concerned whether farmers, facing a repeated choice between risky prospects, demonstrate a preference for maximizing cumulative net earnings versus drawing a winning ball. The results from the multi-round lottery suggest that many farmers experiment with multiple strategies. A small subset of farmers (n=12) consistently preferred the trade-off of higher variability for a positive expected value (option B) and articulated numeracy and cost-benefit analysis of the options as driving their choice. Overall a preference emerges for the option with the least variability in outcomes (C). With this option, participants sacrificed net gain for a reduction in variability. The significant overall preference for lottery C in round four may demonstrate evidence of the "endowment effect" (Kahneman and Tversky, 1979) meaning that, in the final round, participants wanted to ensure they had the highest probability of winning and retaining their earnings. Findings from the loan-taking analysis further highlight the general preference for reducing the variance in outcomes. Although only a small number of participants elected to receive a loan, the majority who did used the loan to pay for choice C.

These results suggest that farmers follow a "safety first" decision-making model that reduces their downside risk, or the options with a higher probability of obtaining low or negative returns. This finding supports the production-based risk assessment of Malawian farmers completed by Smale et al.(1995), who found that Malawian smallholders choose packages of inputs, commonly diversifying their planting portfolio, in order to minimize the chances of falling into the lower range of net returns, even when other options provide higher probabilities of large profits.

In the experiment, farmers paid for the preference of reducing downside risk; they hazarded over-investment by ignoring expected value or net gain. While this finding that Malawian farmers are prone to over-investment may have been made without the use of a small-stakes experiment, this method highlights patterns in the investment behavior of farmers facing risky prospects. Post-experiment interviews further suggest that when reducing variance is costly and the computation of expected outcome is cognitively taxing, vividly presented solutions (yield enhancing inputs) induced through government subsidies are the preferred solution to farming problems. In the context of uncertain market prices for harvest, rising input costs, and increasingly unpredictable rainfall, a safety-first strategy may result in a decrease in yield variance, but no clear improvement in wealth and well-being. If farmers ignore or fail to account for the amount they spent to reduce risk in the game or in farming they may confuse net rewards with gross rewards, trading present security for long-term improvement in wealth.

The second question asked how previous wins and losses and their associated changes in wealth influence subsequent choices. My experiment was developed to simulate the risky options available to small-scale farmers with limited capital and credit, who rely on the yields and incomes from previous cropping cycles to meet both subsistence needs and capital for the investment in agricultural inputs for the following season. As the resources available to a farmer change and a farmer gains experience with strategies and outcomes over sequential rounds or seasons, a preference for the lowest risk, but most expensive investment option is pervasive. Across all rounds, participants tend to adhere to a "win-stay" strategy. However, losses do not drive a significant proportion of participants to shift to another option. Of the decisions that were revised after a loss, experimental results show that participants most commonly sought a higher probability of winning rather than the choice offering a maximum return. While some farmers engaged in high-risk strategies, this approach to decision task was rare. Farmers favored investing to reduce risk rather than maximize expected value, suggesting that an endowment effect based in loss aversion overrides a win-stay, lose-shift rule for decision-making.

The third question asked how participants interpret the relationship between the unframed risk experiment and the risky and uncertain prospects of farming, and more specifically, whether farmers' narratives of risk reveal the use of heuristics that simplify decision-making. Both "thinking aloud" statements and interview responses demonstrate that participants frequently distinguish the probability of wins and losses, and compare these relative probabilities to actual behaviors in farming. The experiment elicited rich description of decision-making under risk. During the post-experiment interview, farmers detailed their preferences for strategies that include the use of yield enhancing technology and the constraints that limit their adoption and intensity of use. Narrative interpretations of risk and probability suggest many Malawians find security in maintaining a familiar strategy with predictable outcomes rather than experimenting or learning from high-risk experimentation.

Conclusion

This study synthesizes the quantitative analysis of a multi-round risk experiment with qualitative perceptions of risky choices among a random sample of Malawian smallholders. Results reveal that sample farmers, facing sequential risky prospects, tend to repeat their investment strategy after a winning outcome and commonly choose to spend money to reduce outcome variability. Experimental results, participants' narrative comments, and post-experiment discussions reveal that farmers tend to ignore the amounts they spent to reduce risk in the game, so that they confuse gross rewards with net rewards. Participants found similarities between the experiment and real farming decisions, and farmers' narrative comments demonstrate consistent recognition of probability and investment costs in both the game and in farming.

In the face of repeated confrontation with risk and uncertainty and the challenging computations involved in accurate cost benefit analysis for farmers, reliance on simple heuristic rules, such as win-stay, may satisfy many farmers' aspirations. With shifting prices for crops and inputs, uncertain climates, and material constraints on investment, safety first thinking to reduce downside risk, may drive choices. Low rates of adoption of yield enhancing technology may stem from combined influences of the endowment effect, in the larger context of loss aversion, and the necessity for satisfactory and reliable yields for both food security and to gain the capital for further investment in technology.

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CHAPTER 6

FOOD INSECURITY AND SOCIAL COMPARISON AMONG RURAL MALAWIAN FARMERS[4]

[4] Lanning, J. and T. Gragson. To be submitted to *Ethos*

Abstract

Agricultural decision-making is often constrained by food insecurity. Researchers possess tools – typically, experienced-based questionnaires – to quantitatively assess food insecurity. Decision-making is also influenced by how a household perceives its own food insecurity in comparison to other households in the community. Using household food insecurity surveys, we may expect to find a range of variation in how individuals perceive their food insecurity relative to the food insecurity of others (some farmers report faring better than the community at large, some report faring similarly, and some report faring worse). Using data from two seasonal food insecurity surveys and follow-up interviews with 79 Malawian farmers, I report on a case of consistent mismatch in which the majority of informants perceive themselves as being more food secure than the community average, and explain how this mismatch may influence both a household's preferred coping behaviors and its agricultural decisions. I discuss how minor changes to food insecurity questionnaires, typically used to understand food insufficiency at the individual or household scale, may allow researchers to contextualize the mismatch between an individual's perception of her household's food needs relative to the food needs among her wider community in the broader context of agricultural decision-making. I elaborate how "response shifts" in the context of seasonality and social comparison may be usefully applied in anthropology to account for this mismatch.

Introduction

Evidence suggests that one's experience with food insecurity comes from both a shared understanding about food as well as a comparative understanding of the farming success and food insecurity of others in an individual's community. This study addresses the relationship between an individuals' personal experience of food insecurity vs. their perception of the food insecurity experienced by other community members. Previous analyses in rural Malawi indicate that cultivation of improved seeds, irrigation, and applying inorganic fertilizers (three technological innovations promoted to improve smallholder food security and reduce poverty) were not associated with a households' degree of food insecurity (Lanning et al, 2011). This gives value to the importance of examining the drivers that influence perception when using food insecurity instruments that draw on personal experience.

