“THEY SAY WEALTH IS IN THE SOIL”: LOCAL KNOWLEDGE AND AGRICULTURAL EXPERIMENTATION AMONG SMALLHOLDER FARMERS IN CENTRAL MALAWI

By

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ABSTRACT

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For smallholders in central Malawi, farm management is complex and dynamic. Farmers’ seasonal decisions are determined by a range of factors including resource availability, environmental changes, and farmer priorities. Moreover, management decisions are influenced by a combination of local knowledge and expert recommendations. Although local knowledge is developed over centuries of experimentation within volatile agroecological systems, smallholder experimentation processes are not well documented in literature and are underutilized in agricultural development projects.

This study aimed to examine the decision-making processes of experimenting farmers and explore the drivers of on-farm experimentation. A mixed methods design incorporated field observations, survey data, and in-depth interviews, where quantitative and qualitative threads had multiple points of interface.

This study found that Malawian farmers across a range of socioeconomic characteristics are inclined to experiment. While experimental methods differ between farmers, there are commonalities in the drivers of experimentation, including climate change, income generation, and improving household nutrition. Farmers’ current practices should be taken into account in the development and implementation of agricultural intervention projects so that such projects might work effectively with smallholders to improve Malawian farming systems.

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KEY TO ABBREVIATIONS

AEDC	Agricultural Extension Development Coordinator
AEDO	Agricultural Extension Development Officer
Africa RISING	Africa Research in Sustainable Intensification for the Next Generation
ANOVA	Analysis of Variance
EPA	Extension Planning Area (a geographical boundary around a specific region; similar to a county in the American system)
GPS	Global Positioning System
MSU IRB	Michigan State University Institutional Review Board
TLU	Tropical Livestock Unit
USAID	United States Agency for International Development

1.0 Introduction

Over the past several decades smallholder agricultural production in Malawi has stagnated due, in part, to rapid population growth and its associated effects on the country's arable land (Schulz *et al.*, 2003; Snapp *et al.*, 2010). Population pressure has forced farmers to utilize smaller pieces of land and reduce or eliminate fallow practices, which has led to low soil fertility and decreased crop production. These agronomic changes have especially affected maize, the country's staple food crop, which is grown continuously and often without crop rotations (Bezner Kerr, 2005; Gilbert, 2004). Approximately 90% of Malawi's rural population are smallholder, subsistence farmers (producing enough food to survive and only enough revenue for immediate needs) who rely on maize-mixed, rainfed fields that are smaller than two hectares (IFAD, 2010). As many families in Malawi are dependent on maize, reduced crop production is made manifest in high rates of malnutrition, where an estimated 47% of children under five years old suffer from growth stunting (UNICEF, 2006-2010). Although the situation for Malawian farm families seems dire, many farmers are actively experimenting with crop diversification, local weed/disease control methods, food storage techniques, and improved crop varieties as a means to increase food security and generate income at the household level.

Until the mid 1970's, local knowledge and farmer experimentation practices were largely unacknowledged by the international research and development communities (Scoones and Thompson, 1994b; Sumberg and Okali, 1997). Thanks to a major paradigm shift over the past several decades, however, a faction of international development researchers have recognized the importance of incorporating local knowledge and utilizing farmer participation in the design and implementation of agricultural intervention programs (Chambers *et al.*, 1989).

Agricultural intervention programs are usually designed and implemented by development practitioners, researchers, extension agents, and other experts, and the primary goal for many interventions is to improve agricultural production in developing countries like Malawi. Intervention projects typically introduce new crops, varieties, or techniques in rural communities and encourage farmers to try improved farming methods. While many of these projects actively encourage independent farmer experimentation, farmers are often trying new things in conjunction with these projects instead of experimenting independently (although project participants frequently adapt or adjust project recommendations to suit their own objectives). Often, the technology or crop brought in by an intervention is not readily adopted by participants because it is contextually inappropriate. To create appropriate, desirable techniques that will pique the interest of farmers, interventions should incorporate local knowledge and farmers' current practice into their projects. In order to do this, however, practitioners must first understand what kinds of experiments farmers are conducting on their own, independent of interventions.

Past research has illustrated the multitude of resourceful and effective ways local people independently manage the natural resources on which their livelihoods depend (Chambers *et al.*, 1989; Scoones and Thompson, 1994a; Warren *et al.*, 1995). Local knowledge is built upon centuries of experimentation with and adaptation to changing agro-ecological conditions. For example, in Malawi (and throughout much of sub-Saharan Africa) the practice of intercropping grain legumes with maize—a technique which has been widely promoted by extensionists, non-profit projects, and research institutions in recent years—has been implemented by local farmers for generations. Although more and more development specialists are beginning to recognize the importance of incorporating local knowledge in agricultural interventions, the literature surrounding farmer experimentation in developing countries (that is, experimentation independent of outside interventions) is relatively scant. There is still much to be learned, therefore, about local agricultural practices and experimentation processes, the influences that shape experimentation, and the ways in which agricultural development projects can be informed by farmer-led experiments. Agricultural researchers, development practitioners, and most importantly Malawian smallholder farmers would greatly benefit from the integration of local practices, experiments, and priorities into agricultural development projects. In the words of one farmer who was encouraged by an intervention project to conduct agricultural experiments as a way to find solutions to her farming challenges, “They say wealth is in the soil”. Through the successful partnership of expert and local knowledge, smallholders will be better equipped to find solutions to their agricultural dilemmas and to maximize on the wealth all around them.

1.1 Purpose of Study

For the purposes of this study, experimentation was defined as any instance where a farmer attempted to plant an unfamiliar crop or variety, or to implement an unfamiliar technique for the very first time. Note the difference in time horizons between a farmer’s *adoption* of a specific crop, variety, or agricultural technique and their *experimentation* with something new: where adoption is the repeated and unchanging use of a specific crop, variety, or agricultural technique over the long term, experimentation is the initial trial of a new or unfamiliar plant or technique—the introduction of a new element into a smallholder’s farming system—and is iterative and constantly evolving from season to season. This study was particularly focused on independent experimentation, where farmers tried new things without the guidance of an expert such as an agricultural intervention project or an extension officer. This type of independent experimentation has been termed “folk experimentation” by Bentley (2006). Due to the inherent negative connotations commonly associated with the word *folk*, however, this study instead employs the terms *local* or *smallholder experimentation* to differentiate these processes from *formal* or *professional experimentation*. The aim of this study was to understand the decision-making processes of those farmers who were experimenting independently of intervention projects, draw distinctions between methods used across smallholder experiments, and explore the motivations (e.g. attitudes) and drivers (e.g. physical resources) of independent experimentation.

1.2 Research Questions

This project focused on the experimentation processes and decision-making of Malawian smallholder farmers (especially, but not exclusively, women) who have tried unfamiliar crops, varieties, and/or techniques in the past two agricultural seasons. In this context, unfamiliar crops, varieties, and techniques are defined as those that a farmer has never previously tried. Experimentation with legume crops was chosen as the primary focus of this study as legumes are common in central Malawi (although legume production is less prominent than sole maize production in this region; see Snapp *et al.*, 2002a), and because legume crops are of critical importance to a multitude of ongoing research and development projects that aim to improve nutrition, soil fertility, and agricultural production (Bezner Kerr and Chirwa, 2004; Gilbert, 2004; Schulz *et al.*, 2003). Additionally, leguminous food crops such as groundnuts are typically secondary only to cereal crops (such as maize and millet) in both cultural importance and prevalence in much of Malawi (IFAD, 2010). The importance of legume crops to Malawian farmers will be further discussed in Section 2.0. The following research questions relating to farmer experimentation with legume crops were investigated:

RQ_1: What are the characteristics of farmers who experiment with unfamiliar legume crops, varieties, and farming techniques related to legume production (e.g. gender, socioeconomic status, etc.)?

RQ_2: What motivates these farmers to experiment with unfamiliar legume crops, varieties, and farming techniques related to legume production?

RQ_3: How are these farmers managing their experimental crops, varieties, and techniques?

1.3 Basis of Study

Past studies have found that different members of the household often have different agricultural and household roles. For example, land preparation tasks (e.g. building/shifting planting ridges) are often undertaken by men, whereas planting, managing (e.g. weeding, pest prevention, etc.), and harvesting tasks are primarily the responsibility of women (Bezner Kerr and Chirwa, 2004; Ferguson, 1992; 1994). Additionally, Central Malawi is predominantly comprised of members of the Chewa tribe. Chewa culture is matrilineal, meaning that land is passed down through the woman's side of Chewa families. Regarding RQ_1, the aforementioned studies and cultural norms led to the theory that female farmers would be more likely to experiment with unfamiliar legume crops and varieties than would male farmers, given that legumes are traditionally planted and managed by women, and a family's land is culturally held by matriarchs and their male relatives.

As the literature surrounding the determinants of experimentation is relatively scant, this study's predictions about the wealth and assets of experimenting farmers were informed by adoption and farm management literature. Although adoption of technologies and farm management practices are not synonymous with *experimentation*, these ideas are interrelated (as will be discussed in Section 2.0) and studies of adoption and management can shed light on the socioeconomic factors associated with on-farm decision making, including the decision to experiment with something new. Previous studies relating to adoption have found that farmers will be more likely to adopt an agricultural technology if they perceive that the benefits of a new technology will exceed its costs (Pannell, 1999; Asfaw *et al*., 2012). Similarly, a recent study of food security and innovation found that less food secure households made fewer management changes (i.e. experimental trials) on their farms than did households that were more food secure (Kristjanson *et al.,* 2012). Based on these studies and the relationship between adoption, management, and experimentation, it was posited that farmers with fewer assets and/or less physical capital (i.e. the most vulnerable households in the population) would be less likely to conduct on-farm experiments because experimentation requires resources (e.g. extra land, new seed, etc.) and has unknown (and potentially undesirable) outcomes.

There are countless factors that influence a farmer's decision-making processes, and this is especially true for farmers who are trying new crops, varieties, or techniques on their farms. All farmers are situated in different physical and socioeconomic contexts (Pannell, 1999), and thus all farmers have different motivations for experimenting and employ different strategies to manage their experiments. To best understand the drivers of on-farm experimentation relating to legume production (RQ_2), in-depth interviews were conducted and questions focused on the decision-making processes of farmers who experimented with unfamiliar crops, varieties, and techniques in the past two growing seasons. This research question was explored by speaking *with* farmers, and not *to* them (Box, 1989), about their life circumstances, farming systems, and agricultural experiments, and the farmer insights gained through these in-depth interviews subsequently added context and clarity to the survey results.

Regarding the management strategies employed by farmers from the beginning of an experiment to the following season (RQ_3), previous studies have found that during the first attempt, a farmer will typically plant a new or unfamiliar crop in a small quantity, or on a small plot of land (Sumberg and Okali, 1997). In the second season, the farmer will scale out the same experiment *only if* she is satisfied with its performance during the previous season (Rhoades and Bebbington, 1995). If, however, the farmer is *dissatisfied* with the outcome of the experiment in the first season, she will change her management strategy during subsequent seasons (e.g. attempt a different spacing arrangement within the row, use a different field or area, implement at a different time in the season, etc.) (Schön, 1983). Regarding farmers' use of a comparison plot or "control", past studies have found mixed results, where some farmers consciously use a control, some farmers use a "historical control" (comparing experiments to their prior understanding of the farm system), and yet other farmers do not actively use any kind of control (Sumberg and Okali, 1997). The exploration of this research question attempted to validate the aforementioned literature through exploratory interviews with innovative farmers, where questions focused on the management of experimental crops, varieties, and/or techniques.

This thesis employed a rural household survey and in-depth interviews to characterize smallholder farms, examine experimentation processes, and explore decision-making at the household and individual levels. The following section will ground this study with existing literature, and subsequently the theoretical framework, methods, and results will be presented. Finally, the implications for future research, extension, and development projects will be discussed.

2.0 Review of Related Literature

Case studies from the existing experimentation literature provide insight into the innovative capacities of local farmers and suggest that farmers are essentially constant experimenters because they are continually adapting to the dynamic conditions (e.g. economic, climatic, etc.) on which their lives and livelihoods depend (Chambers *et al.*, 1989; Scoones and Thompson, 1994b; Warren *et al.*, 1995). Local people have a long history of agricultural experimentation, from potato storage techniques in the Peruvian Andes (Rhoades, 1989) to cocoyam intercropping in northern Ghana (Millar, 1994), to legume varietal selection in Malawi (Ferguson, 1992; 1994).

Farmer-led, or "folk" experimentation (Bentley, 2006), however, differs from formal research experiments in both structure and purpose. According to Bentley (2006), "folk experiments do not have to be scientific…[because farmers] may be knowledgeable and creative but not strictly scientific" (p. 459). When farmers experiment, they "have very specific goals in mind and the results of [their] experiments must be practical" (Rhoades, 1989, p. 9). In other words, farmers must continually experiment and adapt in order to sustain themselves and their families. Past literature has compared local knowledge of farm systems to a musical performance (Richards, 1989); while researchers attempt to conduct experiments ("play an opus") under precise and controlled conditions, local farmers must experiment in dynamic and unstable environments. In the same way that musicians must deal with bad acoustics, stage fright, and many uncontrollable factors, farmers must adapt to changing climates, variable markets, limited resources, and a host of other challenges for which researchers in controlled settings may not need to compensate. Thus, while local experiments often disregard the precision of the scientific method, (Bentley, 2006), they are necessary, carefully planned, and can result in life-changing innovations.

Smallholder experiments differ from formal scientific experiments not only in structure and method, but also in measures of external validity (Misiko and Tittonell, 2011). While replicability and generalizability are necessary measures that validate an experiment in formal science, these measures are often neither necessary nor possible in local experiments. Farmers may not have the luxury of replication due to ever-changing and restrictive factors such as weather and resource availability. Additionally, local experiments are not constructed to be applied or generalized across a wide range of contexts, but rather they are crafted to fit the conditions of one specific farm system. Where formal experiments can be controlled and repeated, local experiments are the “real practice” (Misiko and Tittonell, 2011, p. 1137) and “can only occur ‘in time’, where they are embedded in particular agroecological and sociocultural contexts” (Scoones and Thompson, 1994b, p. 20).

Formal scientists and smallholder farmers also use different criteria to judge the “success” of an experiment. For scientists and researchers in the formal sector, a successful experiment may be that in which one hypothesis is rejected in favor of another hypothesis (Schön, 1983), or where the relationship between two variables yields a high level of statistical significance. Smallholders, however, may deem an experiment successful if it can help them adapt to their circumstances and make it through to the next season, if it can survive or thrive over the long-term, if people like the outcome, or if it “leads to the discovery of something there” (Balée, 1994; Misiko and Tittonell, 2011; Rhoades and Bebbington, 1995; Scoones and Thompson, 1994b; Schön, 1983, p. 145). These epistemological differences between professionals and smallholders should be taken into account to best understand the wide range of criteria that distinguish a successful experiment from a failure. Success, it seems, lies in the eyes of the innovator.

Smallholders conduct many different types of experiments and are driven by a variety of goals. Bentley (2006) claims that local experiments are “motivated by changes in the environment and the economy, and seek to resolve labor and capital constraints” (p. 451). Other studies have classified local experiments into different types, where some farmers experiment out of curiosity, in what has been termed an exploratory experiment (Schön, 1983 as cited in Stolzenback, 1994) or a curiosity experiment (Millar, 1994; Rhoades and Bebbington, 1995). Other farmers innovate to produce a positive change in their farming system, often in response to conditions that are out of their control (e.g. climate change and variability). This type of experiment has been called a move-testing experiment (Schön, 1983) or a problem-solving experiment (Millar, 1994; Rhoades and Bebbington, 1995). Additionally, Millar (1994) argues that the most frequent kinds of experiments conducted by farmers are “adaptive”, whereby a farmer starts with a new technology or technique (e.g. learned from a relative, an old tradition, an extension agent, etc.) and reinvents it to suit his or her specific context. Adaptive experiments can also occur when a farmer takes a familiar technique and applies it to a new environment, in the case of migration, for example (Rhoades and Bebbington, 1995). Bentley (2006) states that the *best* local experiments are adaptive, where farmers do not simply replicate an idea or technique, “but combine new ideas creatively with local knowledge” (p. 452).

From the outside, it is relatively clear to distinguish between multiple types of experiments in local agricultural systems, but many smallholder farmers do not readily label their adaptations and on-farm practices as *experiments* at all. The difficulty, then, lies in how to measure and categorize what agricultural researchers see as “local, on-farm experiments” when those experiments seem like everyday life to the innovators themselves.

To circumvent this epistemological difference, Misiko and Tittonell (2011) used the language of farmer “tryouts” rather than “experiments” in their 2003-2007 study of research partnerships between local farmers and agricultural scientists. For smallholder farmers who do not have access to extra land, seed, time, and other precious resources, there is no practice round or preparation period before beginning an experiment—“tryouts are usually the real practice… [and] when a technology *seems* practical to smallholders, they try it out under their household’s social and farm-level ecological conditions” (p. 1137). For this study, Misiko and Tittonell’s language of “trying out an unfamiliar crop, variety, or technique for the first time ever” was used to convey questions about legume experimentation to farmers who were surveyed and interviewed.

This study focused on experimentation with legume crops and varieties and the associated management techniques of leguminous crops for many reasons. Past research has shown that the traditional Malawian practice of intercropping grain legumes in maize systems can increase soil nitrogen (N) levels and enhance soil fertility, leading to greater maize yields among other benefits (Gilbert, 2004; Snapp *et al.*, 2010; Snapp *et al.*, 2002b). In fact, farmers are more likely to use legumes as intercrops if the legume will provide multiple benefits beyond enhancing soil fertility, alone (Snapp *et al.*, 2002b). Common legume crops used by Malawian farmers as intercrops include pigeon pea, cowpea, common bean, soybean (soya), and groundnut.

These crops can be thought of as secondary crops, as the primary crop for Malawian subsistence farmers is almost always a cereal such as maize or sorghum (IFAD, 2010). Depending on the legume crop(s) used, maize-legume intercrop systems have the potential to yield multiple benefits such as: N fixation in soil; reduced pest and disease pressures; improved soil organic matter and water infiltration (through the incorporation of crop residues); income generation (in the case of groundnut, which can be sold as a cash crop); low seed costs; use as fodder for livestock; minimal labor requirements; late maturity (available when other food sources are not); vast increases in calories and protein in diet (as compared to a maize-dependent diet); potential for use in porridge for young children; and secondary use as medicine for earaches and diarrhea in children (Bezner Kerr and Chirwa, 2004; Gilbert, 2004; Snapp and Silim, 2002). One of the most highly valued benefits of leguminous crops is their high protein and caloric content—a trait that is especially prized by female farmers who are responsible for feeding children. A farmer will often choose what to use as an intercrop based on a given crop's associated benefits.

Just as all farmers have different motivations for experimenting (or not), all farmers have different priorities and goals for their farms (Pannell, 1999). These differences in priorities are most striking, however, between males and females. Past research has found that while both men and women farmers prefer high yielding crops (Schulz *et al.* 2003), women tend to value crops as a food source (protein-rich legumes, in particular), while men tend to value crops for their potential to generate income (Bezner Kerr, 2008; Bezner Kerr *et al.*, 2007; Snapp and Silim, 2002). Women's preference for food crops over cash crops may be the result of food scarcity worries. While many smallholder farmers are resource-poor, female-headed households, in particular, have inadequate access to credit, labor, and agricultural inputs (e.g. fertilizer, seed, etc.) compared to male-headed households (Bezner Kerr, 2005; Snapp *et al.*, 2002a). This lack of resources decreases the comparative food security of female-headed households. Although female-headed households may be less food secure than male-headed households, women are key participants in the Malawian agricultural system. Ethnographic studies in sub-Saharan Africa have revealed that women are intimately involved with the agricultural tasks of weeding, land use, harvesting, and seed selection (Bezner Kerr, 2005; Sharland, 1995). Women farmers' familiarity with these important steps in the agricultural process suggests that "they therefore have more intimate and personal knowledge of the crops themselves and they are the ones who are involved in the key stages of production" (Sharland, 1995, p. 387). Women are not only responsible for seasonal seed selection, planting, and crop management (Bezner Kerr, 2005; Ferguson and Mkandawire, 1993), but they are also the repositories of detailed crop knowledge—from seed storage to plant growth to post-harvest usage.

Qualitative studies have found that when women are the primary decision-makers regarding seasonal seed selection, they will often plant a wide variety of different crops to meet different farm and household needs (Ferguson and Mkandawire, 1993; Ferguson 1992; 1994). By intercropping many different food plants including leguminous crops, women are able to diversify their families' diets (e.g. adding protein through legume consumption), satisfy secondary household needs (e.g. fuel for cooking, livestock fodder, medicinal needs, etc.), ensure year-round food availability (through intentional combinations of early and late maturation crops), and enhance the resilience of their farms through biodiversity (bolstering pest and disease resistance, drought and flood tolerance, etc.). Where women have decision-making power over what to plant they will often grow leguminous crops to bolster their families' protein intake (Ferguson and Mkandawire, 1993; Ferguson 1992), but where men have decision-making power over what to plant they will often grow cash crops to generate income (Bezner Kerr, 2005; Bezner Kerr and Chirwa, 2004).

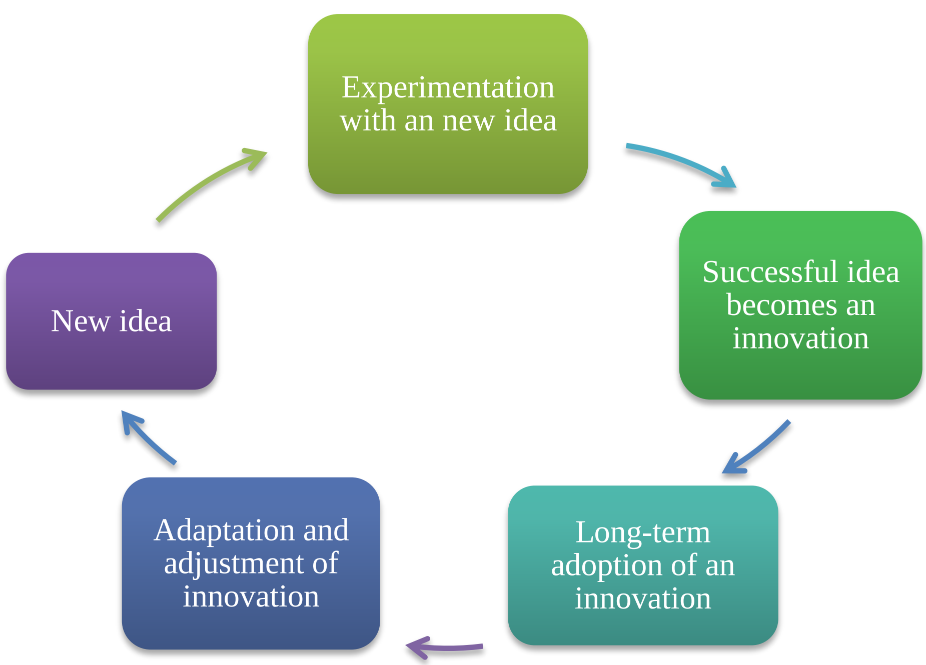
Sometimes the decision-making power over what crops are planted rests with the head of household (Bezner Kerr and Chirwa, 2004), and sometimes the division of labor is such that seasonal seed selection decisions are made by the woman of the house (even if she is not the household head) (Ferguson and Mkandawire, 1993). Therefore, in both the surveys and the interviews, explicit questions were asked regarding *who* was responsible for planting experimental legume crops and *how* that decision was made, because it cannot be assumed that the head was the only "experimenter" in any given household.

2.1 Theoretical Framework

Under the theory of adaptive rationality, Nitsch (1990) contends that farmers manage their complex farm systems through "a continuous interaction among visions, experiences, and experimentation" (p. 69). Similarly, Malawian farmers have a vision for how they would like their farm to develop, a lifetime of agricultural experience, and an array of new experiments, adaptations, and problem solving efforts that they employ to merge their vision with their experienced reality. Schön's theory of Reflection-in-Action (1983) asserts that practitioners who are confronted with uncertain, unstable, complex, or unique situations (in this case, local farmers who manage dynamic, resource-constrained farm systems) will reflect on the complexities of the situation, take inventory of their own knowledge and prior experience, and then conduct an experiment so as to better understand a phenomena and/or to create a change in a situation. During these experiments, the innovator (farmer) is in constant dialogue with her environment; a local farmer assesses how the farm "back-talks" during an experiment (p. 164) and engages in a sort of conversation with the soil and crops.

After an experiment, a farmer may proceed in one of several ways, depending on her perception of the experiment's success. In the case of a dissatisfactory experiment, the farmer may critique her method or theory, make adjustments, and attempt the experiment again. Alternatively, she may terminate the experiment. In the case of a satisfactory or successful experiment (an "innovation"), a farmer may choose to scale-out the innovation and/or repeat it in subsequent seasons. The repeated use of an innovation (which resulted from an experiment) corresponds with the definition of "individual (farm-level) adoption" made by Feder *et al.* (1985), where a new technology is used "in long-run equilibrium [and] when the farmer has full information about the new technology and its potential" (p. 256). Furthermore, Schultz (1975) states that experimenting with new technologies will lead a farmer towards equilibrium, where adoption of an innovation is possible. Thus experimentation is the first step on the adoption spectrum, where experimentation leads to the development of an innovation, and the long-term use of an innovation with repeated successful outcomes will lead to the adoption of that innovation. Such innovations may be adapted or adjusted by farmers in future experiments, making the process truly iterative (Nitsch, 1990). This relationship is depicted in Figure 1.

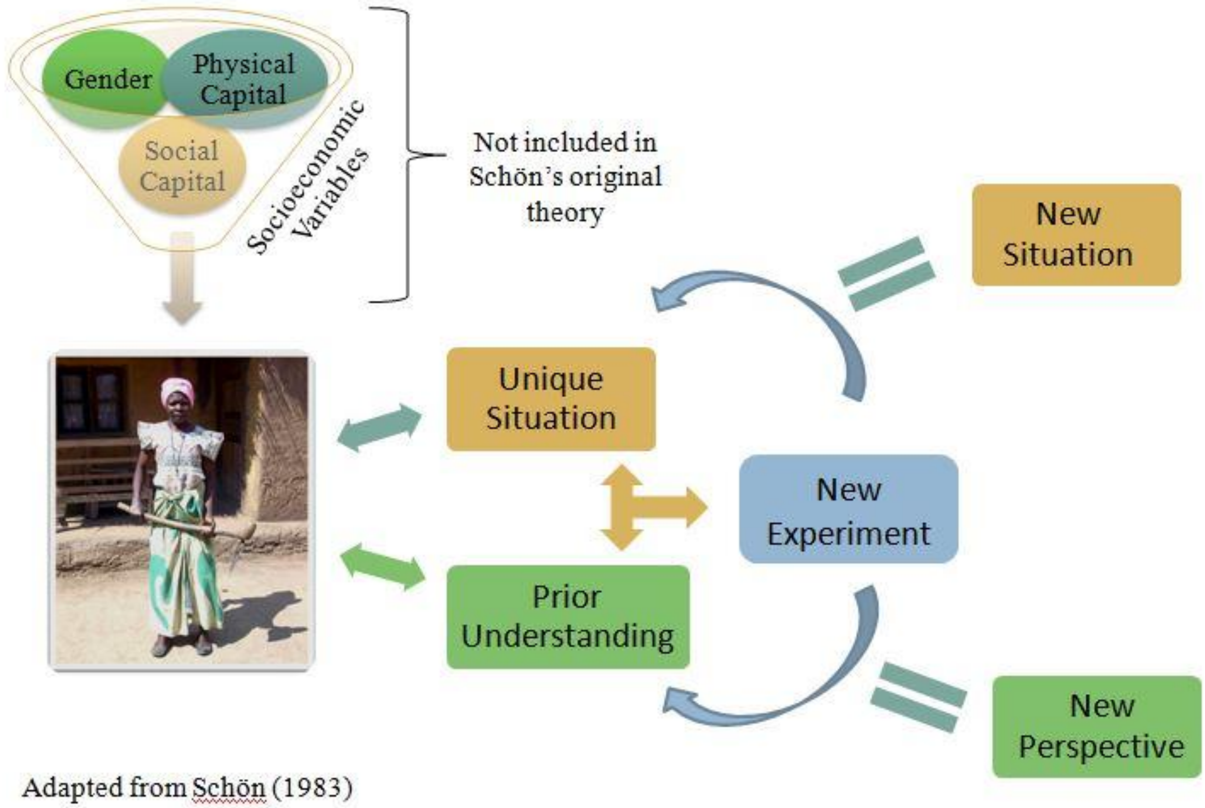
Figure 1. Experimentation to Adoption Process



While experimentation and adoption are closely related, they are not interchangeable terms. These clarifications are provided not only to distinguish between experimentation with an unfamiliar technology and adoption of an innovation, but to assert that the primary focus of this study is on-farm experimentation and the decision-making processes involved therein.

While Schön's Reflection-in-Action theory details many drivers of experimentation (e.g. practitioners' past knowledge and experiences), it neglects to account for the influence of gender and other socioeconomic factors on the decision-making processes involved with experimentation. This omission of gender from Reflection-in-Action necessitates a revision if the theory is to be used in explaining agricultural experimentation (see Figure 2), as culturally prescribed productive roles place women at the forefront of agricultural processes such as legume seed selection and crop production in Malawi (Bezner Kerr and Chirwa, 2004; Ferguson, 1992; 1994). Likewise, other characteristics that are relevant to agricultural experimentation, in particular, should be included in Schön's theory (e.g. socioeconomic status and access to information). Given the characteristics that were explored through RQ_1, close attention was therefore given to the decision-making processes and experimental capacities of female farmers in Malawi, and the influence of resource availability on experimentation processes.

Figure 2. Revised Theory of Reflection-in-Action



The influence of gender in on-farm experimentation and decision making must be examined and accounted for both in theory and in practice. By understanding the drivers of experimentation and decision-making from the perspective of Malawian smallholders (across a range of socioeconomic characteristics), development practitioners and extensionists can work effectively with farmers to support and enhance their existing capacities and farm management techniques.

3.0 Methods

3.1 Overall Approach

This study used a mixed methods framework that utilized field observations, household surveys, and in-depth interviews. The quantitative and qualitative strands of this study had several points of interface: at the design level, during data collection, and during the interpretation of results. An adaptation of the explanatory sequential design described by Creswell and Clark (2011) was used, where quantitative data were collected during the first phase of field work using a survey instrument, and initial analysis of these data informed both the case selection and the development of the interview questionnaire for the second, qualitative phase of field work. The qualitative data were then collected through in-depth interview sessions which were conducted using an interpreter and audio recorder. Immediately following the interview sessions, the recorded conversations were translated into English and transcribed. After completing both phases of the field work, quantitative survey data were analyzed comprehensively using the statistical packages SPSS and R. Results from these statistical tests informed the analysis of the qualitative interview transcripts, which were thematically coded using NVivo 10 qualitative software.

The quantitative data helped to identify a sample and relevant questions for the qualitative interviews and also gave insight into possible emergent themes that were explored during qualitative analysis. Likewise, the qualitative data helped to contextualize and explain the statistical findings gleaned from the survey data by bringing farmers’ voices and personal experiences to light. Rather than using quantitative or qualitative methods alone, the integration of methods used in this study yielded a more thorough, richer understanding of the drivers behind on-farm legume experimentation, the experimental methods used by smallholders, and the characteristics of innovative farmers who conduct on-farm experiments.

3.2 Study Areas

Field work was conducted in two phases over a ten week period from late-May to late-July, 2013. Data were collected from 22 village clusters within five Extension Planning Areas (EPAs), namely Linthipe, Golomoti, Mtakataka, Kandeu, and Nsipe, across two districts of Central Malawi, namely Dedza and Ntcheu. Before entering each study area, the field research team followed politically and culturally appropriate protocol and met with the Agricultural Extension Development Coordinator (AEDC) and at least one Agricultural Extension Development Officer (AEDO) for each EPA, and explained the nature of the research and the project timeline, and expressed gratitude to them for their assistance with the project. Subsequently, the team met with the village headman (or headwoman) and at least one lead farmer in each village cluster to explain the project. As a result, the AEDCs, AEDOs, and village authorities generously provided comprehensive lists of local area households, which were used for random sampling purposes. Study sites were determined by agro-ecological zone, market access, and the presence or absence of interventions by the agricultural research project Africa RISING (Research in Sustainable Intensification for the Next Generation).

Africa RISING is a USAID funded agricultural research initiative that conducts research for development projects in six countries across sub-Saharan Africa, including Malawi. Africa RISING promotes several “best-bet” legume crops (e.g. peanuts (groundnuts), soy bean (soya), cowpea, and pigeonpea), and several novel growing techniques (intercropping two legumes in the first season (doubled-up legumes) and following with a maize crop in the second season). These crops and techniques aim to provide multiple benefits to farmers such as increasing soil fertility, enhancing maize production, generating income, and improving household nutrition.

The project works through the government of Malawi's agricultural extension staff and encourages farmer experimentation through a participatory approach called the mother-baby trial design (Snapp *et al.*, 2002a). Farmers work on researcher-managed, multi-treatment demonstration plots ("mother trials") and replicate their favorite treatments from the mother trial on their own plots ("baby trials"). During the field study (2012-2013 growing season), Africa RISING was concentrated in eight sites across the Dedza and Ntcheu districts of Central Malawi, with two mother trials in each EPA: Linthipe (Mkuwazi and Mbidzi); Golomoti (Msamala and Kalumo); Kandeu (Dauka and Katsese); and Nsipe (Amosi and Nzililongwe). During this period, the project worked with 450 smallholder farmers in the aforementioned villages. Below, Table 1 describes agronomic information about each EPA that hosted a mother trial.

Table 1. EPA Agronomic Information

Characteristic	**Linthipe**	**Golomoti**	**Kandeu**	**Nsipe**
Elevation (meters above sea level)	1238	555	904	868
Annual rainfall (mm)	1005.5	890.6	799.7	810.8
Dominant Soil 1	Loamy clay	Loamy sand	Sandy clay, loam	Sandy clay, loam
Dominant Soil 2	Clay	Clay loam	Loam	Sandy clay
Distance from small market (km)	5	1	2	9
Distance from large market (town) (km)	40	40	35	20
Major crops	Maize, tobacco, groundnut	Maize, cotton, groundnut	Maize, tobacco	Maize, tobacco, groundnut
Number of farming families in the project sections	4623 (Mposa)	2232 (Golomoti Centre)	2362 (Kampanje)	1758 (Mpamazi)

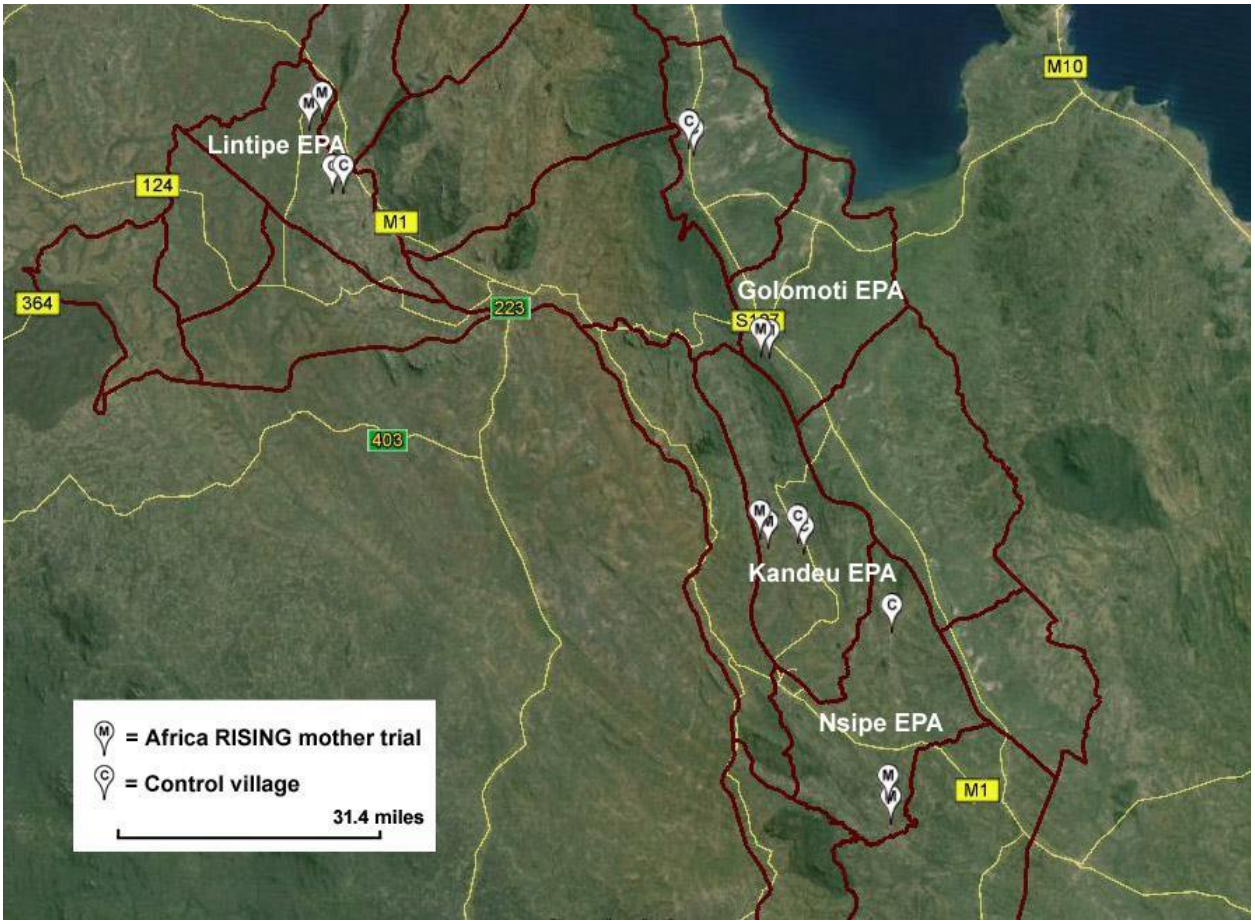
Participation in Africa RISING was voluntary. After enrolling, farmers participated in the preparation and management of the mother trial plot, and seed for the baby trial replications was provided to participating farmers as both an incentive and a means to participate in the project.

This study worked in partnership with Africa RISING, and the study's sample population was based on farmer's participation (or lack thereof) in Africa RISING. The study's sample population was therefore divided into three groups:

- Intervention households: at least one household member was actively participating in Africa RISING
- Local control households: no household members were participating in Africa RISING; households were located within the same village as an Africa RISING mother site
- Distant control households: household members had no prior exposure to Africa RISING; households were located in separate villages from Africa RISING sites, but had similar agroecological conditions and market access as the nearest Africa RISING site.

Intervention, local, and distant control households were chosen from within the same EPAs in Linthipe, Kandeu, and Nsipe. In Golomoti EPA, however, intervention and local control households were chosen within the same EPA, but distant control households were chosen from an adjacent EPA with a similar agroecology (Mtakataka). The map in Figure 3 depicts the Africa RISING sites (where intervention and local control households were located) along with the distant control sites.

Figure 3. Map of Study Areas



3.3 Phase One: Household Survey

3.3.1 Target Population

The target sample size for the first phase of field work was 320 smallholder farmers (160 intervention households, 80 local control-group households, and 80 distant control-group households), distributed evenly amongst at least three villages per EPA: Linthipe; Golomoti/Mtakataka; Kandeu; and Nsipe. Household surveys were administered to a sample of 324 farmer participants (97 males and 227 females) with 163 in Dedza district (approximately 2.61% of the population of Dedza) and 161 in Ntcheu district (approximately 3.41% of the population of Ntcheu). Population information is according to the 2008 Malawi Population and

Housing Census: Spatial Distribution and Urbanization Report (National Statistics Office of Malawi, 2008). Of the total sample, 162 participants were members of intervention households, 81 were from local control households, and 81 were from distant control households, thus the target sample size was slightly exceeded. Below, Table 2 depicts the sample population according to EPA and sample group. The survey instrument, sampling framework, and respondent characteristics will be discussed in the following sections.

Table 2. Survey Sample

District: EPA	Intervention HHs	Local Control HHs	Distant Control HHs	Total HHs
Dedza: Linthipe	42	20	21	83
Dedza: Golomoti	40	20	0	60
Dedza: Mtakataka	0	0	20	20
Ntcheu: Kandeu	40	21	20	81
Ntcheu: Nsipe	40	20	20	80

3.3.2 Data Collection: Survey Instrument and Field Research Team

The household survey was conducted over a three-week period, from May 23 to June 13, 2013. An 18-page survey instrument was used to collect household and farm level data, and question topics included: socioeconomic and demographic characteristics; respondents' memories of the climatic history of their EPA; cropping systems and land use; food security and agricultural production; on-farm experimentation; and participation in Africa RISING and other agricultural intervention programs (Appendix 1). The initial survey instrument was designed with contributions from Michigan State University faculty and Malawian agricultural experts. Survey enumerators: (1) were fluent in both English and Chichewa, (2) had completed

Bachelor's degrees, (3) had prior experience administrating survey questionnaires to local farmers, (4) were not members of the traditional authority, and (4) underwent training and certification according to MSU Institutional Review Board requirements prior to beginning field work. The survey was refined, translated, and pretested in partnership from the enumerators prior to beginning fieldwork.