Experience-based measures reflect cultural and personal values of deprivation and may also include "response drift" from respondents adjusting their internal standards about food security and worry based on changing environmental conditions. In densely populated rural agricultural communities, cultivation is a public act and the mechanisms for coping with food insecurity, such as begging, sharing and day laboring, are social. The environmental conditions influencing response to experience-based instruments may thus include conditions that change seasonally as well as an individual's interaction with other community members.

Food insecurity is a daily and seasonal reality for many rural farmers. The persistent presence of a "better-than-average effect" (BTAE) in farmers' reported food insecurity, however, may demonstrate a self-enhancing and potentially motivating behavior that distances one from the discourse of hunger and unskilled traditionalism that permeates the global perception of rural African livelihoods. If the social and seasonal influence of BTAE can be determined, then response bias may be a foreseeable phenomenon rather than merely a response subjectivity to be ignored.

Food insecurity and social comparison

Food insecurity, defined as uncertain access to a reliably sufficient amount of preferred food for an active and healthy life, affects more than one-third of households in sub-Saharan

Africa (Benson, 2004; FAO, 2004). In Malawi, meeting a households' food requirement is primarily satisfied through small-scale farming in fields of approximately one-hectare (Chirwa 2005, 2012). In the last decade, Malawi has simultaneously been described as the model of modernized agriculture, promoted for its increased yields and use of fertilizer and hybrid seeds (Denning et al., 2009), and as unstable, poorly managed, inefficient, and dependent on the goodwill of international donors to achieve food security (Fund, 2013). With an increase in farm subsidies and access to fertilizer and seeds, Malawi experienced a grain surplus in 2005, even exporting to Lesotho, Swaziland, and Zimbabwe. However, Malawi's role as a model for Africa's "Green Revolution" was ultimately short-lived and by 2013 was ranked globally as the 9th worst country for food insecurity (von Grebmer, 2012; National Statistics Unit, 2013).

Household food security represents the outcome of its members navigating a constellation of economic, political, social, and environmental constraints and challenges while striving to meet their food needs (Misselhorn, 2005; Drewnowski and Specter, 2004; Mkandawire and Aguda, 2009; Hadley et al., 2011; Jones, 2014). The nature of experience-based measures of food insecurity, which ask about the frequency of individual and household experiences, has long been qualified as a subjective presentation of the self (Maxwell, 1992; Webb et al., 2006; Jones et al., 2013). For example, the 18-question Household Food Security Survey module (a precursor to the Household Food Insecurity Access Scale or HFIAS) asks informants to self-report feelings of anxiety and perceptions of food adequacy in addition to its more objective recording of constrained food intake (Kennedy, 2003). Scholars contend that assessing feelings, experience, and perception of food insecurity is subject to biased responses, as informants' internal standard of measurements and values are dynamic, and may shift in relation to their social interaction with others in their community (Maes et al., 2010). In short, interaction lends itself to comparison.

Social psychologists have long recognized that social comparison affects people's attitudes about themselves and their relative standing in their community, in a variety of given parameters. Social comparison theory is a framework for understanding people's perception of themselves relative to other individuals in their surroundings (Festinger, 1954). Social psychologists assert that the perception of self exists as both a unique and a socially compared phenomenon. Humans rely on social interaction for survival and these direct and indirect social interactions shape our view of the self and others (Decety and Sommerville, 2003).

Recognizing that both social comparison and response occur, how may the findings of experience-focused food insecurity instruments be interpreted in densely populated rural agricultural communities where cultivation is often public and the mechanisms for coping with food insecurity, such as begging, sharing and day laboring, are social acts? While experience-based instruments aim to capture self-perception and the experience of worry, coping, and food shortage, the social-comparative nature of these measurements and assessment of food insecurity at the community scale has received little direct attention. In a longitudinal investigation of food insecurity among community health workers in Ethiopia, Maes et al. (2010) found evidence of potential social comparison influencing survey responses. Improvements in self-reported levels of food insecurity, across three surveys, were partially explained by a "response shift" in which respondents change their self-reported food insecurity in relation to their interaction with others in their community. The researchers conclude that social interactions lead to a reassessment of the "internal standard" for food insecurity for health workers as they interact with others suffering from more pronounced food insecurity.

In Malawi, Participatory Rural Appraisal has been used to examine the perception of food insecurity and coping strategies at the community scale (Ali and Delisle, 1999). Researchers asked small groups to identify the number of other households in the community suffering from food insecurity. In two communities in the southern region, small groups participating in the study reported 94% of the community to be food insecure.

The objective of this study is to examine the influence of social, physical and biological realities on self-reported food insecurity across two seasons. This paper builds on a small but important literature examining the social dimension of food insecurity, by considering social comparison theory as a lens through which rural Malawian farmers report their experiences. If response drift occurs, in the absence of correlation between proxies of food insecurity and objective measurements of wealth or nutritional status, is it merely noise in the data or is it something that is predictable based on considering forces such as seasonality and the public nature of labor? In short, if it is predictable rather than merely noise, then instruments such as the HFIAS have utility in capturing response drift as a reflection of changes in lived experience.

Local setting

The study site encompasses a $16km^2$ area (Figure 6.1) that lies between the towns of Dedza and Ntcheu along the Malawi/Mozambique border, in the foothills of the Kirk Range. The households targeted from the rural communities within the Ntcheu district rely on small-scale farming using a combination of local and "improved" agricultural inputs and practices to produce rain-fed maize as the main staple crop. Some households use gravity-fed and riverside irrigation in the valleys and hillsides along the Kirk range to supplement the main rainy season harvest, either in formally organized community schemes or in private wetland fields (*dimba*), irrigating with foot pumps and watering cans. Eighty eight percent of sample households report farming of maize. Area farmers produce for both household consumption and small-scale engagement in weekly markets and seasonal selling of maize and beans. The area is representative of broader Malawian and southern African regional dynamics as smallholder agriculture is the main source of livelihood for over 84% of Malawian households that, on average, own only one hectare of land (Chirwa, 2004).

Ethnic identity in the area reflects a complex history of migration and intermarriage. Among communities in the study area, people commonly identify as Ngoni, often relaying stories of an historical settling of pastoral ancestors from Nguni of South Africa. Yet the majority speak the national language of Chichewa and are engaged in settled agriculture with sporadic ownership of cattle.