Every enumerator was shadowed at least two times throughout the survey process, by one of two research supervisors. This was to accomplish several goals: to ensure that all enumerators were asking the survey questions in a consistent manner; to act as a reference in cases where a respondent gave an unorthodox answer to a question; to assess the enumerators' performance (which later helped to inform who was hired on as an interpreter for the in-depth interviews in the second phase of field work); and to take detailed field notes.

Survey sessions were conducted in Chichewa, and surveys were only conducted with household members over the age of 18 who verbally agreed to participate after listening to an MSU IRB-approved informed consent script. With the exception of one village (where survey interviews were conducted in the center of the village), all survey interviews were conducted at the home of the respondent, and the location of the home was recorded using a GPS device. An average interview lasted approximately 45 minutes for local or distant control households. Intervention household questionnaires contained one subset of questions relating to respondents' participation in Africa RISING that was omitted from control household questionnaires and therefore the average interview time for an intervention household was 1 hour 15 minutes. At the end of each survey session and upon the agreement of the respondent, enumerators took digital photos of respondents and their families. These photos were then printed and given to survey participants at the end of the field work period as a gift for participating in the survey process. Respondents were informed of this gift only after they had completed the survey questionnaire.

3.3.3 Data Collection: Sampling Framework

Intervention households were selected to participate in the survey process using a stratified random sampling method (Vaske, 2008). First, a list of all participating farmers in Africa RISING, divided by EPA (Linthipe, Golomoti, Kandeu, and Nsipe) was obtained. Before randomly selecting a sample from this list, however, participant names were crosschecked with a list of farmers who had recently participated in a separate agricultural household survey led by Wageningen University (Netherlands) in the previous month. Any farmers who had participated in the Wageningen study were eliminated from the sampling pool in order to avoid respondent fatigue or over-surveying of any particular household. Names were then randomly selected from within each EPA using a random number generator. Forty households were randomly selected from within each EPA as a primary sample, with 20-25 additional households selected as alternates in the event that primary households were unavailable. In each EPA, primary and alternate households were selected with an approximately equal distribution between the two Africa RISING mother trial site village clusters. In the field, key informants from each village cluster helped the team to determine the approximate location of the target households, whereby each enumerator completed 3-4 interviews over the course of each day. The team used two days per EPA to collect survey data for 162 intervention households.

Within each intervention household, enumerators attempted to speak with the farmer who had officially participated in Africa RISING, as indicated by the aforementioned participant list. If the intervention farmer was unavailable, enumerators interviewed another adult household member who had thorough knowledge of the household's agricultural production and of the intervention farmer's management of his/her Africa RISING baby plot(s).

Local control households were also sampled using a stratified random method. Within each study site in each EPA, comprehensive lists of all households were obtained from the AEDC, AEDO, and/or the village head person. Before randomly sampling from this list, participant names were crosschecked with the Wageningen University sample and also with the Africa RISING participant list. Households who had been previously surveyed or who were Africa RISING participants were eliminated from the local control sampling pool. After these households were removed from the pool, names were randomly selected from within each EPA using a random number generator. Twenty households were randomly selected from within each EPA as a primary sample, with 20-25 additional households selected as alternates in the event that primary households were unavailable. In each EPA, primary and alternate households were selected with an approximately equal distribution between the two Africa RISING mother trial site village clusters. In the field, key informants from each village cluster helped our team to determine the approximate location of the target households, whereby each enumerator completed 3-4 interviews over the course of each day. The team used one day per EPA to collect survey data for 81 local control households.

Within each local control household, enumerators attempted to speak with the head of household, as indicated by the household lists provided by the AEDCs, AEDOs, and traditional authorities. If the household head was unavailable, enumerators were instructed to interview another adult household member (preferably the household head's spouse, if available) who had thorough knowledge of the household's agricultural production. This sampling method yielded survey interviews across genders and household types, including responses from male heads of household, female heads of household, and female spouses within male-headed households.

Early in the fieldwork period, household lists for Golomoti EPA were unavailable, which resulted in the creation of a last-minute random sampling framework that was neither understood nor consistently followed by the enumerators. This miscommunication resulted in enumerators using arbitrary, convenience selection methods (rather than systematic random methods) to sample local control households in Golomoti EPA. In order to rectify these sampling errors, field work was extended and local control households in Golomoti were re-sampled using household lists and the stratified random sampling methods previously described. One household that had been previously sampled (using the convenience method) was randomly selected from the list to be sampled again. This household was not revisited, but the all of the survey information they had provided during our first visit was kept. All other questionnaires from the first sample of Golomoti local controls were discarded and the information therein was excluded from the data analysis process. Instead, information from the second (random) sample was used to represent local control households in Golomoti EPA. Twenty households were sampled as a part of this group.

Distant control households were sampled using a cluster sampling method (Vaske, 2008). Two distant control villages per EPA were selected to be a part of the survey. Within the distant control villages, a key informant (e.g. lead farmer) led three enumerators to the village center. From there, enumerators "drew" a Y-shaped axis through the village, whereby one enumerator would walk along each axis and sample one household every 50-100 meters. Distances between households were pre-determined according to the village size and layout (less distance between households in smaller, more condensed villages and more distance between households in larger, more dispersed villages) so that all enumerators in a given village measured the same distance between sampled households. Using the Y-axis method, each enumerator surveyed between 3-4 households per distant control village. The team used one day per village to collect survey data for 81 distant control households.

Within each distant control household, enumerators spoke with an adult household member who was present at the time of the interview and who had thorough knowledge of the household's agricultural production (usually the household head or their spouse). In the event that both the household head and their spouse were present at the time of the interview, enumerators spoke with whomever seemed the most open to being interviewed. This sampling method yielded survey interviews across genders and household types, including responses from male heads of household, female heads of household, and female spouses within male-headed households.

3.3.4 Survey Data: Inspection, Entry, and Analysis

During the household survey data collection period, the team met at the end of each field day to assign household identification numbers to the completed questionnaire instruments, check the questionnaires for errors, and code any unusual responses. Following these meetings, the completed questionnaires were inspected for omissions, outliers, and mismatching codes. Errors were corrected by enumerators on the following day. In cases where an enumerator made an irreversible error (e.g. neglected to ask the respondent a question), the enumerator returned to the household and gathered/corrected the relevant information. These daily checks helped to minimize data collection errors and also helped to ensure that all enumerators were interpreting and coding questions consistently. Finally, at the completion of the data collection process, enumerator errors in the data were tested for using an ANOVA test in SPSS. In this test, enumerator identification codes were used as the grouping variables, and the means of the regression analysis variables were tested across all six enumerators. No significant differences between the means of any variables were found across the enumerators, indicating a low likelihood that enumerator bias has corrupted the data.

At several points throughout data collection, enumerators worked in pairs and entered survey data into a Microsoft Excel spreadsheet. Data entry was completed during the field work period, which helped to reduce data entry errors as the information was still fresh in the enumerators' memories. Entered data were checked for entry errors. After the fieldwork periods, a comprehensive codebook was created and the data were cleaned. Unusual codes or errors were checked against the questionnaire hard copies and corrected accordingly.

Initial data analysis was performed using Microsoft Excel, specifically regarding demographic characteristics of the sample population, types of cropping patterns, frequency of experimentation, socioeconomic characteristics of innovative farmers, and farmers' experiences with the Africa RISING project. The preliminary conclusions that were drawn from this initial analysis were presented at the Regional Africa RISING conference in Salima, Malawi, on July 29, 2013. Additionally, initial data analysis provided the basis for the purposive sampling framework which was used in the second, qualitative phase of fieldwork. This framework will be discussed in greater detail in the Section 3.4.

Comprehensive data analysis was performed using the statistical software packages R (agronomic information) and SPSS (demographic information, experimentation data). Agronomic analyses included land use, soil management practices, fertility measures, and frequency of crops grown. The statistical software package SPSS was used to calculate descriptive statistics for household size, dependency ratios, productive and reproductive asset ownership, farm characteristics (e.g. landholding size, number of fields, etc.), education levels, food security indicators, experimentation types and frequencies, and an experimentation classification structure.

The household survey instrument contained the following questions to gauge farmers' experimentation (Appendix 1):

E11. *What new crops did you grow this season (2012-2013) for the first time ever?*

E16. *What new crop varieties did you grow this season (2012-2013) for the first time ever?*

E21. *What new techniques or technologies did you try this season (2012-2013) for the first time ever?*

Follow-up questions prompted respondents to give details about the information source for each new crop, variety, and technique they reported (e.g. *How did you learn about this new crop/variety/technique/technology?*). Response categories were derived from three overarching information sources (Sumberg and Okali, 1997):

1. Institutions that actively promoted new things (e.g. AEDOs, Africa RISING or other non-profit project);
2. Peers/others who suggested new things or where farmers observed new things (e.g. family member, lead or other farmer, private distributors, social groups, radio); and
3. Independent ideas from the farmers' own imagination.

Based on farmers' responses to these experimentation survey questions, a classification structure was created as a basis for further statistical analyses. Note that this classification structure is based on experimentation examples and their information sources, alone, and does not reflect farmers' socioeconomic standing or farm-level characteristcs. The experimentaiton classifications are:

- **Non-experimenters** (n = 96): Farmers who did not report trying anything new in the 2012-2013 season;
- **Project participants** (n = 145): Farmers who *only* reported trying something that had been actively promoted to them (e.g. by extension agents, intervention projects, etc.);
- **Followers** (n = 64): Farmers who reported trying something that they had observed or had heard mention of (e.g. from peers, radio, family members);
- **Independent experimenters** (n = 19): Farmers who reported trying something that was their own idea.

This classification structure is based on a hierarchy which represents the magnitude of experimentation, where independent ideas represent the highest form of experimentation. Thus, independent ideas trumped suggested/observed ideas, which trumped simply following project recommendations. For example, a farmer who tried even one experiment that came from their own imagination was categorized as an *Independent experimenter*, regardless of the other types of experiments they tried. Likewise, a farmer who tried something they had heard on the radio *and* something that was part of an intervention project (but did not try anything from their own imagination) was categorized as a *Follower*. Below, Table 3 illustrates the distribution of Non-experimenters, Project participants, Followers, and Independent experimenters according to their associated sample groups (e.g. intervention, local control, or distant control).

Table 3. Experimentation Classifications by Sample Group

Experimentation Classification	Intervention (*n* = 162)	Local Control (*n* = 81)	Distant Control (*n* = 81)	Total Sample (*n* = 324)
	Group*			
Non-experimenters	12 (7.4%)	39 (48.1%)	45 (55.6%)	96 (29.6%)
Project participants	124 (76.5%)	16 (19.8%)	5 (6.2%)	145 (44.8%)
Followers	19 (11.7%)	23 (28.4%)	22 (27.2%)	64 (19.8%)
Independent experimenters	7 (4.3%)	3 (3.7%)	9 (11.1%)	19 (5.9%)
Total	162 (99.9%)	81 (100%)	81 (100.1%)	324 (100.1%)

*Percentages calculated within Sample Groups
Due to rounding, column totals may not equal 100%

This structure was used as a basis for ANOVA tests which compared socioeconomic and farm-level characteristics of innovative farmers at the household level (Section 4.3). Additionally, chi-square tests were used to analyze intra-household, gendered decision-making and labor issues related to experimentation (Section 4.4).

Finally, a binary logistic regression was used to estimate the probability that a farmer with certain socioeconomic and farm-level characteristics would experiment independently with an unfamiliar crop or technique (Section 4.6). The results of these statisical analyses will be discussed in Section 4.0.

3.4 Phase Two: In-depth Interviews

3.4.1 Target Population and Sampling Framework

The target sample size for the second phase of field work was 20 farmers. The intended sample included both male and female farmers from all three sample groups, across every EPA, and from within both male- and female-headed households. This qualitative sample was drawn from the pool of farmers who had been previously surveyed during the quantitative phase of fieldwork, during which time data were gathered on experimentation both through the survey questionnaire and through detailed field notes. Farmers were sampled for in-depth interviews using a purposive framework (Vaske, 2008), and only those farmers who reported experimentation with new crops, varieties, or technologies, either during the 2012-2013 season or in previous seasons were included in the qualitative sample. Primacy was given to interview those respondents who met the following criteria:

- Those who tried at least one experiment independently (without being prompted by an agricultural intervention project or extension officer);
- RISING participants who had tried a “baby trial” treatment to which they had never before been exposed;
- those who experimented with unfamiliar legume crops and/or technologies (although cash crop, dimba, and other rainfed crop experiments were not excluded);
- those who were experimenting with new crops *and* new technologies simultaneously;
- those who were growing multiple experimental crops/varieties simultaneously;
- those from whom detailed field notes had already been taken (so as to build on previously established rapport with these respondents and also to build on what was already known about their experimentation based on field notes).

In order to incorporate a range of gender perspectives, both men and women were interviewed. Due to women’s close association with legume crops, however, women were given primacy in the interview sample so as to shed more light on their decision-making processes as they related to legume experimentation. Women in the sample were either female-heads of household or spouses within male-headed households. Additionally, respondents were purposefully drawn from five Extension Planning Areas (including Mtakataka, the distant control site corresponding to Golomoti), from all three quantitative sample groups (intervention, local, and distant control households), and across a range of farm sizes (from 0.2 ha to >1.82 ha). Finally, in order to better understand farmers' personal ideas of the success or failure of an experiment, the qualitative sample included farmers who had previously reported that their experiments had been "successful", along with those who had reported that their experiments had "failed". In total, the sampling pool contained 28 farmers (5 primary and 2 alternate farmers from each EPA, with Golomoti and Mtakataka combined for sampling purposes).

Within each household, either the head of household or their spouse was interviewed, depending on who held the most responsibility for planting unfamiliar crops and managing on-farm experiments. Distribution of labor on experimental plots was determined by several questions on the initial quantitative survey, where respondents were asked "Who planted the [unfamiliar] seed?" and "Who managed the experimental [seed or technology]?". To these questions, respondents could answer: household head; household head spouse; both household head and spouse together; or both. Respondents were chosen to participate in the in-depth interviews based on the information they gave on the household survey.

After constructing the sampling framework, the names of primary and alternate farmers were taken to the field where the interview team met with the extension officer for the EPA, who helped to locate target households and introduced the field team to the farmers. Farmers in the sample were alerted several hours in advance that they could be selected for an interview. If farmers in the primary sample were unavailable, names were drawn from the alternate list.

In total, in-depth interviews were held with a sample of 18 farmers (15 females and three males), with 10 in Dedza District and eight in Ntcheu District, meaning that the actual sample was slightly smaller than the target sample. Of the sample, 14 farmers were Africa RISING participants, two were local control farmers, and two were distant control farmers. It is important to note, however, that although 14 interviews were held with Africa RISING participants, the interview conversation covered experiments that were undertaken independently *as well as* those that were conducted with prompting from Africa RISING. All interview participants were over the age of 18 and verbally agreed to participate in the interview after listening to an MSU IRB-approved informed consent script. All interviews were conducted at the respondent's home, and a bottle of Coca-Cola and package of biscuits was provided to each respondent as compensation for participation. Interview content and respondent characteristics will be further discussed in the following sections.

In addition to the 18 farmer interviews, four in-depth interviews were conducted with an Agricultural Extension Development Officer (AEDO) from each the four EPAs with an Africa RISING presence. All interviews were conducted in English (although the interpreter was present, in case of any misunderstandings) and each lasted approximately 45 minutes. These interviews provided a clear understanding of how the Africa RISING mother and baby trial experiments were managed and monitored, what lessons the AEDOs attempted to impart to project participants, which crop combinations were planted as part of the mother trial (and thus which options the participating farmers could choose from for their own baby trials), and any problems that participating farmers may have encountered (from the perspective of the AEDO leading the project). This information informed the interviews with Africa RISING farmers, and it also helped to check the validity of the information that farmers provided during interview conversations.

3.4.2 Data Collection: Interview Structure and Content

In-depth interviews were conducted over a two-week period, from July 1-July 12, 2013. In total, the interview prompt contained 38 questions, although these questions were neither asked in a linear fashion, nor was every question asked to every respondent. The length and structure of any given interview conversation depended primarily on the respondent's comfort, openness, and time constraints. On average, interviews lasted 1 hour and 15 minutes, with the shortest interview at 45 minutes and the longest at 1 hour and 45 minutes. Interviews were conducted in Chichewa, with the assistance of an interpreter. The interpreter had also been an enumerator during the household survey fieldwork phase, and thus she was already familiar with the research questions, the goals of the study, and the respondents. Translation was done *in situ*, where each question was asked first in English and then translated into Chichewa. As the interpreter became familiar with the interview topics and research goals, she occasionally asked probes in Chichewa without waiting for the prompt in English. Respondent answers were also translated from Chichewa to English *in situ.* To minimize recall errors, all interviews were audio recorded with the respondents' permission.

Question topics were related to: experimentation with unfamiliar crops, varieties, and techniques/technologies; management of experiments; motivations for trying something new; sources of information; ideas of "success" and "failure"; levels of satisfaction with experiments; intentions for future experiments; experimentation through Africa RISING and/or other agricultural intervention programs; and general ideas about on-farm experiments (e.g. *To you, what does it mean to "experiment" with new crops, varieties, or techniques?*) (Appendix 2). Most questions focused on experiments that were carried out in the 2011-2012 or 2012-2013 agricultural seasons, although respondents occasionally shared details of experiments that they had conducted prior to 2011. The interview questions were written with contributions from Michigan State University faculty and Malawian agricultural experts.

During the interviews, the interpreter used the phrase “try a new thing” in lieu of the word “experiment”, as there was no exact translation of “experiment” in Chichewa. Despite this linguistic difference, the conversational setting provided clarity of the idea of on-farm experimentation to farmers.

3.4.3 Qualitative Data: Translation, Transcription, and Analysis

Every evening during the interview period, interviews were translated and transcribed. On average, 1 hour of interview tape took 3 hours to translate and transcribe. Each question, probe, and answer was recorded once, as if the conversation did not go through an interpreter. The questions and probes which were asked by the interpreter (in Chichewa) were only recorded in the transcription if they differed significantly from the original English, or if the interpreter asked them without first being prompted in English. During the translation and transcription process, an active effort was made to find the most appropriate English words to best represent the respondents’ ideas as they related to the study. For example, when a respondent used the phrase “trying something new” in Chichewa, the phrase was recorded as “experimenting” in the English transcript.

After all of the interviews were translated and transcribed, the scripts were thematically coded and analyzed using the QSR NVivo 10 qualitative software analysis package. Themes related to experimentation with legumes, maize, other crops, and techniques/technologies, and included: management of experiments; plans for future experiments; motivations that drove experimentation; ideas of success and failure; satisfaction or dissatisfaction with an experiment;

persistence with a failed experiment; self-identification as an “experimenter”; theories as to why a particular experiment succeeded or failed; and memorable quotes (Appendix 3).

To test for validity in the coding structure of the interview content, a second coder (who was not previously associated with the project) was trained to use NVivo 10 software and familiarized with the pre-established coding structure. The second coder analyzed and coded a subset of the full sample of interviews, six of the 18 total scripts (33%). This subset of scripts was chosen for the reliability analysis based on their clarity and representativeness of the whole sample. Subsequently, a test for inter-coder reliability was conducted using NVivo 10. Percentage agreement and Cohen’s Kappa coefficient (which takes into account the amount of agreement that could be expected to occur through chance) were used as indices for reliability. Overall percentage agreement between the coders was 96.4% (3.6% disagreement), and the Kappa coefficient was 0.4849, which indicates fair-good agreement between coders (NVivo10 for Windows Help, 2014).

The following sections will explore on-farm experimentation among Malawian smallholders by drawing from both the qualitative and quantitative data sets. Quotations are used to help interpret quantitative findings related to experimental crops and technologies and the characteristics of innovative farmers. Additionally, quotations are used to shed light on the methods used by farmers when they try something new, and the drivers behind on-farm experimentation. These quotes help give a voice to innovators whose agricultural accomplishments have thus far gone unrecognized. Quotations were chosen according to their clarity and representativeness.

3.5 Respondent Characteristics

3.5.1 Household Survey Respondents

The total sample size for the household survey was 324 respondents, and all respondents who were approached chose to participate in the survey. Below, Tables 4-7 illustrate some socioeconomic characteristics of the sample, disaggregated by geographic region and by sample group. Note that the column for Golomoti EPA also includes respondents who reside in Mtakataka EPA, but are considered distant control households corresponding to Golomoti for purposes of this study, and are thus combined with the Golomoti sample. This will be the case for all tables and figures presented in this paper.

For the purposes of this study, a *household* was defined as a group of people who live together and share a common kitchen. Regarding gender of the household head, for households where a male lived or worked elsewhere and a female made the household and agricultural decisions more than half of the year, the household was defined as female-headed. If a male was present during the growing season, however, and made most of the agricultural decisions for the household (even if he lived elsewhere before and after the growing season), the household was defined as male-headed.

Table 4. Characteristics of Household Survey Population (by EPA)

		EPA				
	Demographic	**Linthipe (*n* = 83)**	**Golomoti (*n* = 80)**	**Kandeu (*n* = 81)**	**Nsipe (*n* = 80)**	**Total Sample**
HH Head Gender:	**Male (*n*):**	57 (69%)	60 (75%)	56 (69%)	58 (73%)	231 (71%)
	Female (*n*):	26 (31%)	20 (25%)	25 (31%)	22 (27%)	93 (29%)
	Avg. HH Size	5.2	5.1	5.2	5.1	5.1
	Dependency Ratio	112	108	104	108	108
	Avg. Farm Size (*n* = 288)	0.71 ha	0.83 ha	0.89 ha	0.97 ha	0.85 ha
	Avg. # of Fields	2.24	1.89	2.38	2.40	2.23
	Avg. # of Tropical Livestock Units	0.50	0.35	0.76	0.48	0.52
	Wealth Index [Range = 2-101]	15.4	15.2	16.8	17.5	16.2
	Avg. # Months Food Supply	8.24	7.16	7.83	9.65	8.22

Total Sample *N* = 324, except where noted

Table 5. Education of Household Head (by EPA)

	EPA				
HH Head Education	**Linthipe (*n* = 50)**	**Golomoti (*n* = 44)**	**Kandeu (*n* = 47)**	**Nsipe (*n* = 36)**	**Total Sample (*n* = 177)**
No Schooling	18 (36%)	13 (30%)	11 (23%)	3 (8%)	45 (25%)
Some Primary	23 (46%)	24 (55%)	26 (56%)	27 (75%)	100 (57%)
Completed Primary	4 (8%)	1 (2%)	3 (6%)	2 (6%)	10 (6%)
Some Secondary	4 (8%)	2 (5%)	5 (11%)	2 (6%)	13 (7%)
Completed Secondary	1 (2%)	4 (9%)	2 (4%)	2 (6%)	9 (5%)

Due to rounding, column totals may exceed 100%

Table 6. Characteristics of Household Survey Population (by Sample Group)

	Demographic	Group: Intervention (n = 162)	Local Control (n = 81)	Distant Control (n = 81)	Total Sample
HH Head Gender:	**Male (n):**	121 (75%)	49 (60%)	61 (75%)	231 (71%)
	Female (n):	41 (25%)	32 (40%)	20 (25%)	93 (29%)
	Avg. HH Size	5.2	4.8	5.2	5.1
	Dependency Ratio	110	110	100	108
	Avg. Farm Size (n = 288)	0.94 ha	0.80 ha	0.73 ha	0.85 ha
	Avg. # of Fields	2.42	2.10	1.98	2.23
	Avg. # of Tropical Livestock Units	0.49	0.63	0.49	0.52
	Wealth Index [Range = 2-101]	16.8	16.7	14.6	16.2
	Avg. # Months Food Supply	8.80	8.12	7.15	8.22

Total Sample N = 324, except where noted

Table 7. Education of Household Head (by Sample Group)

HH Head Education	Group: Intervention (n = 82)	Local Control (n = 45)	Distant Control (n = 50)	Total Sample (n = 177)
No Schooling	14 (17%)	20 (44%)	11 (22%)	45 (25%)
Some Primary	50 (61%)	19 (42%)	31 (62%)	100 (57%)
Completed Primary	5 (6%)	2 (4%)	3 (6%)	10 (6%)
Some Secondary	7 (9%)	4 (9%)	2 (4%)	13 (7%)
Completed Secondary	6 (7%)	0	3 (6%)	9 (5%)

Due to rounding, column totals may not equal 100%

The total survey sample included 71% male-headed households and 29% female-headed households, which is a typical distribution for central Malawi. The majority (56.5%) of respondents had attended some primary school, but had neither completed primary nor began secondary school. Note that the educational data in Tables 5 and 7 only pertains to those interview respondents who were also the head of household (n = 177). Average household size was 5.1 persons, and the average dependency ratio (number of economically inactive persons divided by number of economically active persons; as shown by number of dependents per 100 persons in the working-age population) was 108. Although the standard age groups in dependency ratio statistics for economically inactive persons are 0-14 and 15-64 (Findley, 2014), this study used the age groups 0-14 and 15-69, as persons in rural Malawi are often engaged in agricultural labor until later in life (R. Chikowo, personal communication, March 15, 2013). According to the World Bank Age Dependency Ratio data set (2014), the dependency ratio for the total population of Malawi in 2013 was 95, indicating that the survey population (which consisted wholly of persons who lived in rural areas, most of them farming on less than two hectares of land) contained a larger proportion of dependent persons than did the total population of Malawi in 2013.

Farm size data (total hectares) was recorded only for farmers who worked three or less fields (n = 288; 88.9% of total sample), and it was found that the majority of these farmers held less than one hectare of land (μ = 0.85 ha per household). Farmers in the sample population had slightly smaller landholdings than were reported in the Republic of Malawi and World Bank Malawi Poverty and Vulnerability Assessment (2006), where farmers held an average of 1.2 hectares per household. For this study, a *smallholder* was defined as a farmer who held less than two hectares of land, meaning that at least 90% of the farmers in the sample could be identified as smallholders. Regarding average number of fields, farmers did not share a consistent size-based method for breaking sections of land into “fields” or for breaking fields into “plots”. In general, however, a piece of land was divided into fields and further subdivided into plots. Farmers demarcated the land by agroecological factors such as soil type, topography, water holding capacity, cropping systems, etc. Therefore, field and plot level data were gathered based on respondents’ definitions of a field or plot on their own farm. No assumptions should be made about the uniformity of field and plot sizes across farms. By farmers’ own definitions, it was found that on average farmers held 2.23 fields.

Tropical Livestock Units (TLUs) can be interpreted as indicators of farming system types and livestock animal (productive) assets. The unit is a type of exchange ratio between livestock animals and is calculated by converting adult body weight into metabolic weight (Livestock, Environment and Development Initiative, 2005, as cited by Chilonda and Otte, 2006). Table 8 provides a list of coefficients that were used to convert total number of livestock animals into Tropical Livestock Units (FAO, 2005). Average TLUs for the survey population was 0.52 per household, which is in line with estimates from the Republic of Malawi and World Bank Malawi Poverty and Vulnerability Assessment (2006), where average TLUs were 0.53 per household.

Table 8. Coefficients for TLU Conversion

Livestock Species	**Cattle**	**Pigs**	**Goats**	**Poultry**	**Rabbits**
Coefficient	0.7	0.2	0.1	0.01	Excluded due to infrequency of ownership (n = 2)

The Wealth Index is an asset-based measure of wealth, where both productive and consumer assets, along with housing materials, are assigned a numerical value. The values of each asset are then added together and the sum represents the relative wealth of a household.

Table 9. Asset Values used for Wealth Index

Asset Type	Asset	Value
Housing Material	Fired brick walls	2
	Unfired brick/mud walls	1
	Corrugated iron roof	2
	Thatch roof	1
Productive	Cattle (per animal)	3
	Goats, Pigs (per animal)	2
	Poultry (per animal)	1
Reproductive	Bicycle, Television (per unit)	3
	Cell phone (per unit)	2
	Radio (per unit)	1

Table 9 depicts the ranking system used for the Wealth Index that was used for this study, which was adapted from the Wealth Index used in a study of agricultural production and nutrition among farmers in northern Malawi in 2011 (Snapp *et al.*, 2014). Farmers in our sample had Wealth Index scores ranging from 2-101.

The average number of months that a household's food supply was a rough calculation that farmers provided, based on the amount of maize they had harvested in the weeks before the survey. On average, households thought their maize supplies would last slightly more than eight months, although several farmers claimed that their supplies would be gone within the first month after harvest. Food security status varied across farmers, and was largely dependent upon climate, available resources, and landholding size. This figure, therefore, should be interpreted with caution.

3.5.2 In-depth Interview Respondents

The total sample size for the qualitative interviews was 18 respondents, and all respondents who were approached chose to participate in the interview. Below, Table 10 illustrates some socioeconomic characteristics of the sample. Note that the terms *household* and *household head gender* were defined in the same way as during the household survey (see Section 3.5.1).

The interview population included five respondents each from Linthipe, Golomoti/Mtakataka, and Nsipe EPAs, and three respondents from Kandeu EPA. Fourteen respondents were active participants in the Africa RISING project (and four were non-participants), although many of these respondents conducted at least one experiment independently of those that were promoted by Africa RISING. Female respondents were specifically targeted to participate in the qualitative interviews, which resulted in 15 female respondents and three male respondents. Female respondents, however, came from different household types, where six were heads of their own households, and nine were spouses within male-headed households. We did not interview any males from within a female-headed household. Respondents ranged in age from 25-54 years of age. The household size for most respondents ranged from three-six persons, and most respondents farmed one hectare of land or less. Likewise, the majority of respondents had 1.0 Tropical Livestock Units or less and scored in the lowest quartile of the Wealth Index.

Table 10. Socioeconomic Characteristics of In-Depth Interview Population

EPA	Linthipe	5
	Golomoti/Mtakataka	5
	Kandeu	3
	Nsipe	5
RISING Participant	Yes	14
	No	4

Table 10. (cont'd)

Gender (by Household Type)	Male (MHH)	3
	Female (MHH)	9
	Female (FHH)	6
Age Group	25 – 34	7
	35 – 44	7
	45 – 54	4
Household Size	3 – 4 persons	6
	5 – 6 persons	10
	7 persons	2
Farm Size	≤ 0.5 ha	4
	0.6 - 1 ha	11
	> 1 ha	3
TLUs	0 – 0.1	6
	0.2 – 1.0	10
	> 1.0	2
Wealth Index [Range = 2-101]	2 – 10	7
	11 – 25	8
	25 – 40	2
	> 40	1

Despite these general trends, however, some interview respondents came from large households (seven or more members), cultivated relatively large farms (> 1 hectare), and owned numerous reproductive and productive assets (high TLU counts and/or Wealth Index scores). Thus, the interview sample contained representatives from across a wide range of socioeconomic standings (within the Malawian smallholder population), which gave insight into the drivers, management practices, and decision-making processes related to on-farm experimentation across many perspectives.

4.0 Results

The following sections will detail findings from the quantitative and qualitative strands of our study, and will address the research questions posed at the beginning of this paper. Note that as the survey and the interviews yielded a wealth of information related to on-farm experimentation beyond legume production, alone, the discussion will include trends related to general experimentation as well as those trends related to legume production, specifically.

4.1 "Experimentation" versus "Everyday Practice"

As discussed in Section 2.0, scientists in the formal sector and experimenting smallholders often come from very different epistemological backgrounds, and they use different vernacular to describe their "experimentation" processes. From early in the design stage of this project, we expected that these differences might influence our study. In an attempt to overcome this epistemological and linguistic difference, we used a definition of "experimentation" that could be translated into Chichewa and still retain its meaning, where we explained to farmers that we were interested in any "unfamiliar crops, varieties, or techniques/technologies that they had tried for the first time ever". Using this definition, we gathered survey data on 572 examples of experiments that took place in 2012-2013. The interview data, however, reveals that despite the large frequency of experiments reported in our survey, some examples may still have gone unrecorded due to miscommunications and the ways in which farmers conceptualized their own actions.

Although all of the in-depth interview respondents were purposefully selected according to their propensity to try new things (information we learned from the survey data), and all of them fit our definition of an "experimenter", many of these innovative farmers interpreted the questions about “trying new things” to mean “trying new things *with an intervention project*”. Some of these farmers claimed that they had never experimented with new crops, varieties or technologies prior to joining an intervention project, but by the conclusion of the interview we usually discovered that these farmers had tried many new things on their own, but they were doing so without thinking of their actions as “experimental” or “innovative”:

> *INT: Previously on your own, you’ve never tried anything new?*
>
> 1140: No, previously we were just growing local maize. Then when we stopped that, now is when we’re growing maize for sale [hybrid].
>
> *INT: What about last season, when you weren’t working with RISING and you tried a new hybrid maize variety, and a new groundnut variety, and a new bean variety?*
>
> 1140: Oh! It was experimenting? I thought experimenting would mean only working with these projects.

> *INT: So before you started participating in these projects, did you try new things on your farm just on your own?*
>
> 4110: We were only planting local maize.
>
> *INT: You didn’t try any new crops or any new spacings just as your own idea before these projects?*
>
> 4110: No.
>
> ****Later in the interview****
>
> *INT: Where did you get the idea to plant the three plots like that to compare [different crops]?*
>
> 4110: It was my own idea.

These quotes illustrate that despite our efforts to make the terms “experimentation” and “trying new things” mutually understandable, it often required an in-depth conversation to surmount the epistemological and linguistic differences between Malawian farmers and formal scientists. Therefore, although the basic experimentation questions we asked on the survey instrument revealed 572 examples of farmer experiments, it is likely that many more examples were inadvertently omitted. If the assertions are true that farmers are constant experimenters (Chambers *et al.*, 1989; Scoones and Thompson, 1994b; Warren *et al.*, 1995) and that on-farm experimentation is so common as to be called “ubiquitous” by some studies (Rhoades and Bebbington, 1995: 306), then it is almost certain that some of the Non-experimenters in our sample actually were trying new things, but we failed to capture that information in a fixed-response questionnaire. While quantitative data yield important socioeconomic and farm-level information about experimenters, we need to exercise caution when making inferences about experimenters using these household survey data. Qualitative data, therefore, are vital to the understanding of on-farm experimentation processes, and provide invaluable insight into the more nuanced aspects of smallholder experimentation.

Overall, the household survey data and the in-depth interview data are the most insightful when interpreted in tandem, and therefore many of the following sections draw from both data sets. We turn now to the quantitative and qualitative data to explore the types of experiments that were reported, the characteristics of experimenters, and farmers’ motivations and methodologies for conducting experiments.

4.2 Types of Experiments

To begin our analyses of on-farm experimentation, we needed to first understand what kinds of experiments farmers were conducting. We used the survey instrument to ask farmers what unfamiliar crops, varieties, and techniques/technologies they experimented with in the 2012-2013 season, and from those questions we elicited 572 examples of experiments that farmers had tried. These examples came from 228 farmers (70.1% of the total sample). The frequency distributions of these experiments can be seen in Figures 4-7. Similar experiments were grouped together under a common theme (e.g. "land preparation experiments" include shifting ridges, using box ridges, and measuring the precise distance between ridges).

Figure 4. Total Frequency (%) Distribution of Experiments

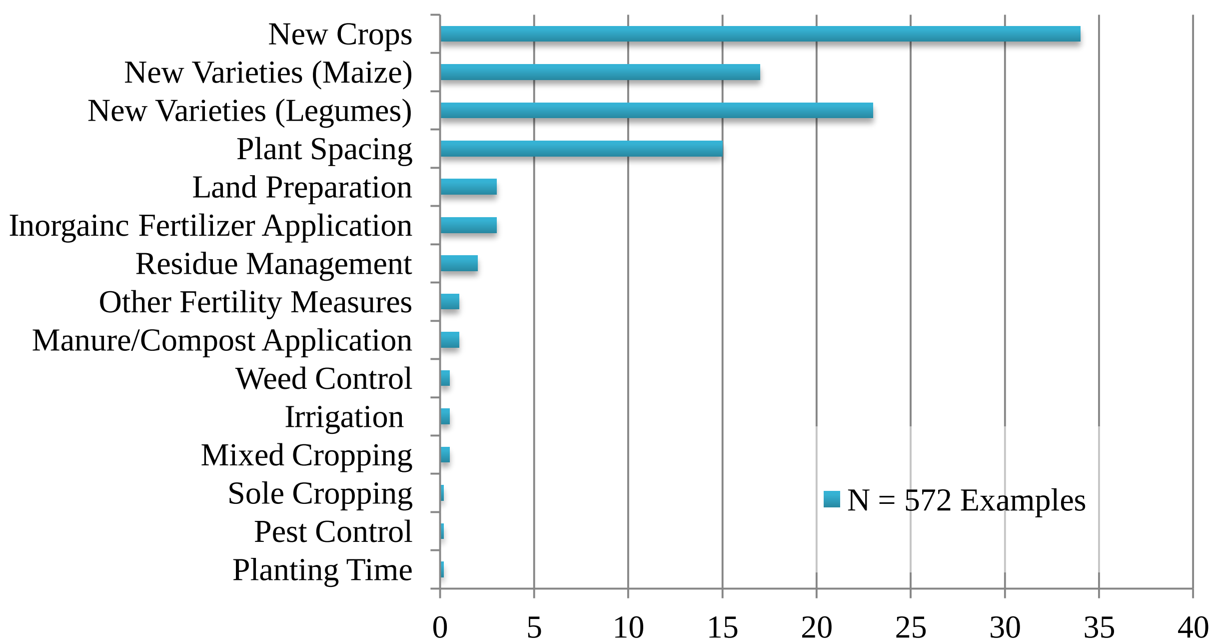


Figure 4 illustrates that 89% of experiments reported on the survey fell into three categories: new crops 34%; new varieties (maize and legumes) 40%; and plant spacing experiments 15%. Likewise, when the experiment examples were disaggregated—both according to sample groups of Intervention, Local control, and Distant control, and according to the experimentation classification categories of Project participants, Followers, and Independents (for definitions of these groups see Section 3.3.4)—similar trends emerged in the frequency distributions (Figures 5 and 6). For reference, Figures 7 and 8 depict all of the new crop experiments that farmers tried, disaggregated by sample groups and experimentation classifications, respectively.

Figure 5. Frequency (%) Distrubtion of Experiments (by Sample Group)

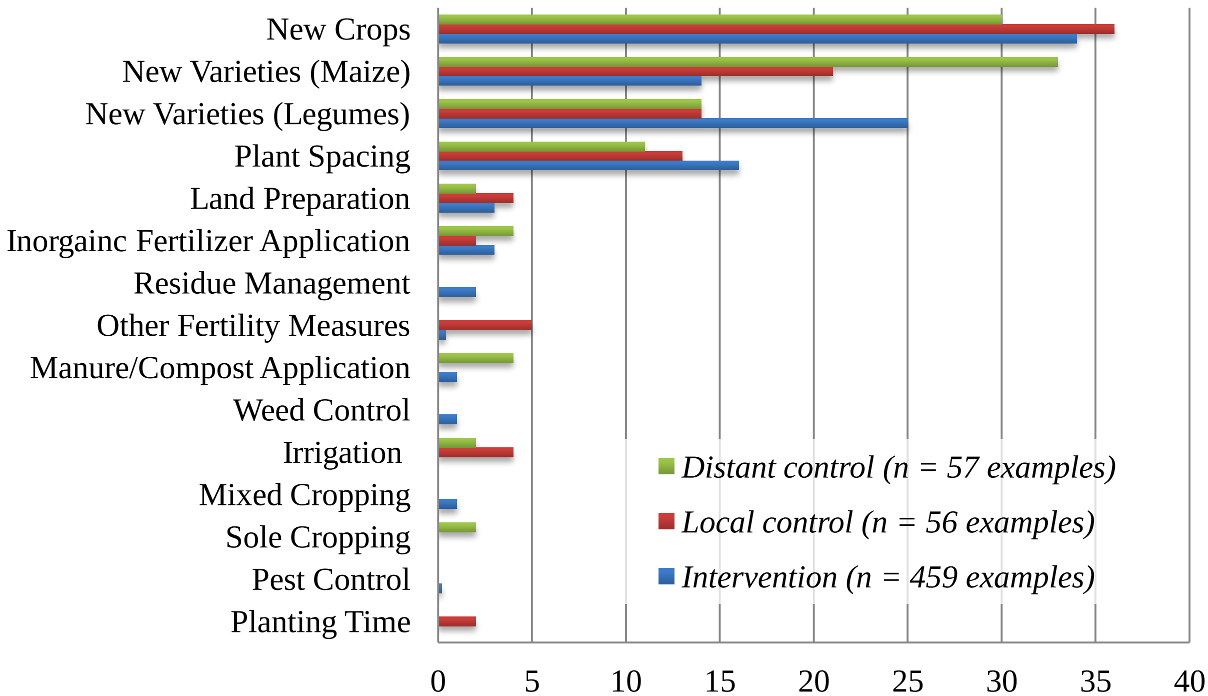


Figure 6. Frequency (%) Distribution of Experiments (by Experimenter Classification)