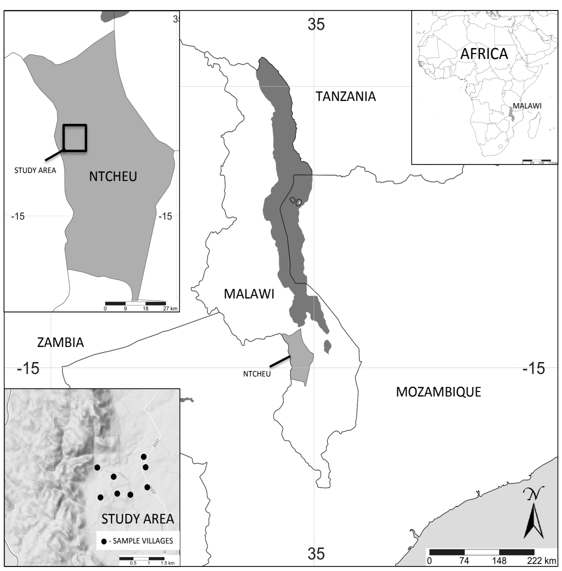


Figure 6.1: Map of the study area and sample villages in the district of Ntcheu, Malawi

Malawi’s climate is semi-arid, with a single rainy season between November and April. Farms and fields in the study area range between 940 and 1060 meters above sea level. Community members commonly perceive the frequency and intensity of rainfall to be increasingly inconsistent and unpredictable and report that climate uncertainty constrains their agricultural production and influences household food insecurity.

Households commonly supplement farming with informal temporary or seasonal employment, or *ganyu*. Nearly 60% of sample informants report completing ganyu in 2013. Ganyu is both an economic and social act. Both individuals and small groups may complete agricultural labor in the fields of another household as well as work on road repairs, transporting water for domestic use or brick making, and small-scale construction projects. While a farmer may be employed in the same ganyu several times in a year and may rely on the same neighbor for employment, it is never a guarantee that jobs will be available. When ganyu jobs are available, it is an employers' market where laborers have little control over hours and wages. Ganyu aids food insecure households, supplementing both harvests and income. However, residents note it may have deleterious effects on one’s own fields, as labor is siphoned away from maintaining crops in the search for cash.

A limited number of residents in the area augment farming income with additional employment in the form of salaried jobs, engagement in tobacco production, producing charcoal, or with remittances. Income generation via charcoal production is associated with a household’s proximity to the remaining forested areas in the Kirk Range; households in the valley lack trees for charcoal production. Eighteen percent of households report growing tobacco in 2013 and an additional 18% of households report previous involvement with growing tobacco, but currently lack resources such as fertilizer and seed or lack the interest in managing the risk and labor required for participation in the tobacco market. Supplementing income by engaging in tobacco production is notoriously unstable due to the unpredictable nature of tobacco markets and pricing (Mkwara and Marsh, 2014).

The market engagement of smallholders in the area is constrained by access and availability. Although the closest town of Ntcheu has paved roads, electricity, a daily market, bus access, and several shops for buying food, clothes, building supplies, and agricultural inputs, the communities in the study site are between 18-21 km away by a network of seasonably passable dirt roads. Residents either carry goods by hand or transport harvests by bicycle, climbing more than 400 m to reach markets on the main road between the capital city of Lilongwe and the main southern region city of Blantyre. As crops mature, residents may also sell harvests to mobile buyers in exchange for maize, beans, and dried fish from Lake Malawi and to the government owned Agricultural Development and Marketing Corporation (ADMARC). Selling to mobile buyers has advantages, as they come directly to the farmers' home, but they buy at unpredictable prices and, if farmers' frequent complaints are to be believed, tamper with scales. Uncertainty pervades the process of selling harvest and buying inputs at the local ADMARC as well. The non-negotiable and low buying prices and lack of purchasing funds are countered by relatively consistent availability of maize for purchase during the lean season when rain-fed maize has not fully matured (Chirwa, 2005). Acquiring agricultural inputs requires a cash income or a combination of cash and access to government seed and fertilizer subsidy coupons. The transaction costs involved in sourcing inputs, purchasing them, and shipping them from towns to rural areas on rented vehicles or piecemeal over several bicycle journeys further constrains livelihood diversification and food security. Summary statistics of household demographics and sources of income for sample individuals are presented in Table 6.1.

Table 6.1: Selected demographic characteristics of 79 sample household heads

	Mean (SD)	Median	Range
Household Size	4.4 (±1.8)	4.5	1-8
Age of Respondent	43.3 (±16.3)	41	19-85
Completed Years of Education of Respondent	6.1 (±3.8)	6	0-13+
Years Farming in the Study Area	17.2 (±13.8)	11.5	2-59
Agricultural Income 2013 (MK)	48,324 (±88,030)	20,000	0-620,000
Remittance Received 2013 (MK)	5,146 (±14,868)	0	0-96,000
Income Spent on Inorganic Fertilizer 2013 (MK)	21,104 (±29,173)	9,200	0-129,200
% Completing Day-labor (Ganyu) in 2013	59.5		
% Producing Charcoal for Sale in 2013	17.7		
% w/ Salaried Employment in 2013	12.3		
% Using Irrigation in 2013	19		

Note: $1USD = 410 Malawi Kwacha (MK), SD: Standard Deviation

Methods

Sampling

Surveys were administered seasonally to a sample of rural smallholder households in the Ntcheu District of central Malawi. The sample included 85 farming households drawn randomly from an exhaustive census of eight rural communities within the district. A small number of households missed the second survey round. Due to missing data, these analyses address data collected with 79 individuals (49 women and 30 men) who self-identified as the head-of household at the time of the first seasonal iteration of the survey. One Malawian research assistant was trained in administering the survey and accompanied the lead author in both rounds of data collection and during follow-up interviews.

Ethnographic approach

The lead author has lived and worked in Malawi for 35 months over the 12 years preceding this study, first as a Peace Corps volunteer (2000 – 2002) and subsequently working in the study area as a consultant for a community-led irrigation scheme. He has previously conducted research in the area testing the cross-cultural validity of a food insecurity survey

(Pérez-Escamilla et al., 2004) in a rural Malawian context (Lanning et al., 2011). For this study, participant observation was conducted in the eight communities of the study area, including attendance at the annual fertilizer and seed subsidy coupon distribution, weekly markets, monthly nutrition rehabilitation appointments at the local health clinic, and in the homes and fields of smallholders, over 15 months between December 2012 and July 2014.

Administration of each seasonal food insecurity survey was followed-up by a semi-structured interview assessing agricultural decision-making, livelihood constraints, coping strategies, and attitudes towards risk with all 79 household heads. Emergent themes within the data were grouped using both *a priori* and *in vivo* coded categories and are used here in the analysis of the quantitative results of the adapted survey instrument.

Six months after completing both rounds of the survey, a third follow-up interview asked informants to explain the degree and direction of any difference that existed between the self and community scores between the dry and rainy season. The interview examined the specific traits and behaviors that influenced observed difference between self and community scores, as well as general traits and behaviors of successful or model farmers in the area to contextualize social comparisons. In order to examine if a shared model of behavior for achieving food security existed within the study area, individuals were asked to describe the techniques, technologies used, and general behaviors of other households that they perceived to have the greatest food security.