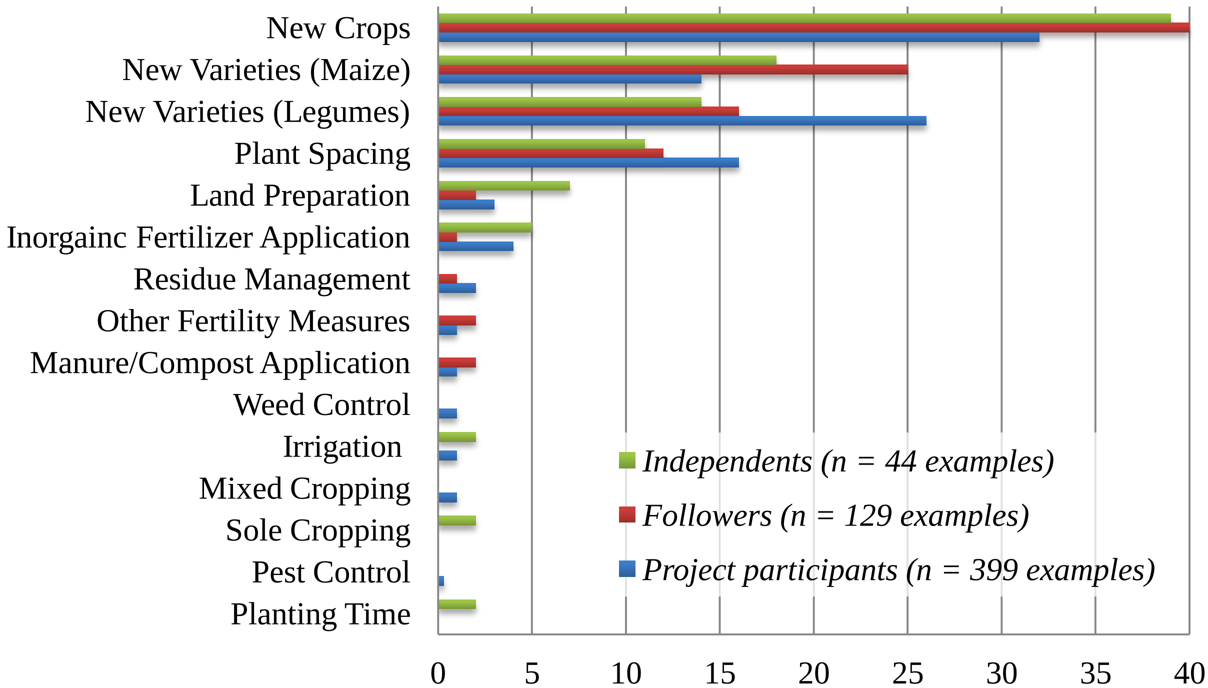


Figure 7. Frequency (%) Distribution of New Crops (by Sample Group)

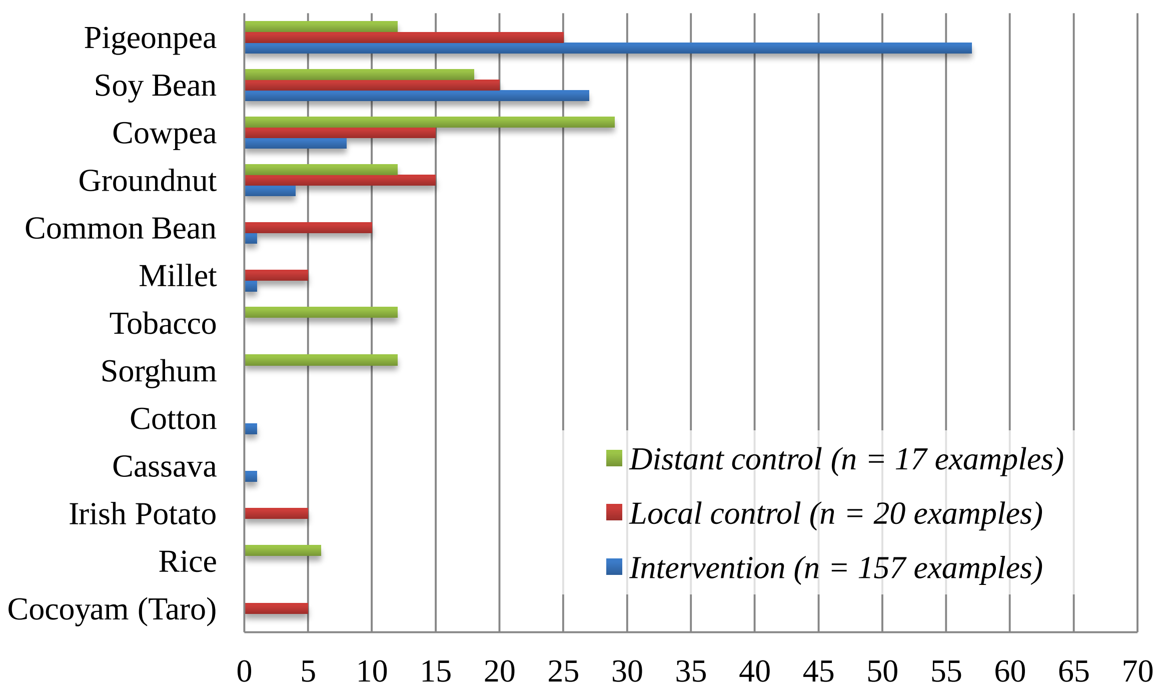
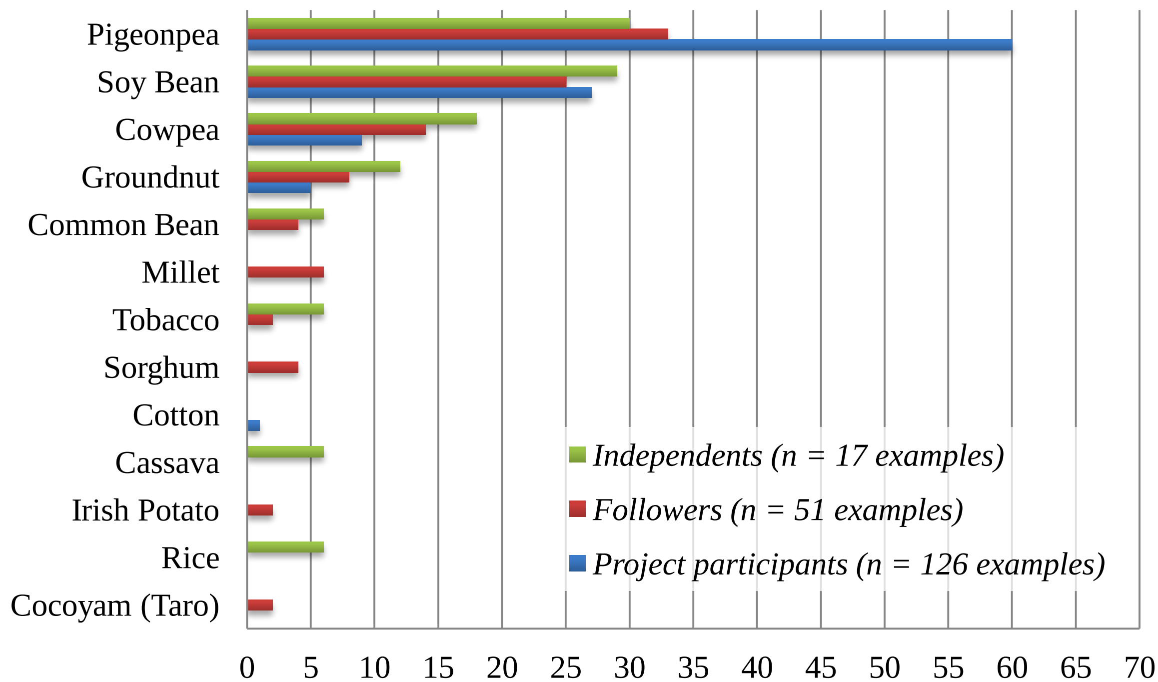


Figure 8. Frequency (%) Distribution of New Crops (by Experimenter Classification)



Across all three experimentation classifications, farmers had a propensity to try new crops, varieties, and plant spacing techniques more often than other types of experiments. Note, however, that a larger percentage of Independent experimenters (18%) and Followers (25%) tried new maize varieties than did Project participants (14%). Additionally, Project participants tried more new leguminous varieties than either Independent experimenters or Followers (26% compared to 14% and 16%, respectively) (Figure 6). Likewise, a much larger percentage of Project participants tried pigeonpea (60%) than either Independent experimenters (30%) or Followers (33%) (Figure 8). This trend is reflective of the recommendations made by Africa RISING in 2012-2013, where the project encouraged its participants to grow specific legume crops (e.g. pigeonpea), and 76.5% of Project participants were working with Africa RISING in that season (Table 3). The apparent popularity of crop, variety, and plant spacing experiments across experimenter groups will be further discussed in Section 5.2.

In addition to the survey questions, we also used the in-depth farmer interviews to gain insight into the types of experiments farmers were trying. The quotes in Table 11 illustrate some of the experimentation themes we created based on survey and interview responses. Note that some themes (e.g. crop rotation) are detailed in Table 11, but are not included in the previous frequency distributions (Figures 4-6). This discrepancy exists because in the interviews, we elicited information about farmers' past experiments (sometimes as far back as 11 years), while the surveys only gathered information about the 2012-2013 season.

Table 11. Examples of Farmers' Experiments from Interviews

Experiment Type	**Examples from Interviews**
New Variety	2134: For groundnuts, I tried a new variety…Because we were told that this new variety of groundnuts yields more than the local variety.
New Crop	3205: The new crop I've tried is pigeonpea that we received.
Plant Spacing	3126: We wanted to compare. For this new variety, it's something new, so if we plant it in a local way, it might not do well. That's why we changed the plant spacings.
Plant Spacing + Land Preparation	1217: We take a ruler then we use it to make sure the distance between planting stations is the same, and also the distance between the ridges is the same. Then we use a small plot and apply manure on that plot. Then we plant the seed using 1:1 technique. Then we see the difference from where we were planting 3:3. We like to see the difference.
Land Preparation + Reside Management	4219: With the fertility of our soils, now we've started incorporating residues and we've starting using box ridges so that when there is a lot of rain, we don't lose the water. Rather the box ridges should hold some of the water so in case of drought, the crops will survive. And also, incorporating crop residues traps the moisture in the soil. So then, when there is a lot of sun the crops don't die. Then, we plant the crops we want on the fields.

Table 11. (cont'd)

Residue Management	3205: The green residues, we incorporate them in the soil. Because we start harvesting groundnuts before maize. Then it's like we've buried them while they're fresh, so they rot, then they act like manure.
Manure/Compost Application	4104: Yes. When I made the ridges, I was applying manure on the planting station which would later be used for maize.
Crop Rotation	4219: On the field where we planted maize this season, we can't plant maize again next season. Instead, we plant groundnuts on that field. Where we have grown tobacco this season, next season we grow maize. We change the fields.
Sole Cropping	3205: …because previously we were just intercropping, in the same field maize, in the same field soya, and in the same field groundnuts. So last season was the first time to divide the field into 3: on one plot soya, on another plot maize, on the last plot groundnuts.

It is important to note that the examples of farmers' experiments we report are similar to those detailed in Scoones and Thompson (1994a), and the frequency distributions of the experiments in Figure 4 are similar to those reported by Sumberg and Okali (1997) and Kristjanson *et al.* (2012).

4.3 Innovative Farmers at the Household Level

After gaining an understanding of the types of experiments that farmers were conducting, we continued our statistical analyses with several tests that would help to answer the research question: What kinds of farmers are experimenting with unfamiliar legume crops, varieties, and farming techniques related to legume production? To explore this question, we used a one-way analysis of variance (ANOVA) test to compare the means of several socioeconomic and farm-level factors across four experimentation groups: Non-experimenters, Project participants, Followers, and Independents (for definitions of these groups, see Section 3.3.4). For this test, the independent variable was the experimentation group, and the grouping (dependent) variables were: household size; dependency ratio; wealth index score; tropical livestock units; farm size; and number of fields held. As gender of the household head was a binary variable, it was not included in this analysis, but for reference this data can be seen in Table 12. The means of the grouping variables used in the analysis can be found in Table 13.

Table 12. Gender of Household Head by Experimentation Groups

HH Head Gender	**Non-experimenters (*n* = 96)**	**Project participants (*n* = 145)**	**Followers (*n* = 64)**	**Independents (*n* = 19)**	**Total (*N* = 324)**
Male (%)	26.8%	46.3%	21.6%	5.2%	99.9%
Female (%)	36.6%	40.9%	15.1%	7.5%	100.1%

Due to rounding, row totals may not equal 100%

Table 13. Grouping (Dependent) Variable Means by Independent Variable Groups

	Mean (*S.D.*) by Independent Variable Group			
Grouping (Dependent) Variables	**Non-experimenters (*n* = 96)**	**Project participants (*n* = 145)**	**Followers (*n* = 64)**	**Independents (*n* = 19)**
Household Size	5.03 (2.11)	5.36 (1.81)	4.91 (1.72)	4.47 (1.95)
Dependency Ratio	1.05 (0.80)	1.13 (0.86)	1.09 (0.75)	0.91 (0.89)
Wealth Index [Range = 2-101]	14.85 (14.07)	16.39 (13.11)	17.44 (17.04)	17.58 (21.41)
TLUs	0.62 (1.40)	0.44 (0.76)	0.56 (1.39)	0.52 (1.13)
Farm Size (total ha)*	0.77 (0.47)	0.91 (0.72)	0.85 (0.49)	0.81 (0.50)
Number of Fields	2.05 (1.29)	2.31 (1.20)	2.19 (0.92)	2.63 (1.61)

*Note smaller sample size for this variable: Non-experimenters (*n* = 87); Project participants (*n* = 126); Followers (*n* = 59); Independents (*n* = 16)

The overall ANOVA test revealed that none of the six grouping variables differed significantly across experimentation groups, although the descriptive statistics indicate that non-experimenters scored lower on the asset-based wealth index than did experimenting farmers. As explained in Section 4.1, it is difficult to make inferences about a nuanced topic, such as smallholder experimentation, with survey data alone. In light of the inconclusive ANOVA test, we turn now to the qualitative data from our farmer interviews to gain an understanding of the differences between experimenter groups.

During the interviews, farmers commonly spoke of the ways in which the size of their landholdings (or the number of fields they held) affected their experimentation processes. Many farmers shared the opinion that beginning a new experiment (or scaling out a successful experiment) required more land, which often meant renting in additional field(s):

> 1105:…if you stick to planting on the same plot each year, you will suffer from hunger. But you should rotate, rent in more land, to experiment on that soil you've rented in to see the yields.
>
> 2134: Next season, I'm planning to grow on ¾ acres, when I find some more land.
>
> 2263: For next season, I want to rent in some more land, so that when we plant maize on the other field, on a separate field we will plant cowpea.
>
> 2132:…I paid money to rent in a field, then when we went, [my husband] said we should be tilling, then we sow the seed, then after the rains fell in February we transplanted the rice [experimental crop].

Likewise, some farmers who wanted to experiment with specific crops needed access to fields with particular characteristics (e.g. soil type, proximity to water source, etc.) in order to do so, and if they did not have access to those fields, they could not conduct (or repeat) their experiment:

> 2312: For mustard, we used the rented in plot. Then the owner took it back. Then we didn't grow mustard again.

In the same spirit, a few farmers described how their limited landholdings resulted in the forced abandonment of an experiment:

> *INT: So why did you decide not to plant the 8073 or the 8033 this season?*
>
> 4104: I didn't have enough land because I also wanted to plant the variety I received this season [from RISING]…
>
> *INT: So you gave that land to the Africa RISING hybrid instead, this year?*
>
> 4104: Yes.

Not all farmers, however, abandoned their experiments due to land shortages. For some farmers, land constraints caused the modification, rather than the abandonment, of a planned experiment:

> 1140:…sometimes the field is not enough…So to avoid leaving out some crops, the crops should be intercropped.
>
> 4129: We first intercrop [the experimental crops] because the area is not large enough to plant each crop separately. So we feel that if we divided the plots, we'd harvest little maize. So we just intercrop [the experimental crops] in the same field.

These farmer insights help us to understand that when challenged by limited resources—such as fields held—innovative farmers felt they had two options: abandon their planned experiment or make an adjustment to the experiment's design. Therefore, while farmers who hold fewer fields may face more complications in their experimentation processes than farmers with more fields, fewer fields does not necessarily result in less experimentation. These results will be revisited in Section 5.3.

4.4 Innovative Farmers Within the Household

While household data provide a wealth of information about the socioeconomic and agronomic characteristics of our experimentation groups at the macro level, we cannot fully understand the smallholder experimentation process without looking at the effects of individual-level characteristics on the labor and decision-making processes of on-farm experimentation. As we posited that female farmers would be more likely to experiment with unfamiliar legumes than would male farmers, given that legume crops are traditionally planted and managed by women, we used statistical analyses to investigate the effects of gender on experimentation.

In order to better understand the relationship between gender and experimentation, we used the survey instrument to ask farmers several questions about the distribution of labor during the initial planting of new crops/varieties and the initial implementation of new techniques/technologies during experiments in the 2012-2013 season (Appendix 1). A Chi-square test was used to determine the strength of the relationship between the experimenter's gender and the type of experimental crop or variety that was grown (Table 14).

Table 14. Gender and Experimental Crops, Varieties, and Techniques

Crops (n = 194):	**Male**	**Female**	**Both**	**Other***	**Total**
Legumes	32 (17.6%)	66 (36.3%)	83 (45.6%)	1 (0.5%)	182 (100%)
Cash	1 (33.3%)	0	2 (66.7%)	0	3 (100%)
Tubers	2 (66.7%)	0	1 (33.3%)	0	3 (100%)
Grains	1 (16.7%)	3 (50%)	2 (33.3%)	0	6 (100%)
Total Experiments by Gender†	36 (18.6%)	69 (35.6%)	88 (45.4%)	1 (0.5%)	194 (100.1%)
Varieties (n = 226):	**Male**	**Female**	**Both**	**Other***	**Total**
Maize	6 (6.2%)	39 (40.2%)	51 (52.6%)	1 (1%)	97 (100%)
Legumes	11 (8.5%)	46 (35.7%)	71 (55%)	1 (0.8%)	129 (100%)
Total Experiments by Gender	17 (7.5%)	85 (37.6%)	122 (54%)	2 (0.9%)	226 (100%)
Techniques (n = 152):	**Male**	**Female**	**Both**	**Other***	**Total**
Total Experiments by Gender	22 (14.5%)	48 (31.6%)	82 (53.9%)	0	152 (100%)

*Represents laborer for whom no gender information was known (e.g. child)
†Due to rounding, row total exceeds 100%

The Chi-square tests revealed that the experimenter's gender did not have a statisitically significant effect on the types of crops/varieties that were planted experimentally, or on the type of experimental technique that was attempted: crops: χ^2 (9, N = 194) = 7.37, p > .05; varieties: χ^2 (3, N = 226) = 0.81, p > .05; tech: χ^2 (22, N = 152) = 31.21, p > .05. Despite the non-significant *p*-value of the Chi-square test, there are several important trends that emerged in the analysis.

Firstly, we found that legume crop experiments were by far the most commonly reported among all respondents, where farmers said that 94% of the experimental crops they had tried in 2012-2013 were leguminous (note that leguminous crops were some of the most common experimental crops even among those farmers who did not participate in Africa RISING; see Figure 7). Likewise, farmers reported that 57.1% of the experimental varieties they tried in 2012-2013 were leguminous. It is also important to note the gender distribution of experimenters who grew unfamiliar legumes. The majority of experimental legume crops and varieties that were grown in 2012-2013 were planted by both spouses together (crops: 45.6% planted by both spouses; varieties: 55% planted by both spouses). In instances where only one person reported planting an experimental legume crop, however, women planted over twice as many unfamiliar legume crops as men (36.3% compared to 17.6% planted by men). Similarly, women planted over four times as many experimental legume varieties as men (35.7% by women compared to 8.5% by men).

This trend extends beyond experimental legumes: respondents reported that the majority of experiments (with crops, varieties, and techniques/technologies) were conducted by both spouses together. Those experiments that were conducted by only one person, however, were more often attempted by solo females than by solo males (crop experiments: 35.6% by females, 18.6% by males; variety experiments: 37.6% by females, 7.5% by males; tech experiments: 31.6% by females, 14.5% by males). Finally, it should be noted that both male and female respondents reported that for crop, varietal, and technical experiments, the majority of labor was undertaken by both spouses together, closely followed by solo women. For reference, these data can be seen in Table 15.