Survey Instrument

We use an adapted version of the Household Food Insecurity Access Scale (HFIAS), measuring self-perception and the experience of coping with uncertain access to preferred food in Malawi (Coates et al., 2007; Knueppel et al., 2010). The standard 9-item instrument was translated into Chichewa and back translated for pilot testing. After pilot testing the standard instrument, we made four modifications based on suggestions from key informants and respondents. First, we include questions for both staples (*nsima*, maize-based foods) and side-dish foods (*ndiwo*, e.g., mustard, rape, cabbage, tomatoes) in order to recover seasonal differences in the availability of these food classes that are considered contingent on rainfall or access to irrigation. Second, we include two questions addressing strategies for coping with food insecurity (i.e., begging and borrowing) with the aim of capturing seasonal variation in the experience of food insecurity. Third, key informants suggested we use "drought or wild foods" rather than "non-preferred food" as used in the original instrument as this term was unspecific and poorly understood. Finally, we used a 90-day recall period rather than the original 30-day recall period to capture an overall perception over the course of a rainy and a dry season.

Each individual was surveyed twice, once during the "dry" season (July to September) following the harvest of rain-fed maize and a second time during the "rainy" season (January to March) regarded as a time of hunger in Malawi (Kerr et al., 2008). On each occasion, the individual first completed the adapted 10-question questionnaire for self, "how often did you worry…" then completed the questionnaire a second time for community, "how often did others in your community worry…". The respondent was not guided to a specific definition of "community." The possible frequency of occurrence responses to each of the 10 questions include "never," "sometimes," "frequently," and "daily" coded from 0-3 respectively. For each respondent there are consequently four response profiles: 1) dry season individual *(DI)*, 2) dry season community *(DC)*, 3) rainy season individual *(RI)*, and 4) rainy season community *(RC).*

Members of each informants' immediate family, including children and spouse were frequently present during our conversations. Data collectors attempted to ensure neighbors and extended family members were not present during interviews to reduce social pressure on informants' responses.

Results

Semi-structured interviews

Farming in rural Malawi is a public and inherently social act. Preparing fields, planting, irrigating, weeding, fertilizing, and harvesting cannot be done in private. The timing of farm related tasks are driven by rainfall, sunlight, and temperature: factors shared by a community. In densely populated farming communities, the close proximity of fields means one is often laboring in her field while a neighbor is laboring in his. Even when walking to the market, to the hospital, or to the river to wash clothes, a farmer is certain to pass others completing daily agricultural tasks. These interactions are opportunities to discuss farming and compare food insecurity. As one smallholder explained, "We are in the same village so we are like one family. People come to me to ask for things so, without even going to their households, I can know that people have these problems."

Smallholders in our sample expressed that their perception of food insecurity stemmed both from their own experience and from comparison with others in their community. By observing the behavior of others, smallholders may contextualize their own experience of food insecurity. As one household head stated, "As a woman I am at the bore hole [to fill water containers] everyday and I hear the people complaining about a lack of food. This year I am hearing less of these stories. I see fewer people going to the mountains to harvest wild food than I have seen in other years."

Smallholders are cued to the success of another's harvest by observing and discussing coping strategies. In their explanation of why differences were present between self and community food insecurity scores, farmers described seeing, hearing of, and personally experiencing when other households purchase, beg, or borrow food and witnessing the degree to which community members engage in ganyu. As one farmer stated, “I can see people go to the fields to work for food from someone. I can also see them carrying a plate of ufa [maize flour] from another house where they must have had to beg for flour.” Another added that, “I know who else is suffering because I am meeting them while doing ganyu and seeing them buying maize when I am at the ADMARC (Agricultural Development and Marketing Corporation)”

Smallholders also referred to their limited ability to redress food insecurity through alternative income streams, such as ganyu and charcoal production. One respondent noted that, “If there is cash there is inequality. You can sell charcoal but only if you can get the trees. You need money for everything here. Without a salary and only the weekly pay of ganyu you’re never able to afford to pay people to work in your garden for less than you are making working in someone else’s garden.” Another farmer, noting the difference in behaviors between those who are successful in farming and those who struggle explained that, “The families with enough maize write a note and advertise so everyone can read it. Then others go door to door seeking ganyu. These people don’t have time to farm their own fields and so they harvest less. These people live a life of loving money, but then the money runs out and they are struggling. Others use the money to buy meat and sell their maize in the dry season. They don’t realize they have run out of food until it is too late.”

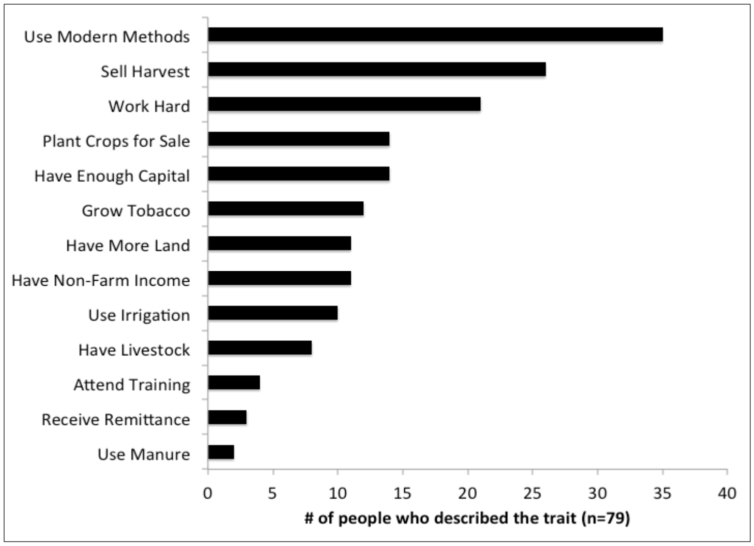
Evidence suggesting that internal standards of food security shift seasonally was present in interview responses. While farming tasks occur year-round, the visibility of farm labor increases in preparation for the rains and during planting and weeding early in the rainy season. In the dry season (May- October) days spent in the field are not tied to specific shared events;

farmers inconsistently visit their fields once harvesting is completed, delaying field preparation as the rains have not yet begun. In the months and days preceding the rains and throughout the rainy season, cultivation and field management occurs is a daily and shared event among smallholders. Informants described how the indirect evidence of farming success and the increasing food insecurity that occurs as food stores run low are more public during the rainy season. One farmer noted that, "Now (during rains) there are people coming to my house to beg for food. I visit houses for chatting and no food is given and now there are even weddings without food because households lack enough food to feed others."

Follow-up interviews

The six-month follow-up interview addressed discrepancies that existed between the self and community food insecurity scores in the dry and rainy season. In response to the questions "why is your self-rating different than your rating for the community" and "in what ways do food secure individuals farm," respondents most frequently identified the use of "modern" farming methods and the selling of harvests as the two behaviors that distinguish one as food secure or lead one to have more food security than others in the community. The use of "modern" methods is broadly defined as the application of inorganic fertilizer and the planting of improved seed varieties and is distinguished from using manure or local seed. One hundred percent of sample farmers used inorganic fertilizer and 97% planted some portion of their fields with improved maize seed in 2013. The frequency of the emergent behaviors and traits that result in greater food security based on the semi-structured interviews are presented in Table 6.2.

Table 6.2: Emergent traits and behaviors explaining of food secure individuals.



Qualitative results also pointed to farmers using self-reported food insecurity as a form of self-enhancement in the face of limited opportunities to change the material conditions of their life. Within the local comparative context, some farmers believed that others underreport their degree of household food insecurity to avoid appearing poor and unable to practice modern farming. As one respondent summarized:

> "Some people don't speak the truth, but they know they have problems. They lack a spirit of accepting their life and sleeping with hunger. They don't want to humble themselves and look cheap. I can't set a high price on myself while I am only worth a chicken, but people do. Others don't accept what they are going through and say they are okay while they have problems. They have a spirit of loving themselves too much selfishly and don't accept reality. Instead of allowing other people to help you, you block those blessings in the end."
>
> \- 40 year-old farmer and mother of five

Quantitative findings

The sum of the frequency-of-occurrence responses to the 10 questions for each of the four profiles is designed to reflect a single statistical dimension of food security. The original range in value for each scale was 0-30. However, since the recall period was increased from 30 to 90 days, it was subsequently decided that three occurrence levels (never = 0, sometimes/frequently = 1, and daily = 2) on a scale of 0-20 was less subject to recall bias. There is no statistically significant loss of information from collapsing the four response levels to three response levels. The four resulting scales used in this analysis are labeled DITOT, DCTOT, RITOT and RCTOT.

A Cronbach's alpha assessment of each of the four scales each composed of 10 items suggests good reliability in measuring the underlying concept of food security (Table 6.3). The square root of α is the estimated correlation of a test with errorless true scores (Nunnally & Bernstein, 1994).

Table 6.3: Cronbach's alpha assessment of each of the four food insecurity scales

Scale	**α**	**√α**
Dry Individual Total (DITOT)	0.6737	0.82
Dry Community Total (DCTOT)	0.8384	0.92
Rain Individual Total (RITOT)	0.7112	0.84
Rain Community Total (RCTOT)	0.7729	0.88

Evidence suggests three potential drivers of variation in how people perceive and report their household food insecurity. These include a) daily and seasonal experiences, b) comparison to other households and individuals in their community, and c) comparison to shared discourses and models of successful modern farming. The questionnaire results allow us to address the first two of these drivers, which we do by examining the response scales and the associated domains.

Ethnographic evidence allows us to make four discrete directional, one-sided predictions. First, the relation between the self score for the dry vs. rainy season will be: DryInd < RainInd. This reflects the seasonal reality of food insecurity for rural Malawians marked by general food abundance during the dry season following harvest of rain-fed maize, and decreased food abundance during the rainy season as the food stores from the previous harvest are dwindling as they await the next harvest. Second, the relation between the self score and the community score will be: *Ind < *Com, reflecting the 'better-than-average' effect observed in numerous previous studies. Third, DryCom < RainCom reflects the observation that the social-comparative nature of food insecurity is accentuated during the rainy season as farm labor, including planting and weeding, increases during in the rainy season. Fourth, the relation between all four scales is expected to be: DryInd < RainInd < DryCom < RainCom reflecting the combined effect of "better-than-average" and seasonality. Summary statistics presented in Table 6.4 for the four scales suggests support for all four predictions.

Table 6.4: Summary statistics for four food insecurity scales

	Mean	**SE**	**95% CI**	
Dry Individual Total	2.19	.23	1.73	2.65
Dry Community Total	5.77	.39	5.00	6.55
Rain Individual Total	3.49	.28	2.94	4.04
Rain Community Total	9.35	.28	8.80	9.91

A Wilcoxon sign rank test confirms both the significance and direction of these observed differences (see Table 6.5).

Table 6.5: Results of Wilcoxon sign rank test comparing food insecurity scales

Ho:	**z =**	**Prob > l z l**
DITOT = DCTOT	-6.725	0.0000
DITOT = RITOT	-3.832	0.0001
DITOT = RCTOT	-7.724	0.0000
RITOT = DCTOT	-4.200	0.0000
RITOT = RCTOT	-7.571	0.0000
DCTOT = RCTOT	-6.608	0.0000

The 10 questions on each scale relate to three domains of food security thought to be universal with respect to the access component of household food security (Coates et al., 2007).

The three focal domains examined by our modified instrument are: ***anxiety and uncertainty (ANX)*** about the amount of food available to a household, the lived experience of ***insufficient food intake (TKE)***, and ***strategies for coping (STR)*** with food insecurity. These domains are defined by reference to the scores from component questions as follows:

var: **ANXIETY (DIANX, DCANX, RIANX, RCANX)** (three questions: 1, 2 and 8)
1) How often have you worried you'd run out of staple food before finding more
2) How often have you worried you'd run out of side-dish food before finding more
8) How often do you worry you are not cooking enough to feed your family

var: **INTAKE (DITKE, DCTKE, RITKE, RCTKE)** (four questions: 3, 4, 7 and 9)
3) How often have you actually run out of staple food before finding more
4) How often have you actually run out of side-dish food before finding more
7) How often are your children/family hungry and you have nothing to feed them
9) How often do members of your entire household go an entire day with eating food from waking until sleeping

var: **STRATEGY (DISTR, DCSTR, RISTR, RCSTR)** (three questions: 5, 6 and 10).
5) How often have you begged for food from another household
6) How often have you borrowed food from another household
10) How often have you cooked drought or wild foods because you lacked other food

A biplot (Figure 6.2) of the three domains across all four scales further supports both the relation between the scales as well as the ethnographic expectations. The vectors for each domain within each scale overlap closely, further supporting the results that in each case they combine to form a well-defined scale. The vectors for RI* and DI* lie nearly at right angles, or orthogonally to each other, indicating a clear separation between self and community evaluations. The RI* and DI* vectors, as well as the RC* and DC* vectors have angles of incidence between the pairs indicating they are highly correlated.