Table 15. Respondent's Gender by Gender of Experimenter

	New Crop Experiments				
Respondent Gender:	**Male**	**Female**	**Both**	**Other***	**Total**
Male	14 (21.2%)	26 (39.4%)	26 (39.4%)	0	66 (100%)
Female	22 (17.2%)	43 (33.6%)	62 (48.4%)	1 (0.8%)	128 (100%)
Total†	36 (18.6%)	69 (35.6%)	88 (45.4%)	1 (0.5%)	194 (100.1%)
	New Varietal Experiments				
Respondent Gender:	**Male**	**Female**	**Both**	**Other***	**Total**
Male	5 (6.4%)	28 (35.9%)	45 (57.7%)	0	78 (100%)
Female	12 (8.1%)	57 (38.5%)	77 (52.0%)	2 (1.4%)	148 (100%)
Total	17 (7.5%)	85 (37.6%)	122 (54.0%)	2 (0.9%)	226 (100%)
	New Technical Experiments				
Respondent Gender:	**Male**	**Female**	**Both**	**Other***	**Total**
Male	6 (10.9%)	17 (30.9%)	32 (58.2%)	0	(100%)
Female	16 (16.5%)	31 (32.0%)	50 (51.5%)	0	(100%)
Total	22 (14.5%)	48 (31.6%)	82 (53.9%)	0	(100%)

*Represents laborer for whom no gender information was known (e.g. child)
†Due to rounding, row total exceeds 100%

Although we did not find a statistically significant relationship to support the notion that women are more likely to experiment with legumes than men, the frequency distributions in Table 14 still provide us with valuable insight into the gendered division of labor associated with on-farm experimentation.

4.5 Farmer Motivations and Methodologies

4.5.1 Initiating an Experiment

To address our second research question (What motivates farmers to experiment with unfamiliar legume crops, varieties, and farming techniques related to legume production?), we held in-depth interview sessions with 18 innovative farmers. During the interviews, we asked farmers about their motivations for trying new things, in general, and for trying specific crops, varieties, and techniques/technologies (Appendix 2). Respondents discussed many different motivations behind each of their experiments, and often farmers tried something new for multiple reasons and with several goals in mind. The motivations described by farmers fell into three overarching categories, two of which were modified versions of experiment categories used by Sumberg and Okali (1997) in their study of on-farm experimentation: proactive and reactive motivations. Additionally, we created "external" motivations as a third category. The first half of this section addresses farmer motivations for all experiments, and in the second half we discuss differences in motivations between experiments, specifically between maize varietal experiments and other crop/varietal experiments (e.g. legumes).

Proactive experiments included those that were driven by a farmer's desire to create a positive change in her life circumstances or farm system, for example to increase food production, generate household income, improve soil fertility, or maximize land use. *Reactive* experiments were those that were prompted by a farmer's response to unexpected circumstances, such as climate change, pest or disease problems, or access to resources. Lastly, *external* experiments were those where a farmer was invited to try something new by an influential source (e.g. intervention project, extension officer, etc.). Note that while reactive motivations sometimes drove new experiments, it was also common for reactive factors (such as limited resources) to cause farmers to adjust an experiment or abandon it altogether. Unlike proactive and external motivators that primarily drove new experiments, reactive factors could also act as barriers to experimentation.

According to our qualitative coding structure, farmers spoke of proactive experimentation 162 times, reactive experimentation 65 times, and external experiments 77 times. As was previously stated, however, farmers in our sample were usually motivated by a combination of factors that spanned one or more of the motivation categories. It was not uncommon, for example, for one experiment to be identified as both proactively and externally driven, where a farmer tried something because it would benefit her *and* because it was suggested by an extension officer. In Table 16, we use farmer quotes to provide examples of experiments in all three motivation categories, as well as experiments that were driven by multiple motivations.

Table 16. Farmer Motivations for Experimentation

Motivation	Examples from Interviews
Proactive	1105: I tried this because there wasn't enough food for my household. I have small children who are orphans, so if I don't work hard, I'll have problems with raising the kids.
	2134: We try new things because we'd like to compare the benefits of the crops we previously grew and the crops we're currently growing.
	INT: Why do you want to try zero tillage? 2263: To reduce labor. Because land preparation [with hand hoes] is labor intensive.
	2301: I like to be like these other people who do not lack things. We should not just rely on getting help from other people, but we should be self reliant. That's why we experiment.
	3126: [So that] The village should be developed. And also the households should be food secure.
	4129: For soya, most people who grow it can sell it and get lots of money. When you harvest a lot, you can sell it and use the money for other household needs.
Reactive	1140: We try new things because of the changes in the rain. That's why we stopped planting those crops which are hard to grow when the rains aren't enough, and go instead for those crops which still grow well with less rain.
	INT: So why did you decide to try a new variety of hybrid? 2312: Because DK 8033 [usual variety] was no longer available.
	4134: I would try something [new] if I had enough resources. But the main problem here is fertilizer, because the prices of fertilizer have risen very high. But if we had enough fertilizer, we could experiment.
	4219: We weren't happy with the prices for which we sold the cotton. That's why this year we only grew tobacco.

Table 16. (cont'd)

External	2263: Experimenting, sometimes the AEDO tells us to do it like this, like this, like this. Then we go to our fields and practice what he advised us. *INT: So do you think World Vision and your experience with them made you more brave to try new things, like new crops?* 2301: Yes. They say wealth is in the soil. 3105: The AEDO told us that there's also pigeonpea here, and you need to plant it. We didn't refuse that. We received the seed just to try it. 4110: We received it from Africa RISING, so I wanted to see its yields.
Multiple Motivations	2134: For us to grow soya, they told us that we may get two main benefits. One is making soya porridge from soya flour, and the other is getting money from the sales. So when we received the soya seed, we decided to grow it to make soya porridge for the children, and it's nutritious. And the remaining produce, to sell. *[External, proactive]* 3126: Because of the problems with the local varieties. We wanted to compare the new varieties and the old varieties to see which one will yield more, and which one would benefit us the most. *[Reactive, proactive]* 4219: Because when we were conducting our tobacco meetings, we were told that a farmer shouldn't just rely on one crop. For example, if you grow maize and you rely on it to eat and to sell, it won't work well. You need to grow more than one crop, so that if one crop isn't selling well, you can try the other crop. And also, if you rely on one crop, when the rains aren't good you'll suffer a lot because you won't have food for your household. *[External, proactive]*

Just as it was common for one experiment to be driven by multiple motivations, as illustrated in Table 16, it was also common for a farmer to conduct different experiments for different purposes. In other words, we did not encounter any farmers whose every experiment was *only* influenced by one type of motivator. Farmer motivations were thus impossible to categorize by socioeconomic status or farm-level characteristics because the drivers of experimentation are complex and vary from case to case and farmer to farmer.

We did, however, identify a trend in experiment types, specifically in the motivations behind maize varietal experimentation. Among those farmers who tried hybrid maize for the first time or who tried a new variety of hybrid maize, many of their experiments seemed to be motivated by farmers' reactions to changes in rainfall patterns:

> 1109: The things that are changing are, for example, we used to grow local maize. But with the way the rains are coming, because it [local] matures late, it's different from hybrid maize, which is still doing well with the way the rains are coming.
>
> 1217: Sometimes [the rain is] erratic. Sometimes it stops early. So when you plant hybrid, it still does well even if rain stops early.
>
> *INT: So why did you decide to try and plant hybrid maize last season for the first time?*
> 3205: Because I saw that this local variety wasn't doing well.
> *INT: How?*
> 3205: It's not doing well because of the changes in the weather patterns. So we decided that it would be better to grow hybrid maize.
>
> 4134: Sometimes [we experiment] because of the way the rains are coming. For instance, some years we plant local maize, and then we see that the maize doesn't do well with those rains. That's why we change the variety, to try one which would do better with those rains. And also because maybe when we change, we may get better yields and sell some to get money.

In contrast, those farmers who planted new non-maize crops and/or varieties (most of these experiments involved legumes) often identified motivations that were *not* related to climate change or rainfall patterns, such as income generation, food production, improving the farm system, etc.:

> 1140: This year, for us to grow those crops, we were told they would help to solve some household problems. For example, if soya yields a lot and you sell it, you may use that money to address some other problems. That's why we decided to grow soya and cowpea.

> *INT: So why did you decide to plant cowpea and pigeonpea?*
> 1217: Crop diversity. When you diversify crops, you get money from all those crops when you harvest a lot.

> *INT: And why did you want to plant cowpea?*
> 2263: Money!

> 4134: I wanted to use it [pigeonpea] to help with the relish problem. And also because when the leaves fall on the soil, they increase the soil fertility.

Regarding experimentation with new techniques/technologies (applied to both maize and non-maize crops), farmers reported a wide range of motivators, including climate change, improving the farm system, reducing labor, etc.:

> 2134: The difference is that for zero tillage, it reduces labor. We don't spent so much time cultivating the field. Weeds don't grow quickly because they're hindered by the maize stalks. It's only maize which grows, not the weeds. Then we just go and pull up the

weeds from the maize field. And also when there's too much sun, it doesn't penetrate easily, and the field remains moist for a longer period of time.

2263: We were told that with zero tillage, after you lay the maize stalks, you just plant. Even if the rain isn't enough, the maize won't wilt because the soil is still moist.

4110: Because for example, if the rain stops for 2 weeks, during that time, the field will still be moist and the crops will still grow well where you've made box ridges. The crops don't wilt because the field stays moist.

4134: Incorporating crop residues is very beneficial because it increases soil fertility. The soil doesn't lose its fertility when you incorporate those residues.

4219: Because a field where we grew tobacco, groundnuts, or soya, is fertile. It's like we've increased the soil fertility [by growing those crops]. Then, if the next season, you grow maize on that field, the yield will be high.

These examples indicate that farmers in our sample frequently experimented with hybrid maize varieties as a reaction to changing rainfall patterns, and with non-maize crops and varieties to meet various other goals (income, household nutrition, farm health, etc.). These farmers also indicated that their technical experiments were driven by a wide range of factors including climate change, improving farm health, and others. These qualitative findings are compounded when we draw from the survey data, where 86.1% of farmers said they had noticed changes in the rains over the last 20 years, and out of those farmers, 67.2% reported that the changes they noticed included: less rain; erratic rainfall; and a tendency for the rains to stop before the crops had matured. When taken in combination, these results indicate that farmers are not only noticing climate change, but they are actively experimenting with maize varieties and with new techniques/technologies in an effort to mitigate undesirable changes. The implications of these results will be discussed further in Section 5.2.

4.5.2 Designing an Experiment

After we gained an understanding of the motivators that drive farmers to initiate an experiment, we needed to further explore the methods used by farmers when conducting an experiment. This section relates to our final research question: How are farmers managing their experimental crops, varieties, and techniques? During the interviews, we asked farmers detailed questions about the ways they set up their experiments (Appendix 2). These questions related to the size of the experiment (e.g. plot size, amount of seed, etc.), the use of a comparison or "control", and the separation of new crops/varieties from familiar ones.

In general, our results surrounding an experiments' size are aligned with those of similar studies (Rhoades, 1989; Sumberg and Okali, 1997), where most farmers started an experiment on a small scale, either planting a small amount of seed or using a small tract of land:

1105: We start with small quantities [of seed].

1121: We just plant on a piece of land, like a bed, to try.

INT: And how big was the area where you tried the zero tillage this year?

2301: It was one bed…It was just experimenting, so it was small.

4110: I tried the new variety on a small plot.

INT: So the first time that you tried it, were you nervous that it wouldn't work?

4219: Yes, we doubted it. And we only tried it on one field.

Likewise, our findings related to farmers' use of a comparison or "control" were similar to those found by Sumberg and Okali (1997), where some farmers consciously compared an experiment to a control plot during the same season, other farmers compared an experiment to what Sumberg and Okali called a "historical control" (farmers' detailed knowledge of the past performance of a crop or technique after years of experience), and still other farmers did not use any obvious control—historical or otherwise. Illustrative quotes can be found in Table 17.

Table 17. Farmers' Use of a "Control" in Experiments

Control	*INT: So besides the different variety, did you plant it just the same, with the 1:1 spacing and the fertilizer application?* 1217: There were no differences. *INT: Demeter. The way you grew it, was it the same way [as the old variety], or was there some differences?* 2312: It was just the same.
No control	*INT: Did you also plant the local variety [cowpea] as 1:1?* 2134: No, for local I planted 3:3. *INT: So the first time you planted it [hybrid], did you plant it the same as you planted your local maize?* 3205: No. For this one [hybrid], we planted 1:1. *INT: Did you plant the old varieties and the new varieties in the same way? Like both as sole crops, both the same spacing?* 4219: They were different.

To better understand the ways in which farmers implement an experiment, we also asked respondents about their planting methods—whether experimental crops/varieties were separated from familiar crops, or whether they were planted together. Again, farmers elicited mixed responses, where sometimes new and old crops were separated (so farmers could see the new crops' benefits) and sometimes new and old crops were planted together (so farmers could analyze the performance of an experimental crop as an intercrop). Related quotes can be found in Table 18.

Table 18. Farmers' Separation of Crops

Separate experimental crops from familiar crops	1105: I start planting it as a sole crop, so that I should see it. 1109: When we plant them on the same plot, we wouldn't notice the crop that we're very interested in. 1217: I wanted to see the benefits of the new variety, and compare them to those of the previous variety. 3205: We divided the field. We planted hybrid on one side and local maize on the other side.
Plant experimental crops together with familiar crops	2134: We wanted to compare the yields to see which would do best—as a sole or an intercrop. *INT: And why did you decide to plant it in those 3 different ways: one as a sole crop, one intercropped with cowpea, and one intercropped with pigeonpea?* 4134: I wanted to see the yields when we intercropped the different crops. 4219: In the past, we planted it [an experimental crop] as a sole crop. But now, with the way things are changing, we sometimes start with intercropping. *INT: For the first time?* 4219: Yes. So we can see if the intercrops do well or not.

These differences in design across farmers (and even across experiments) indicate that although farmers use a variety of management techniques when trying an experimental crop, variety, or technique/technology, whichever method they use has a definite purpose and farmers have specific goals in mind when they implement an experiment using certain methods. We will propose a potential explanation for these methodological variations in the Section 5.3.

4.5.3 Repeating, Adjusting, or Abandoning an Experiment

After we had learned more about why farmers initiated experiments and the methods they used to conduct experiments, we turned to the decision-making process of farmers after the conclusion of an experiment. To understand farmers' attitudes and their decision-making processes, we asked questions during the interview about farmers' assessment criteria ("success" or "failure") and their attitudes of satisfaction (or dissatisfaction) with a completed experiment (Appendix 2). The following quotes demonstrate how those assessments and attitudes (together with a farmer's resources and social situation) shaped farmers' intentions for future experimentation and helped determine if they would repeat, adjust and repeat (i.e. scale out, scale back, or make a change), or abandon their original experiment.

Through our conversations with interview respondents, we learned that the relationship between success (failure), satisfaction (dissatisfaction), and future intentions is not direct, but is mediated by factors such as resource availability. Thus, dissatisfaction with an experiment does not necessarily result in the abandonment of that experiment. Likewise, satisfaction with an experiment does not necessarily result in its repetition.

Regarding farmers' assessment criteria, interview respondents defined an experiment as a "success" if the experimenter gained something from it (e.g. food, income, knowledge, etc.), and a "failed" experiment as one that did not meet the farmer's expectations or desired outcomes. These definitions are represented by the quotes in Table 19.

Table 19. Ideas of "Success" and "Failure"

Success	*INT: And the whole thing, would you say that was a successful experiment?* 2134: Yes. *INT: Why would you say it was successful?* 2134: Because we were able to compare the yields. Across the 4 plots, we were able to compare the yields to see which did better. And we found out that the 2:2 had a better yield than the 3:3. 4104: I saw that the maize yielded well, unlike just planting without using anything. Planting without anything, you get nothing. But planting with manure, at least you get something. *INT: So do you think that this was a successful experiment that you tried?* 4104: Yes, it's a good technique because if you don't have enough money to buy fertilizer, you can just use manure. *INT: So do you think that that new spacing was a successful experiment…?* 4110: Yes. *INT: And why do you think so?* 4110: Because previously, we were just planting plants one here, the other one over there [with large spaces between plants], without following any strategy. Instead of planting many seeds in a row, we were only planting a few seeds per row. Where before we were planting 3 seeds, now we're planting 6, and now we're harvesting more.
Failure	1105: It has proved to be a failure because I've tried it twice [without harvesting anything]. 2301: …This season, I didn't harvest anything. But last season, I got 3 bags. This season, ah! Nothing. Not even a bag. 3205: For the pigeonpea, we just planted it, and now the goats are eating it. So we haven't seen any benefits from it. 4134: This season we didn't harvest anything, and we won't harvest anything, because the goats are eating the crop, as I already said [during the survey], because this variety is late maturing. So now goats and cattle have eaten up the pigeonpea. *INT: So it's all gone?* 4134: Yes, we haven't gotten anything.

Farmers' attitudes (satisfaction or dissatisfaction) did not predictably correspond with their experimental outcomes. Successful experiments were consistently associated with feelings of happiness or satisfaction, but farmers did not always equate failed experiments with dissatisfaction. On the contrary, it was common for an innovator to be satisfied with the outcomes of a failed experiment if she felt that she had learned something in the process, or that the experiment's failure could be attributed to another factor beyond the experimental crop or technique, itself (e.g. weather, personal health, etc.):

INT: So were you happy that you planted pigeonpea?

1217: Yes. Although we didn't eat anything.

INT: Even though you've harvested nothing because of goats?

1217: Yes, the seed is appealing. That's why we did not eat it [before planting it], but we were happy we grew it.

2301: I found it to be a good technique. Only the problem is that the rain stopped early. The stalks were healthy, indicating that we could have had large yield. But the rains stopped early, then the maize wilted.

INT: So were you satisfied that you tried this this season?

2301: Yes, I'm very happy.

3126: No. Since the beginning we got nothing.

INT: So are you happy that you tried that this year?

3126: Very much!

INT: Why?!

3126: This just happened because of the rains.

INT: Were you happy that you planted it?

4129: Yes.

INT: Why were you happy, even though you had no yield?

4129: Because I tried to grow it, just the way my friends did. It didn't work well because I was in the hospital.

At the conclusion of any experiment, an innovator had to determine if they would repeat, adjust and repeat (i.e. scale out, scale back, or make a change), or abandon their original experiment. A number of factors influenced this decision, including the interplay between the assessment (success or failure) of the experiment and the attitude (satisfaction or dissatisfaction) of the experimenter, as illustrated in the above quotes. Additionally, the future of an experiment was determined in part by a farmer's access to resources. During the in-depth interviews, farmers identified certain resources as being influential during the experimentation process, including: landholdings (both total farm size and number of fields); input availability in local markets, from intervention projects, or through government subsidies (e.g. seed, fertilizer, pesticides, etc.); household income to purchase agricultural inputs; and available labor (which was closely related to health issues).

Overall, farmers expressed that their choice to continue or abandon an experiment varies with every experiment, which is consistent with the theoretical frameworks supporting this study (Nitsch, 1990; Schön, 1983). There are several important trends, however, that emerged during the interviews. Firstly, although successful experiments always resulted in feelings of satisfaction, a failed experiment could result in either feelings of satisfaction or dissatisfaction. Secondly, when an experiment was deemed successful, a farmers' access to resources had a great deal of influence over the farmer's decision to continue or abandon an experiment. For example, one farmer had the desire to scale out ("adjust and repeat") a successful experiment, but due to resource constraints (landholding size, in this case) she was only able to "repeat" the experiment:

INT: And will you plant more next year than you did this year?

1140: The field is just the same [size], every season we grow there so we won't increase the area. The only difference is just the yield. Like for different seasons, we get different numbers of bags. But the area is just the same.

INT: So if you had more land, would you want to plant more of this?

1140: Yes, I would increase the area.

Likewise, another farmer learned through experimentation that she preferred one variety of groundnut over another, and because she had the resources (available seed) to plant her favorite variety the following season and she felt she had gained all she could from the comparison experiment, she only planted one variety the next season (and thus abandoned the comparison experiment):

INT: And so that season did you plant the local and the hybrid?

4110: Yes.

…

INT: And you found that the yield from the hybrid was much better?

4110: Yes.

INT: Any other differences that you noticed?

4110: The hybrid variety doesn't spread across ridges. But for the local variety it spreads so much! So that it's even difficult to harvest.

INT: Anything else that was different?

4110: No, the yields only. It just spreads but it doesn't yield that much.

…

INT: And so this season, did you decide to plant just the hybrid?

4110: Yes, hybrid only.

INT: So are you happy that you tried the local that one season?

4110: Yes, because I've seen the bad and good sides of it.

Resource availability was thus a crucial element of many farmers' decision-making processes following *successful* experiments.

In the event of a *failed* experiment, however, a farmer's decision-making process was not dependent on her access to resources, alone, but on the interplay between her attitude (satisfaction or dissatisfaction) *and* her access to resources. A farmer who was dissatisfied with her failed experiment *and* had access to resources was not likely to "repeat" or "adjust and repeat" the experiment. It was common for dissatisfaction to lead to abandonment even if the innovator had access to the resources to retry an experiment, because farmers who were dissatisfied felt they had gained nothing (e.g. yield, knowledge, etc.) from an experiment and thus did not want to try again:

INT: So did you decide to plant it again this year?

3126: No, we didn't plant it.

INT: Ah, why didn't you grow it again?

3126: Because of what happened last year; we didn't clearly see any benefits. And also because the soil type doesn't suit well with cotton.

A farmer with limited access to resources, however, sometimes had less freedom to abandon a failed experiment, despite their dissatisfaction, because repeating the experiment (in the hope that it would turn out better after a second attempt) was a safer option than abandoning it, as in the case of free or subsidized seed, for example:

INT: So do you expect to have any harvest from them?

1105: No, we won't harvest anything.

INT: So are you glad you planted pigeonpeas this year?

1105: No, I'm not happy.

INT: So will you plant them again next year?

1105: If we receive it, we will plant it.

INT: If you receive the seed next year, what will you do differently for the pigeonpeas?

1105: If the first rains will come early, then we will plant early.

INT: So why did you decide to try a new variety of hybrid [last season]?

2312: Because DK 8033 [previous variety] was no longer available. But I liked it [DK8033] because it yielded a lot.

INT: It was no longer available?

2312: Yes. And then because this [new Demeter variety] was for free, we then decided to just get it to cover the whole field. But it yields less than DK 8033 yielded.

INT: So this season, did you go back to the first hybrid you were growing, or did you grow Demeter again?

2312: No, Demeter again.

INT: Because the other seed still wasn't available?

2312: Yes.

Regardless of whether a farmer had the *desire* to repeat an experiment or abandon it, their decisions were largely influenced by their access to productive resources. Lack of access to resources is commonly seen as a barrier to experimentation, but in the case of farmers who are forced to try unfamiliar seeds season after season—perhaps due to their dependence on volatile subsidies or their participation in revolving intervention projects—the lack of access to resources can actually be a driver of experimentation, although these experiments are not independently motivated. The influence of resource availability on experimentation will be further discussed in Section 5.3.

4.6 Drivers of On-Farm Experiments

After considering the inconclusive results of the ANOVA test between experimenter groups (Section 4.3) and the insights gained from the qualitative data surrounding the influence of resources on experimentation (Sections 4.3; 4.5.3), we came back to the quantitative data and conducted a regression analysis to predict experimentation likelihood among our survey respondents. Binary logistic regression analyses are commonly used in studies that aim to understand the likelihood of technology adoption (e.g. Barungi *et al.*, 2013), and as adoption is closely related to experimentation, we found a binary logistic analysis to be the most fitting regression for our data. Our dependent variable was binary, where Non-experimenters = 0 and Independent experimenters = 1, where experimentation was a function of: number of fields planted in 2012-2013 season; total field area; exposure to extension information; household head gender; Tropical Livestock Units; Wealth Index score; and the interactions of several of these variables. These predictor variables can be found in Table 20.

Table 20. Description of Predictor Variables Used in Logistic Regression Analysis

Variable Name	**Variable Description**	**Measure**
HH Head Gender	Gender of household head	0 = Male 1 = Female
Total Fields	Total fields held	Count
Farm Size	Total farm size (ha) – only for farmers holding 3 fields or less	Hectares
TLU	Tropical livestock units held	Weighted count
Wealth Index Score	Score on asset-based wealth index	Weighted count
Extension	Extension advice received in 2012-2013	0 = No 1 = Yes
HH Head Gender_ Total Fields	Gender of household head by Total fields held	Interaction
HH Head Gender_ Wealth Index Score	Gender of household head by Score on asset-based wealth index	Interaction
Wealth Index Score_ Total Fields	Score on asset-based wealth index by Total fields held	Interaction
Wealth Index Score^2	Score on asset-based wealth index (squared)	Interaction
Total Fields^2	Total fields held (squared)	Interaction

The binary logistic regression formula was expressed as:

$$logit(p) = a + b_1x_1 + b_2x_2 + b_3x_{3\ldots}$$

where *logit(p)* is a binary indicator variable that equals 1 if a farmer planted an unfamiliar crop or tried an unfamiliar technology independent of an agricultural intervention and zero otherwise; a is a constant of the equation; and b is the coefficient of the predictor variables. As the logistic regression was meant to analyze the drivers of *independent* experimentation, Followers and Independent experimenters (from the aforementioned classification structure) were coded as 1 (n = 241), and Non-experimenters and Project participants were coded as zero (n = 83).

A test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between Independent experimenters and Non-experimenters, where χ^2 (11, N = 288) = 33.04, p = .001. Although Nagelkerke's R^2 indicated a relatively weak relationship between prediction and grouping (.159), prediction success overall was 74.3% (96.7% for non-experimenters and 10.7% for experimenters). The Wald criterion demonstrated that the following variables are significant determinants of experimentation: *wealth index score* ($p < .05$); *extension advice* ($p < .001$). Additionally, *HH head gender* displayed marginal significance ($p = .056$). These results can be found in Table 21.

Table 21. Logistic Regression Analysis of Experimentation

Independent Variable	**B**	**S.E.**	**Wald**	**Sig.**	**Exp(B)**
HH Head Gender	- 1.745	.911	3.666	.056	.175
Total Fields	-.100	1.205	.007	.934	.905
Farm Size	-.174	.322	.293	.588	.840
TLU	-.638	.353	3.265	.071	.528
Wealth Index Score	-.111	.048	5.357	.021	.895
Extension	-1.160	.300	14.944	.000	.313
HH Head Gender_ Total Fields	.472	.462	1.047	.306	1.603
HH Head Gender_ Wealth Index Score	.036	.030	1.391	.238	1.036
Wealth Index Score_ Total Fields	.034	.018	3.551	.060	1.035
Wealth Index Score^2	.001	.001	3.362	.067	1.001
Total Fields^2	-.042	.303	.019	.890	.959
Constant	.446	1.174	.144	.704	

Model χ^2 (11) = 33.038, p = .001
Pseudo R^2 = .159
N = 288

Note: The dependent variable in this analysis is coded so that 0 = non-experimenter and 1 = experimenter.

For the significant predictor variables of *wealth index score and extension*, EXP(B) values were less than 1.0, indicating that as these predictor variables are raised by one unit, the odds ratio becomes smaller, and therefore the likelihood of experimentation decreases. In other words, those households that had fewer assets or received no extension advice were more likely to experiment than households that had more assets or received some extension advice in the previous season. Regarding the marginal significance of *household head gender*, the EXP(B) value of this variable indicates that members of male-headed households were more likely to experiment independently than are members of female-headed households. This result was not altogether unexpected, given the nature of experimentation as—in part—an individual-level process, regardless of the gender of the household head (see Section 4.4).The implications of these results will be further discussed in Section 5.1.

4.7 Summary of Results

Out of a total of 324 farmers surveyed, 228 (70.1% of total sample) reported conducting at least one experiment in the 2012-2013 season. Those 228 farmers elicited 572 examples of experimental crops, varieties, and/or techniques that they had tried both independently and through an intervention project. We learned in Section 4.2 that 89% of the reported experiments from 2012-2013 had involved new crops, varieties, or plant spacing techniques, and this trend held true for all three experimenter groups (Participants, Followers, and Independents).

In Section 4.3, an ANOVA test revealed no significant differences in socioeconomic or farm-level means between experimenters and non-experimenters, or between farmers who conducted different types of experiments. These inconclusive findings were supplemented with qualitative data, where many farmers shared the opinion that starting a new experiment (or scaling out a successful experiment) required more land, which often meant renting in additional field(s). These insights helped us to understand that when challenged by limited resources—such as fields held—innovative farmers felt they had two options: abandon their planned experiment or make an adjustment to the experiment's design.

Section 4.4 highlighted legume experiments, and we learned that 94% of experimental crops that farmers had tried in 2012-2013 were leguminous, and 57.1% of experimental varieties that farmers had tried in 2012-2013 were leguminous. In this section, we also examined the relationship between gender and legume experimentation, and found no statistically significant differences between men and women and their propensity to experiment with legumes. The frequency distributions from this test illustrated that the majority of experimental legume crops and varieties that were grown in 2012-2013 were planted by both spouses together (crops: 45.6% planted by both spouses; varieties: 55% planted by both spouses). When only one person reported planting an experimental legume, however, women planted over twice as many unfamiliar legume crops as men (36.3% compared to 17.6% planted by men) and over four times as many unfamiliar legume varieties as men (35.7% by women compared to 8.5% by men). Regarding all experiments (not just those involving legumes), similar trends emerged. The majority of experiments (with crops, varieties, and techniques/technologies) were conducted by both spouses together. Those experiments that were conducted by only one person, however, were more often attempted by solo females than by solo males: crop experiments: 35.6% by females, 18.6% by males; variety experiments: 37.6% by females, 7.5% by males; technical experiments: 31.6% by females, 14.5% by males.

As we learned in Section 4.1, not all farmers thought of their actions as "trying new things" or "experimenting", and the inconclusive ANOVA test in Section 4.3 also illustrated the difficulty of measuring experimentation quantitatively. The best way we found to overcome these challenges was to hold in-depth conversations with farmers. Therefore, Section 4.5 used interview data to explore the motivations and methodologies behind smallholder experimentation.

In Section 4.5.1, we learned that experimentation was driven by many motivators, including proactive, reactive, and external forces, or sometimes a combination of all three. Maize varietal experiments were more commonly driven by reactive forces (especially changes in rainfall patterns) than anything else, and other varietal/crop experiments were driven primarily by proactive and external forces (such as income generation, nutrition, participation in an intervention project, etc.). Technical experiments were driven by a range of motivators including, but not limited to, climate change and variability. These data suggested that farmers tried new maize varieties and some technical experiments because they were concerned about climate change. These findings were corroborated by the survey data, where 86.1% of farmers said they had noticed changes in the rains over the last 20 years, and out of those farmers, 67.2% reported that the changes they noticed included: less rain; erratic rainfall; and a tendency for the rains to stop before the crops had matured. When taken in combination, these results indicated that farmers were not only noticing climate change, but they were actively experimenting with maize varieties and new techniques in an effort to mitigate any undesirable changes.

Whereas Section 4.5.1 dealt with the motivations behind experimentation, Section 4.5.2 focused on a farmer's management strategy once they had decided to conduct an experiment. Through examination of the qualitative data, we learned that most farmers conducted their experiments differently, where the only common practice among respondents was the propensity to start an experiment on a small scale. Regarding the use of a "control" or comparison, we found that some farmers used a simultaneous control, some farmers used a historical control, and some farmers did not use any kind of comparison in their experiments. Likewise, we found that where some farmers tried experimental crops/varieties on a separate plot from their traditional crops, some farmers preferred to intercrop unfamiliar crops/varieties with their traditional ones. Overall, we found that although farmers used a variety of management techniques when trying an experimental crop, variety, or technique/technology, whichever method a farmer used had a specific purpose and reason behind it.

Section 4.5.3 looked at the end results of farmers' experiments, specifically regarding the interaction between a farmer's assessment of an experiment (success or failure), attitude about the experimental outcomes (satisfied or dissatisfied), access to resources, and future intentions for the experiment. In general, successful experiments were associated with feelings of happiness or satisfaction, and the future of a successful experiment was closely tied to a farmer's access to resources. Failed experiments, contrastingly, could result in either satisfaction or dissatisfaction, and the future of a failed experiment relied upon both a farmer's attitude *and* their access to resources.

After considering the differences between experimenters, the motivations that drive a farmer to trying something new, and the emergent relationship between resources and experimentation, in Section 4.6 we built a model to predict the likelihood of experimentation and tested it using a binary logistic regression analysis. Prediction success overall was 74.3% (96.7% for non-experimenters and 10.7% for experimenters), and the Wald criterion suggested that those households that had fewer assets or received no extension advice in the previous season were more likely to experiment than households that had more assets or received some extension advice in the previous season. The logistic regression results run contrary to some of the findings reported in Sections 4.3 and 4.5. These apparently contradictory findings, as well as the previously outlined results and their implications, will be discussed in detail in Section 5.0.

5.0 Discussion and Recommendations for Further Research

5.1 Farmers Who Experiment

In total, our study identified 228 experimenting farmers, or 70.1% of our total sample. While we cannot claim, therefore, that all farmers try new things as a matter of course, we can discern that smallholder experimentation is widespread, especially when we consider that many examples of experimentation may have been inadvertently omitted from our study due to the epistemological and linguistic differences that exist between smallholders and researchers in the formal sector.

We wanted to understand the differences across experimenting farmers, specifically the gendered division of labor on experimental plots. Intra-household frequency distributions illustrated that the majority of experiments (with crops, varieties, and techniques) were conducted by both spouses together, but that those experiments that were undertaken by only one person were more often attempted by solo females than by solo males: crop experiments: 35.6% by females, 18.6% by males; variety experiments: 37.6% by females, 7.5% by males; technical experiments: 31.6% by females, 14.5% by males. Note that these trends hold true when even experiments are disaggregated by crop categories (e.g. legume experimentation), where the majority of experimental legume crops and varieties that were grown in 2012-2013 were planted by both spouses together (crops: 45.6% planted by both spouses; varieties: 55% planted by both spouses). In instances where only one person reported planting an experimental legume crop, however, women planted over twice as many unfamiliar legume crops as men (36.3% compared to 17.6% planted by men), and over four times as many experimental legume varieties as men (35.7% by women compared to 8.5% by men).

These data call into question the commonly-held notion that legumes are "women's crops", as legume experimentation was reportedly conducted by both spouses in the majority of cases. As a whole, however, when labor was divided between spouses, experimentation (with legumes, but also in general) was undertaken mainly by women. Even in instances where both spouses conducted experiments together, it is likely that women's priorities were as influential as men's in shaping the experiment. We will discuss some of the motivations that may have been driving these women to experiment in Section 5.2.

Next, we differentiated between experimenters according to the source of their ideas, where those farmers who had only tried something new as part of a project or at the advice of an extension officer were called Project participants (n = 145), those farmers who tried at least one experiment that they had seed from a peer and replicated were called Followers (n = 64), and those farmers who had tried at least one experiment that had spawned from their own minds were called Independents (n = 19). Approximately one-third of our sample population reported participation in an agriculture or non-profit project in 2012-2013, and 55% of our sample population reported receiving extension advice in the same season. Due to this effectual saturation of new ideas into a very small and densely populated area, it was thus difficult to measure *truly* independent experimentation, which is why we used the aforementioned classification structure.

We measured group differences across the four experimentation classifications using an ANOVA test. The results of this test demonstrated that experimenting farmers came from a wide range of socioeconomic backgrounds and farm types, and that there were no statistically significant differences across experimenters, or between farmers who tried something new in 2012-2013 and those who did not. This inconclusive statistical finding led us back to the in-depth interview data, where we learned that many farmers felt their capacity to experiment hinged on their access to land. If their access to land was limited, many farmers felt that they either had to abandon their experimental plans or creatively adjust them if possible (e.g. intercrop an experimental crop with a traditional crop instead of planting each as sole crops).

Finally, we wanted to gain a better understanding of a farmer's likelihood to try something new *without* being guided by an intervention project or extension officer. To accomplish this goal, we used a binary logistic regression test where farmers who had tried at least one experiment on their own (either replicating a peer's experiment or trying out their own idea) were coded as "1", and farmers who did not experiment or *only* experimented with project/extension guidance were coded as "0". Unlike the ANOVA, the regression did not measure all types of experimentation. Rather, the regression attempted to look more closely at those experiments that farmers conducted *independent* from intervention projects/extension advice.

Due to the skewed values of the binary dependent variable in our logistic regression model (non-experimenters: n = 241; independent experimenters: n = 83), the results of this analysis should be interpreted with caution. Future analyses of this experimenter classification structure would benefit from using a multinomial logistic regression to estimate the determinants of group membership across all four experimenter categories, rather than only using a binary structure. That being said, the binary regression yielded some interesting results that warrant discussion.

The logistic regression demonstrated that the likelihood of independent experimentation was greater for households that owned fewer assets or received no extension advice in the previous season. Those households that held more assets or received some extension advice in the previous season were less likely to experiment, or they only tried new things as they had been advised by an intervention project or extension officer.

The logistic regression results were surprising, in that they contradicted our theory (which was grounded in literature) that farmers who have fewer assets and/or less physical capital (e.g. landholdings, livestock, etc.)—and who would thus have less resilient farm systems and livelihoods—would be *less* likely to experiment with new crops, varieties, and technologies for want of resources (e.g. "experimental" plots of land) and/or for fear of the opportunity cost that might accompany a failed experiment. Why did the regression analysis conclude, then, that resource-poor farmers would be more likely to experiment independently, while farmers with greater access to resources would be less likely to experiment independently?

Perhaps these results reflect the tenacity of resource-poor farmers: If they have the desire to create a change or they need to solve a problem in their farm system but they do not have the resources or they cannot access an extension agent, then they will help themselves by experimenting independently. We spoke with many farmers who had problems with poor soil fertility, for example, but did not have the capital to purchase large amounts of fertilizer so they actively experimented with more accessible alternatives to build up their soil fertility (e.g. manure, compost, crop rotations, etc.).

Although experimentation is certainly influenced by resource availability (as we will discuss in Section 5.2), it is not *dependent* upon it. During the in-depth interviews, we heard from several resource-poor farmers who attempted to cope with the changing rainfall patterns not by purchasing hybrid seed (which they could neither find in local markets nor afford to buy), but by experimenting with planting times and/or seed spacings to maximize their crops' water use efficiency. These farmers conducted independent, limited-resource experiments because they had no other way to improve their farming systems. In light of these qualitative findings, it is not altogether surprising that the logistic regression told us that farmers with fewer assets and less extension advice were more likely to conduct independent experiments.

Along the same lines, perhaps those farmers with more assets or greater extension access were less likely to experiment independently *because* they had access to "expert" advice and they preferred to follow those recommendations as opposed to experimenting on their own. Unfortunately, the logistic regression does not tell us whether access to extension advice *encouraged* expert-guided experimentation, or *inhibited* independent experimentation among smallholders.

We also need to consider the coding of the dependent variable in the logistic regression. Remember that those farmers who were not experimenting or who were *only* experimenting as part of an intervention project/with extension advice were coded as "0", and those farmers who were experimenting independently were coded as "1". Perhaps the regression results thus reflected the unintended exclusion of farmers with fewer resources and less extension access from intervention projects such as Africa RISING. This interpretation is made more valid by the proximity of the Africa RISING mother trial plots to main roads—where farmers with more assets (e.g. bicycles, cell phones) would be better able to travel to the mother trial plots to participate in work days. Additionally, Africa RISING participants were recruited by extension agents, so those farmers who previously had regular contact with an extension agent would have been more likely to hear about the project than those farmers who did not have access to extension. If the regression results are indeed a reflection of the socioeconomic status or extension access of intervention project participants, then it would seem that these projects are missing their mark by inadvertantly excluding resource-poor and/or information-poor farmers.

One aspect of the logistic regression remains to be addressed: prediction success overall was 74.3%, but there was a stark difference between prediction success of non-experimenters (96.7%) and prediction success of experimenters (10.7%). Why does this disparity exist? Personality type and natural curiosity are two factors that undoubtedly influence a farmer's propensity to experiment, but that would be difficult to measure and that we neglected to measure in this study. These personal characteristics might have confounded the predictive ability of our logistic regression, which could explain the disparity in the prediction success percentages. Additionally, as we will discuss in Section 5.2, the motivations that drove every experiment were different, and farmers often had multiple goals in mind for every experiment they conducted. Experimentation probabilities may vary not only by socioeconomic and farm-level characteristics, but also by personality traits and individual motivations. These nuances in experimentation likelihood cannot easily be captured quantitatively, which lends even more value to the range of mixed methods (i.e. survey data, in-depth conversations, field observations) used in this study.

Ultimately, we have learned throughout this study that household surveys are useful tools for gleaning demographic information, but they do not yield the most reliable data when the subject of study is nuanced, intricate, and highly individualized, such as smallholder experimentation. It is difficult, therefore, to extrapolate concrete conclusions based on statistical analyses using our household survey data, such as the binary logistic regression and ANOVA tests. The qualitative insights we gained from the in-depth interviews are thus of critical importance in helping us to understand the ways in which farmers try new things, their experimental priorities and preferences, and their motivations for experimenting.

5.2 Experimental Crops, Varieties, and Techniques

Overall, we found that 89% of experiments reported in 2012-2013 fell into three categories: new crops, 34%; new varieties (maize and non-maize), 40%; and plant spacing experiments, 15%. When experiment examples were disaggregated according to the experimentation classification categories of Participants, Followers, and Independents, similar trends emerged in the frequency distributions. Across all three groups, experimenting farmers had a propensity to try new crops, varieties, and plant spacing techniques more often than other types of experiments. It is important to note that the examples and frequencies of farmers' experiments we reported are in line with the findings of similar studies of farmer experimentation (Scoones and Thompson, 1994a; Sumberg and Okali, 1997). Additionally, we found that 94% of the experimental crops and 57.1% of the experimental varieties that farmers had tried in 2012-2013 were leguminous. These data illustrate that regardless of the source of an experimenter's ideas, smallholders had specific interest in experimenting with leguminous crops and varieties primarily, and with maize varieties secondarily (42.9% of experimental varieties tried in 2012-2013 were maize). Also remember from Section 5.1 that the majority of on-farm experiments were being conducted either by both spouses together, or by women alone, meaning that women's priorities likely had a large impact on what kinds of experiments were being tried. When taken in combination with our qualitative data, these similarities across experiments can give us insight into farmers' interests, concerns, and priorities.