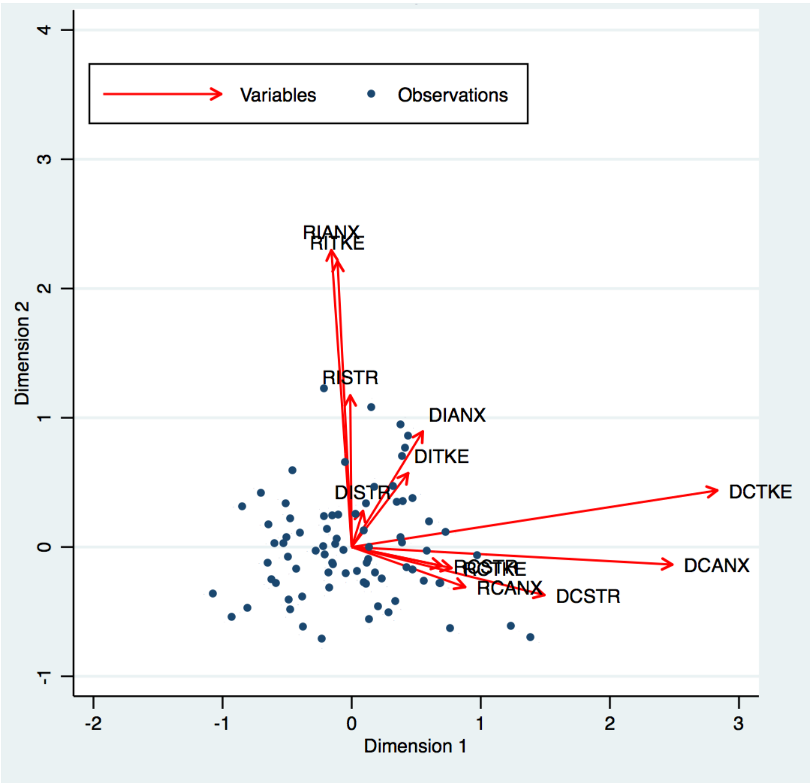


Figure 6.2: Biplot of three domains of food insecurity across four scales

<u>Implications</u>

Maes et al. (2010) argue that response shifts in longitudinal food insecurity assessments occur among informants who experience repeated encounters with others they perceive to be poorer and hungrier. Our study suggests that response shift emerges more broadly as a predictable response to individuals' interaction with the social, physical, and biological world around them. Smallholders are sensitive to things that affect them; they succeed by doing farming. However, their perceived success emerges not only from measuring their own yield, but through social comparison with others in the community and in response to changing seasonal conditions.

Experience-based measurements of food insecurity ask individuals to recall and evaluate their experience with food insecurity. These measurements rely on self-perception and assume individuals will accurately recall their personal experiences. Our data support the conclusion that experience-based food insecurity instruments applied in agricultural communities, in which residents share livelihood opportunities and constraints, invites social comparison. Food insecurity is a relative phenomenon. Individuals know or believe they know the food insecurity status of others around them based on social interactions and observation. Further, individuals generally share a model of the farming behaviors that lead to food security and they know how often they follow the model behaviors and, through social interactions, how often others in the community do as well.

Understanding the shared model and behaviors of food secure households, such as using modern agricultural inputs and selling harvest through market engagement, is critical to understanding how people measure their own success. Feelings and emotional responses to food insecurity, as opposed to alternative food insecurity measurements such as diet-diversity, caloric intake or anthropometrics, likely capture a wider definition of livelihood success beyond only food insecurity. The shared model of traits and behaviors that lead to food security and the qualitative explanation for differences between food secure and food insecure households suggest that Malawian farmers consistently identify the use of "modern" farming methods, such as planting improved hybrid seeds and applying inorganic fertilizer, and engaging in the marketing of harvests as the pathway to achieving household food security. An individual may assess her own food insecurity based on how well she has employed food secure farming behaviors in her own fields in comparison to her perception of how others have.

The tendency to consistently self-report lower food insecurity scores compared to the food insecurity of the community, across two seasons, reflects a general heuristic of self-enhancement and evidence of the "better-than-average" effect in reporting food insecurity. The feeling of insecurity is more than a feeling of worry about food shortfalls and daily hunger. The feelings also encompass a sense of belonging and worth. These food shortfalls and constraints are a reflection of economic, environmental, and socio-political constraints, but they are also evidence that one may not be achieving the revered status of a farmer employing modern methods and engaging in the market. By asserting that one is food insecure but that the community is more food insecure, an individual may achieve a favored status closer to the idealized model, even if she cannot actually change her households' circumstances or fully engage in the behaviors that Malawians identified as resulting in food security.

The value of ethnography lies in the ability to use it to reveal the intricacy of social interactions over time. It is useful in making clear that farming is a social act. The question then is what is the value added of ethnography to a researcher in need of the efficiency and broad validity of survey instruments. By drawing out the statements and observations that speak to causality, gleaned from long-term ethnography, one is able to formulate predictions that are testable using survey instruments.

Our longitudinal qualitative and quantitative results demonstrate that, in rural Malawi, farming, food insecurity, and strategies for coping with food insecurity are social acts embedded in physical and biological realities. Farmers have ample opportunities to observe the inputs and outcomes of community members' strategies to supply food to their families and markets. This highly social food production environment fosters social comparison as individuals evaluate their own food insecurity across seasons. While food insecurity is a daily and seasonal reality for many rural farmers, the persistent presence of the "better-than-average" effect in farmers' reported food insecurity demonstrates a self-enhancing behavior that distances one from the discourse of hunger and unskilled traditionalism that permeates the global perception of rural African livelihoods.

Taking caution with self-reported scores

If respondents use a comparison target when self-reporting individual experiences with food insecurity, data may be imprecise and inaccurate in regards to the status of a household in a community and the relative status of its food insecurity when targeting relief, input assistance, or other interventions. These data demonstrate consistent “better-than-average” bias in self reported food insecurity across two seasons. Comparison bias is found to be greater when individuals compare themselves to an “average other" rather than to a specific target person. There is also evidence of a dampening of the effect when individuals self-report their status in the presence of a comparison target (Alicke, Klotz et al. 1995). In this study, the comparison reference point of “community” was left to the informant to interpret. Therefore, it is possible that while social comparison does occur when an individual responds to a food insecurity survey, the reference point for the comparison may not be the community as a whole but to a few frequently encountered individuals or those who are considered to suffer the greatest. This unspecified reference point for comparison may explain the frequency of downward comparison. Further research exploring the social comparative nature of food insecurity survey responses should address this.

Conclusion

Using food insecurity data collected in two seasons, this study examined an underexplored social-comparative lens for understanding the incidence of food insecurity demonstrating that individuals consistently rank themselves as more food secure and the community as less food secure, particularly in the rainy season. However, the broader impact of this study is not noting that BTAE exists and that Malawian farmers engage in it. Rather, by identifying it and its affect on response shift, we may more precisely factor out what elements of difference within a population are due to random noise. Thus, by recognizing that the combined influence of social comparison and seasonal response drift exists, the response drift present in measurements of food insecurity is a knowable phenomenon reflecting changes in lived experiences. The drivers that influence and biased self-perception should be accounted for when using food insecurity assessment instruments that draw on personal experience and the feelings associated with food insecurity as guiding metrics.

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CHAPTER 7

CONCLUSION

Smallholders in the New African Green Revolution

The aim of this dissertation was to disentangle the drivers of agricultural decision-making in an environment of induced innovation, via the policies and practices of the new African Green Revolution in Malawi. It presents aspects of a counternarrative to the dominant discourse of rural problems and their technological solutions in Malawian agriculture. The thrust of the Green Revolution agenda for combatting global poverty and hunger is broadly premised on the assumption that the value of increased yields outweighs the inherent cost of attaining yield-enhancing technology. The theory is straightforward: a "bumper crop," achieved through techno-chemical intensification methods, allows farmers to sell surplus yields. Market integrated farmers, employing Green Revolution technology, thus move beyond cultivating for subsistence alone and begin cultivating for profit. In ideal conditions, such as those found on researcher-led demonstration farms with abundant inputs and labor, predicted yield gains from technology have been achieved. However, the failure of the Green Revolution strategy to effectively pull or push Malawian smallholders towards net positive returns and improved wellbeing through the adoption and intense use of technology reflects the imperfections of the technocratic strategy iteratively promoted by private-public partnerships in Malawi since the 1970s. It either assumes smallholder homogeneity or ignores the unequal access to productive resources necessary for wide-scale or pro-poor growth through Green Revolution strategies.

The reality of smallholder cultivation is a far cry from the ideal found in policy recommendations and demonstration plots. Peasant conservatism and a conception of smallholders as “laggards, “inefficient,” “irrational,” and “stagnant” are cited as explanations for the gap between models for modernized agricultural production and the reality of chronic impoverishment and food insecurity (Tchale, 2009; Dorward and Chirwa, 2011). In contrast, for many Malawian smallholders, the sub-optimal outcomes of techno-chemical intensification stem from a combination of heterogeneous access to and availability of high cost inputs, wealth inequality, erratic rainfall, soil infertility, chronic ill-health, corruption, limited of extension services, increasing demand to divert labor from own-farm production, and limited arable land per person. The problem is broader than a Malthusian crisis of population exceeding capacity. Thus, the solution is likely to require more than growth in yields.

This conclusion will first provide a brief summary and synthesis of the data analysis in chapters 4, 5, and 6. Next, I will address the implications of these findings for both the agenda of the African Green Revolution and for future research addressing smallholders’ materially and cognitively costly decision-making in stochastic economic and ecological settings. Finally, I will discuss future directions for my own research that address and build on the findings of this study.

Chapter Summaries

The central question of this dissertation has been: *how do smallholders make agricultural decisions in rural Malawi, a country in the vanguard of the new African Green Revolution?* Each chapter dissects aspects of this broader question. These analyses are drawn from long-term fieldwork among smallholders that examined the drivers of intensity of use of agricultural technology (Chapter 4), farmers’ attitudes towards risk in both experimental and real-life settings

(Chapter 5), and the social-comparative nature of the experience of seasonal food insecurity (Chapter 6).

Chapter 4 critically engaged the claim that inorganic fertilizer and improved seed use is a scale-neutral strategy to reduce poverty and food insecurity broadly among communities of rural smallholders in Malawi. In it, I argued that the outcomes of the new African Green Revolution are increasingly indistinguishable from those of the first Green Revolution in Asia and Latin America. Here, I examined the predictors of households' investment in improved maize seed and inorganic fertilizer, addressing how different factors drive the decision to invest in each technology. This chapter explored the how differential access to technology and disparate rates of use intensity among households are both a cause and effect of local-level economic and social inequality in rural communities. As expected, analyses suggest that the cost of modern input use is prohibitive and that technology differentially benefits producers with greater material wealth, as well as human and natural capital. I found that while promotion of Green Revolution solutions to poverty may demonstrate benefits at the macro-scale, through aggregate national yield increases, they might further exacerbate economic and social inequalities at the micro-scale. Smallholders securing inputs with capital derived from the sale of harvests and through temporary and low-paying off-farm employment risk increased ill effects, as the cost of accessing and employing inputs increases.

Chapter 5 contributes to a broader understanding of how Malawian smallholders understand the concept of risk and how outcome variability influences investment strategies over time. A direct contribution of this study is the novel methodological approach taken to examine attitudes towards risk. Attitudes were addressed in a broader sense than is common in the literature of agricultural economics. This study explored the ethnographic complexity of the decision-making rather than focusing effort on developing a mathematically formulated model of human behavior (Chibnik, 2011). In this chapter, I combined a multi-round real-reward choice experiment with "thinking-aloud" interviews to elicit participants' preferences and probabilistic assessment of choices, as well as their narratives of the decision-making process. Quantitative analyses of the multi-round experiment indicated that farmers focus on reducing variability in each round of the experiment rather than maximizing their net gain over several rounds. The outcome of the preceding round influences subsequent choice, but in unexpected ways. *Win-stay, lose-shift* was an expected strategy for mitigating the cognitive challenge of calculating expected value and variance, such that participants may repeat a choice after a positive outcome and try a new strategy in the face of loss. However, while farmers demonstrate a *win-stay* strategy, choices did not indicate *lose-shift* behaviors. More generally, choices and narratives indicate that a *safety-first* strategy influences both experimental and real-life decisions. Choices in the repeated confrontation with risky prospects gravitated towards options with a higher probability of obtaining low or negative returns, rather than maximum net gains. In the experiment, farmers paid for the preference of reducing downside risk; hazarding over-investment by ignoring net gain. I argue that, in employing Green Revolution technology, farmers may confuse gross and net rewards. A correlation may be drawn between a preference for vividly presented options in the experiment (i.e. the option with the most winning balls) and smallholders' belief that monocropping of improved seeds and the use of inorganic fertilizer is the most lucrative solution to poverty, especially when it also the guiding agricultural innovation policy of the Malawi government and its development partners.

Chapter 6 contributes to the literature on food insecurity and social-comparison theory. Here, I examined how perceptions of food insecurity, across two seasons, are associated with attributes of producers, their intensity of use of agricultural technologies, and their access to exogenous sources for mitigating food shortfalls, such as remittances and off-farm employment. In the absence of predictive relationships, this chapter explored the social dimension of food insecurity, comparing how individuals perceive their own food insecurity relative to that of others in their community. This comparative analysis demonstrated a well-documented bias in social psychology in which an individual consistently ranks himself better than an unspecified *average* individual. I argue that this pervasive *better-than-average* effect reflects a self-enhancing behavior in reporting household food insecurity that allows one to distance himself from the discourse of hunger and unskilled traditionalism that permeate the global perception of rural African smallholders. When cultivation, exchange, and coping with food shortage occur in a highly social and materially constrained environment, they invite comparison between households with limited capacity to address food insecurity through behavior change. These biased self-reports may result in systematic and predictable underreporting of food insecurity, reflecting a motivational reaction of farmers coping with food insecurity psychologically, in the absence of material means.

Limitations

Do these chapters answer the question of how Malawian smallholders make agricultural decisions? Yes, but with limitations. This study was limited by the challenge of observing change over time. That wealth and household endowments drive the intensity of technology use challenges the broad expectation of the Alliance for an African Green Revolution that scale-neutral inputs, which achieve high returns in controlled settings, will productively transfer to heterogeneous communities of farmers. However, Chapter 4 lacks the depth of time to document a cause and effect relationship between the promotion of agricultural technology and increasing economic and social inequality. Sample farmers' narratives and the well documented impacts of the Green Revolution in Latin America and Asia do suggest that the drivers of intensification I have described, combined with growing pressure on arable land and erratic rainfall, are likely to result in pockets of growth in a sea of vulnerability (Fan and Hazell, 2001).

I predict that the rate at which economically constrained households engage in ganyu labor is telling of future conditions in Malawi. Scholars contend that ganyu acts to reduce food insecurity, allowing smallholders to fill seasonal food shortage through employment (Whiteside, 2000). In contrast, sample farmers in this study reported ganyu to be a "necessary evil," drawing them away from adequately addressing the needs in their own fields in order to recover from shortages in the previous season. As discussed by Dawson et al. (2016:214), the polarizing affect of Green Revolution strategies on rural communities may create a "burgeoning underclass" dependent on sporadic off-farm employment opportunities to escape a poverty trap. Bezner-Kerr (2005), Bryceson (2006), and Takane (2008) demonstrate further evidence that this pattern is developing Malawi.

An additional limitation exists in the analysis of attitudes towards risk. In my effort to design a simple, yet externally valid experimental game certain flaws became apparent. The game described in Chapter 5 suffers from flaws common to many experiments. First, while the game benefits from offering real-rewards, the initial endowment participants invested reflects a windfall. Participants' experimental choices were potentially influenced by this sudden influx of free cash. For some, it may have resulted in a *house-money effect* (Thaler and Johnson, 1990), leading them to take greater risks with free monies than they would have made with their own. For others, the windfall may have had an *endowment effect* (Thaler, 1980), meaning they intentionally avoided taking risk in the experiment as compared to their behavior in a real-life setting.

By aiming for simplicity in gameplay, I created difficulty in data analysis. The opportunity for participants to play subsequent rounds based on the outcome of the previous round allowed for interesting analysis of heuristics shortcuts, such as *win-stay, lose-shift*. However, it made for a messy understanding of normative behavior. The variability in pathways between choice one and choice four, with wins and losses in between, was too large for the small sample size. I was unable to conduct a meaningful analysis of the relationships between traits of individuals and choices.

Finally, experiments are commonly challenged for the effect of problem and outcome framing on choices. By design, the experiment aimed to mimic agricultural investment decisions over multiple seasons. However, certain assumptions and reductions were made about the relative risk and return for each of the three lotteries. The calculation of expected value and variance were abstractly related to actual relative costs and benefits of agricultural investments, leading to caution in interpreting the association between experimental choices and real-life decisions. Following Tucker (2012:174), I found that “experiments are a useful complement to interviews and observation; experiments may reveal information that cannot be easily learned by other methods.” When narratives alone may not be accurate description of past mental processes (Nisbett and Wilson, 1977), experiments may act as a tool for eliciting both instructive quantitative and qualitative data.

Direction of future research

If employing Green Revolution technologies is degrading soils, exposing monocultures to market and climate shocks, enhancing and entrenching micro-scale economic and social inequality, and eroding the livelihood security and lifestyle of smallholders, why does it persist in Malawi? A reader may argue that one might rightfully expect an answer to that question by the end of this dissertation. However, regardless of my extensive fieldwork and residence in Malawi, these analyses have increased my awareness of the complexity driving the persistence of technocratic and modernist solutions to poverty and food insecurity. To conclude that smallholders are a heterogeneous group whose livelihoods are maintained in a stochastic economic, political, social, and ecological setting leads me to question what strategy, in conjunction with or in the absence of the new Green Revolution, may improve the wellbeing of smallholders? Further, how does the increasing push towards technological innovation influence local knowledge and do these policies result in deskilling of smallholders (Stone, 2007)

To this end, I aim to assess farmers' knowledge of different seed varieties and their history of use of both local and improved seeds. While this dissertation has addressed the high cognitive costs involved in agricultural decision-making, the constant influx of new seed varieties is overwhelming. Farmers must navigate advice from extension workers, seed company advertisements (on the radio and billboards), government promotion of specific seed varieties through FISP, and recommendations from other area farmers. I am interested in establishing whether an *indigenous knowledge* of maize varieties persists in this dynamic environment. Seed saving and seed exchange occurs. However, recycling and unintentional crossbreeding of hybrid varieties is common. As the range of genetic and environmental diversity shrinks, are farmers able to discriminate the relationship between genotype, phenotype, and environments?

Building on the themes introduced in Chapter 6, I plan to further explore the relationship between food insecurity and social-comparison. It is well understood that a person who is food insecure is not necessarily hungry. What is less well understood, beyond the potential physical manifestations of nutritional deficiency, is how coping with food insecurity and its associated mental costs are embodied. The downward social comparison described in this dissertation, which is more pronounced in lean seasons, suggests the use of self-esteem enhancing coping strategies to maintain mental health in the face of insufficient diet and constrained mitigation strategies. Untangling the link between the experience of food insecurity and mental health has both theoretical and methodological implications for our understanding of wellbeing and the embodiment of food insecurity in different cultural and social contexts.

I intend to engage in research that draws on anthropological method and theory to quantitatively and qualitatively assess the prestige value that individuals within communities apply to foods. This research will ask how food insecurity is linked to mental ill health, by studying how seasonal dietary shifts precipitate changes in the nutritional value and social meaning of foods consumed by Malawian farmers. This work thus has the potential to transform our understanding of the consequences of food insecurity for wellbeing and facilitate connections between two complementary disciplines - anthropology and public health. By directly addressing the physical and mental health outcomes of the social meaning attributed to food, this research generates new knowledge relevant to longstanding questions about how the social and cultural dimensions of food become embodied. This work will contribute to larger theoretical debates about how modes of production shape people's relationships to food - in particular, whether agricultural societies experience food socially, as their counterparts in foraging and pastoralist economies have been shown to do (e.g., Douglas, 1966). Such questions are of central theoretical importance for economic, ecological, and medical anthropology.

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