From our qualitative data, we learned that many farmers were reactively motivated to experiment with new maize varieties, especially in relation to changes in rainfall patterns. When we also consider that 86.1% of farmers said they had noticed changes in the rains over the last 20 years, and out of those farmers, 67.2% reported that the changes they noticed included: less rain;

erratic rainfall; or a tendency for the rains to stop before the crops had matured, we can understand why almost half of the varietal experiments reported were maize-based. Most farmers in our study had noticed rainfall changes and were concerned about how their livelihoods would be impacted by those changes. In light of their observations, concerned farmers actively experimented with maize varieties (and new techniques, in some instances) in an effort to mitigate the undesirable effects of climate change on their staple food crop.

Contrary to maize, other crop and varietal experiments (which primarily consisted of leguminous plants) were found to be driven primarily by proactive and external forces (such as income generation, nutrition, participation in an intervention project, etc.). Where maize is the staple crop in central Malawi and farmers were primarily concerned with maintaining maize growth in the face of climate change, many farmers reported experimentation with legume crops in order to meet other, more diverse goals. Some farmers tried cowpea because it seemed to be a viable cash crop alternative to cotton or tobacco. Other farmers reported that after trying soya for only one season, they had already begun to notice positive diet-related changes in their children. Still others grew pigeonpea to promote soil fertility in the face of increasing synthetic fertilizer costs. Farmers who experimented with legumes were motivated by a wide range of priorities and concerns. Additionally, experimenting farmers (especially women) seemed very interested in trying out new legume crops or varieties if they thought those new plants would meet multiple goals.

5.3 Managing an Experiment from Start to Finish

Just as farmers expressed various motivations that drove their experimentation, most farmers used different methods to conduct their experiments, and each method was driven by a specific goal. Some farmers who wanted to compare a traditional variety to an experimental one grew the two simultaneously, using the same plant spacings, fertility measures, and so on, so as to have a stable comparison or "control" by which to measure the growth of the experiment. Other farmers based their assessment of new techniques on their past experience with traditional techniques, a sort of "historical control". Still other farmers did not use any obvious control, and inserted experimental crops directly into their existing farm system, for example intercropping a new crop with a traditional one, so they could see how unfamiliar plants would interact with the system as a whole. Overall, farmers used a variety of different methods when trying new things, and behind every method was an intentional decision and a desired outcome. One of the only similarities across experimenters was that many farmers preferred to start their experiments on a small scale. These findings indicate that farmer experimentation is not haphazard, but rather on-farm experiments were carefully planned and implemented so that the farmer could gain the most knowledge (along with other benefits) from only one trial with a new crop, variety, or technique.

After the conclusion of an experiment, farmers go through a complex decision-making process to determine whether they will repeat an experiment, adjust and repeat it, or abandon it. Most farmers reported being satisfied with the outcomes of their experiments, regardless of whether the experiment succeeded or failed (according to farmers' own definitions), and many farmers only expressed dissatisfaction with an experiment if they felt they had gained absolutely nothing from it (e.g. knowledge, good yield, income, etc.). Depending on the interplay between a farmers' assessment of their experiment, their attitude about the experiment, and the resources available to them, they would decide whether to repeat, adjust and repeat, or abandon the experiment.

The interviews we had with farmers validated our logistic regression findings, where a farmer's decision to experiment was largely related to their access to resources such as land, inputs (e.g. seed), and household income. Some farmers who were satisfied with their experiments did not have the resources to try them again, at least not without making some adjustments to the experimental design. Similarly, some farmers who were dissatisfied with their experiments were so dependent upon subsidies or intervention projects that they had to repeat the experiment (e.g. grow the undesirable crop again), because free seed was better than nothing. Farmers who had access to adequate resources, however, were the most at liberty to repeat, adjust and repeat, or abandon an experiment depending on their assessment of and attitude toward a new crop, variety, or technique.

These results tell us that general experimentation (i.e. the decision "to try or not to try") is not dependent upon resources, because even a farmer who has extremely limited resources can try a new crop through an intervention project, or can experiment with different plant spacings or planting times without overreaching their means. The decision-making process after the completion of an experiment, however, is strongly influenced by a farmer's resources, as is a farmer's ability to try a specific experiment (e.g. for a farmer who sees her neighbor trying a new crop, but cannot afford to purchase the seed). We therefore need to better understand how resource-poor farmers shape their experiments from season to season compared to farmers with available resources.

5.4 Smallholder Experiments and the Theory of Reflection-in-Action

Schön's theory of Reflection-in-Action (1983) asserts that experimentation and decision-making after an experiment's conclusion are dependent upon the interaction of a complex situation, an innovator's knowledge and experience, and the innovator's perceptions of the experimental outcomes. Based on the interactions of these factors, the theory posits that after dissatisfactory experiment, a farmer may critique her experimental design, make adjustments, and attempt the experiment again. Alternatively, she may abandon the experiment. In the case of a satisfactory experiment, a farmer may choose to scale-out the innovation and/or repeat it in subsequent seasons.

While these theoretical conclusions are not incorrect, they are over-simplified. We have seen that there are several other important factors that shape a farmer's decision-making processes prior to, during, and after an experiment, including: access to resources (physical capital such as seed and land; social capital such as involvement in an intervention project or access to extension advice) and priorities and concerns (which are reflective of gender, considering that women participated in over 80% of crop experiments, over 90% of varietal experiments, and over 85% of technical experiments either alone or with their spouses).

Farmers' physical capital, social capital, and gender wield significant influence on their knowledge base and past experiences, and in turn over their experimentation processes. Likewise, farmers' goals and priorities will influence their perceptions of an experiment's outcome. The experimentation process, therefore, cannot be generalized for all persons as it is in Schön's (1983) theory of Reflection-in-Action. Rather, the decision-making process associated with every experiment is dependent upon the characteristics of the experimenters, themselves.

5.5 Implications for Development

The primary aims of this study were to gain an understanding of the characteristics of experimenting smallholders, to learn why they try new things, and to discover how they prefer to conduct experiments. Throughout the course of the project's design, fieldwork, analysis, and dissemination of results, we have attempted to recognize and congratulate smallholders for the progress they have made through agricultural experimentation. By studying on-farm experimentation, we have also learned several important lessons that we hope will influence future research and development projects in Malawi and the surrounding region, so that development practitioners might be design more effective and sustainable interventions around current farmer practices and preferences.

Firstly, we learned that the likelihood of experimentation that was *independent* from interventions and extension was higher for male-headed and resource-poor households. While these results suggest tenacity among independent experimenters, they also suggest that those resource-poor farmers were experimenting independently because they had been inadvertently overlooked by intervention projects and extension agents. If this is the case, the harbingers of "expert knowledge" could be leaving behind some of the most vulnerable and marginalized smallholders in Malawi. Future projects should actively and deliberately include a certain population of resource-poor farmers for the benefit of both parties—farmers who had less were more likely to try new things on their own, and if these farmers were to be involved in an intervention project they could bring fresh insight and experience to share with other participants.

We also learned that women were actively involved in more than 80% of all reported experiments in 2012-2013, and therefore women's concerns and priorities were likely crucial in shaping the types of experiments that were conducted on-farm. Many of those farmers who experimented with new maize varieties did so out of concern about climate change, and many of those farmers who experimented with legumes were hoping to meet multiple goals by growing leguminous crops. These findings indicate that before promoting a certain crop or variety in any given area, projects should firstly take inventory of the priorities and concerns of local farmers (especially women), and only after these priorities are taken into consideration should intervention projects introduce new crops, varieties, and/or techniques.

Finally, we learned that in their own experiments, farmers use an array of intentional but varied methods. Most farmers preferred to try new things on a small scale, so perhaps intervention projects should follow suit. The structure of Africa RISING's mother-baby trials is a sound example of using small experimental plots that are appealing to many farmers. Otherwise, however, many farmers differed in their use of a "control" and their intercropping or sole-cropping preferences, depending on the goals they wanted to meet. What would happen if a project introduced a new crop or technique and then left farmers to experiment with it using their own methods? Perhaps an altogether new innovation would be born from the experience, or perhaps the exercise would facilitate farmer-to-farmer learning rather than encouraging dependence on outside knowledge.

Designing a project that integrates formal science with local knowledge is neither quick nor easy. It is likely, however, that projects which incorporate the methodologies used by farmers in their own independent experiments will be better equipped to help farmers achieve their goals while simultaneously respecting their achievements. It is clear that smallholders have a great capacity for experimentation, and their knowledge, experience, preferences, and priorities—if properly understood and incorporated—could be benefit both future agricultural development projects and their participants.

5.6 Limitations and Suggestions for Future Research

Although this study yielded an ample amount of quantitative and qualitative data and provided extensive insight into smallholder experimentation in Malawi, there were limitations to the study and there are questions about farmer experiments that have yet to be answered.

Through a combination of qualitative and quantitative data analysis, we learned that experimentation is influenced by a farmer's productive resources such as landholdings, input availability and access, asset ownership, and access to information. While we have a basic understanding of these relationships, we need to learn more about the experiments of resource-poor farmers compared to those farmers who have better access to resources. For example: Do resource poor farmers try more technical experiments than crop/varietal experiments because seed is expensive or difficult to access? Likewise, do farmers with available resources try more crop/varietal experiments because they have the means to access seed? Is there a level of wealth where experimentation shifts from dependent (i.e. conducted in partnership with an intervention project or extension officer) to independent? These economic questions are important to consider in future research of on-farm experimentation.

Additionally, many respondents in our study were asked to detail experiments from several months or years prior to the interviews, and therefore recall error (along with the epistemological and linguistic differences addressed in Section 4.1) may have resulted in the omission of some cases of experimentation from our study. To circumvent similar issues in future experimentation studies, we first suggest conducting in-depth interviews with multiple self-identified "non-experimenters" to understand whether these farmers really were not trying new things, or if they were experimenting but failed to report their attempts due to a miscommunication. Unfortunately, we did not interview any non-experimenters in this study, and their perspectives may have provided some insight into the barriers or challenges of experimentation. We also suggest that future experimentation studies implement a mixed-methods longitudinal design that begins by recording farmers' intended experiments (and their hopes and goals for those experiments) before planting, measures the progress of and modifications to those experiments throughout the growing season, details the post-harvest outcomes (both agronomic and attitudinal), and finally records farmers' modifications to their experimental designs in the following season. Such a study would provide a comprehensive picture of on-farm experimentation from start to finish, and would drastically reduce recall error and miscommunications between researchers and farmers.

An in-depth, long-term study would also help us to better understand if the experiments that farmers are trying are true representations of their interests, concerns, and priorities, or if most of these common experiments are the result of convenience, more than anything. In other words, are farmers commonly experimenting with new legume varieties, for example, because they *want* to grow a new legume, or because a new legume was available to them and was the only thing they were *able* to try? While our study focused mainly on experiments that farmers have already conducted, there is much to be learned about farmer priorities by asking farmers about the experiments they *wanted* to try but *could not.*

Finally, we learned during our fieldwork that farmers in central Malawi, are bombarded with new ideas from all directions—extension officers, radio advertisements, subsidy programs, seed distributors, intervention projects, and peers, to name only a few information sources. Due to this effectual saturation of new ideas into the region, it was difficult to measure truly independent experimentation. This concern leads us to wonder what this study would have found, had it been conducted in a less information-saturated place, or in a less densely populated place where ideas do not flow as rapidly between areas. Previous studies have found that farmers worldwide are actively experimenting, just like those farmers in central Malawi, but what kinds of crops, varieties, and techniques are farmers in less densely populated areas trying? By conducting similar studies across the world, we can better understand and support on-farm innovations and farmer capacities on a global scale.

5.7 Conclusions

This study has vividly illustrated that smallholder farmers in central Malawi are capable of agricultural experimentation, and are actively working to improve their livelihoods and farm systems by trying new crops, varieties, and/or techniques on their farms. These experiments are deliberately planned and executed by tenacious smallholders whose decisions are influenced by their gender, their access to information, and their available resources. Women and resource-poor farmers are particularly rich repositories of local knowledge based on a multitude of on-farm experiments.

The methods, motivations, and accomplishments of experimenting smallholders, however, are underrepresented in the existing body of agriculture and development literature. This research provides valuable insight on the socioeconomic characteristics of innovators and the drivers of smallholder experimentation, and these insights will bolster the relatively scant literature that currently surrounds agricultural experimentation.

Additionally, the findings of this study attempt to validate the experimentation processes of innovative smallholders to the research, extension, and development communities. Malawian farmers are trying new things in conjunction with experts, but they are also bolstering their own expertise by experimenting independently. The details of *what* smallholders are trying, *why* they want to try new things, and *how* they prefer to conduct experiments provide valuable insight into the decision-making processes and priorities of Malawian farmers. Future intervention projects that are designed around these decision-making processes and build on farmers' expertise and priorities are likely to result in more relevant, readily adopted strategies for improving Malawian agriculture.

Regarding extension opportunities, this study found that the most vulnerable smallholders (those who held fewer assets or received no extension advice in the previous year) were more likely to experiment than households that were less vulnerable (e.g. had more assets or received some extension advice in the previous season). The relevance of extension information could therefore be strengthened if extension agents worked to target the most vulnerable populations (including women within male-headed households), learn about their experimentation processes, and incorporate that local knowledge into future extension projects and share it among other farmers who are not experimenting.

Most importantly, the findings of this study demonstrate the numerous ways in which Malawian smallholders are working to solve their own agricultural problems through the creative combination of local knowledge and new tools and information. By widely disseminating our findings, we will encourage innovative smallholders in their efforts and also make known the accomplishments of these innovators to non-experimenting farmers in the same areas. We hope that by encouraging experimentation among smallholders, those farmers who are hesitant to experiment independently (i.e. without the guidance of an extension agent, intervention project, etc.) will begin to see the innovators in their own communities as accessible resources for agricultural advice and collaboration.

As agriculture is the lifeblood for the majority of Malawians, the country's current agricultural situation—low yields, poor soil fertility, and overcrowded arable land—warrants immediate, creative solutions. Fortunately, agricultural experts are actively working to sustainably increase yields, boost soil fertility, and improve household nutrition. These experts include extension agents, international research and development programs, and innovative smallholder farmers. The successful collaboration of these expert groups has great potential to yield solutions to the challenges facing Malawian farmers, but first the ideas and innovations of smallholders must be understood, validated, and integrated into the development paradigm.

APPENDICES

APPENDIX A

Household Survey Instrument

Enumerator code:	**Date of visit:**
District: 1=Dedza; 2=Ntcheu	**EPA:**
Village:	**GPS coordinates of house:** (S): (E):
Sample group: 1=Int.; 2=LC; 3=DC	**Household code:**
Entered by:	**Checked by:**

Section A. Household Information

Enumerator (say to respondent): First, I will ask you some questions about your household and assets.

Gawo A. Mbiri ya Pakhomo

Ofunsa (Nenani kwa Ofunsidwa): Poyamba, Tikufunsani Mafunso okhudzana ndi pakhomo panu, katundu ndi za umoyo.

A1. What is the main construction material of *the outside walls of the household's dwelling* unit? **Kodi Zipangizo zomwe munamangira khoma la nyumba yanu yokhalamo, ndi chani?**	Mud/Mud bricks/Clay (not fired) / Matope/Njerwa zosawotcha/Yosinja ndi dothi	1
	Fired bricks/Stone / Njerwa zowotcha/Miyala	2
	Timber / Matabwa	3
	Cement/Concrete block / Simenti/ ma boloko a simenti	4
	Sticks/Maize stalks / Ndodo/ Mapesi	5
	Thatch/Cardboard / Udzu/ Makatoni	6
	Other (specify) / Zina (tchulani):	99

A2. What is the main construction material of the *roof of the household's dwelling unit?* **Kodi zipangizo zomwe munamangira denga la nyumba yanu yokhalamo ndi chani?**	Grass thatch / Udzu	1
	Corrugated iron sheet / Malata	2
	Clay tiles / slate / Ma pale a dothi/ sileti	3
	Other (specify) / Zina (tchulani):	99

A3. What is the main construction material of the Nkhokwe? **Kodi zipangizo zomwe munamangira nkhokwe yanu ndi chani?**	Mud/Mud bricks/Clay (not fired)/ Matope/Njerwa zosawotcha/Dothi	1
	Corrugated iron sheets / Malata	2
	Sticks / Ndodo Mitengo	3
	Bamboo / Nsungwi	4
	Grass thatch / Udzu	5
	Does not own Nkhokwe / Palibe nkhokwe	0
	Other (specify) / Zina (tchulani):	99

A4. What is the name of the Primary Respondent? **Kodi dzina la omwe mukulankhula nawo ndi ndani?**	

A5. What is your age? (Write in age) / **Muli ndi zaka zingati?**		
A6. *What is the respondent's gender?* **Kodi jenda ya omwe mukulankhula nawo ndi chani?**	Male / Mwamuna	1
	Female / Mkazi	2
A7. Are you the head of this household? **Kodi ndinu mutu wa banja?**	Yes (skip to Question A10) Eya (pitani ku funso lachi A10)	1
	No / Ayi	2
A8. *What's your* relationship to the head of this household? **Ubale wanu ndi mutu wa banja ndi otani?**	Spouse / Wachikondi	1
	Son/Daughter / Mwana	2
	Father/Mother / Makolo	3
	Brother/Sister / Achimwene / achemwali	4
	Other (specify) / Zina (tchulani):	99
A9. What is the name of the household head? **Kodi dzina la mutu wa banja lino ndi ndani?**		
A10. What is the gender of the household head?	Male / Mwamuna	1

Kodi jenda ya mutu wa banja lino ndi chani?	Female / Mkazi	2

A11. What is your marital status? **Kodi muli pabanja lotani?**	Monogamous married and living with spouse Wokwatila ndipo akukhala limodzi ndi wokondedwa wawo	1
	Polygamous married and living with spouse Wamitala ndipo akukhala ndi wokondedwa wawo	2
	Married and heading household; spouse lives or works elsewhere Wokwatira ndinso mutu wa banja; Wokondedwa amakhala kapena amagwira ntchito kwina	3
	Separated/divorced/widowed and living without spouse Wosiyana/Wosudzulidwa/Woferedwa ndipo sanakwatirenso	4
	Never married / Sanakwatirepo	5
	Other (specify) / Zina (tchulani):	99

A12. To which ethnic group do you belong? **Kodi inu ndi mtundu wanji wa anthu?**	Chewa	1
	Ngoni	2
	Tumbuka	3
	Tonga	4
	Lomwe	5
	Sena	6
	Yao	7
	Mang'anja	8
	Nkhonde	9
	Other (specify) / Zina (Tchulani):	99
A13. What is your level of education? **Kodi maphunziro anu munalekeza pati?**	No schooling / Sadapitepo ku sukulu	1
	Some primary school / Sadamalize ku pulayimale	2
	Completed primary school / Adamaliza ku pulayimale	3
	Some secondary school / Sanamalize ku sekondale	4
	Completed secondary school / Adamaliza ku sekondale	5
	Post-secondary school / Adaphunzira kuposera ku sekondale	6
A14. How did you come to this village? **Munabwera bwanji m'mudzi muno?**	Born in this village Anabadwira m'mudzi mom'muno	1
	Migrated with family (as child) Adasamukilamo ndi banja lomwe (ali mwana)	2
	Migrated alone / Adasamukilamo yekha	3
	Married someone from village Adakwatira/wa m'mudzimo	4
	Other (specify) / Zina (Tchulani):	99
A15. For how many years have you lived in this village? **Mmudzi muno mwakhalamo kwa zaka zingati?**	Less than 5 years / Zochepera zisanu (5)	1
	Between 5 and 15 years / Pakati pa 5 ndi 15	2
	Between 15 and 30 years / Pakati pa 15 ndi 30	3
	More than 30 years / Kupitilira makumi 30	4

A16. How many children aged 14 years or less are in this household? **Kodi pa nyumba panu pali ana angati a zaka khumi ndi zinayi (14) kapena zocheperapo?**	
A17. How many people aged 15-69 years are in this household? **Kodi ndi anthu angati m'nyumbamu amene ali ndi zaka pakati pa 15 ndi 69?**	
A18. How many people aged 70 years or above are in this household?	

Kodi ndi anthu angati m'nyumbamu amene ali ndi zaka 70 kapena kupitilira pamenepo?		
A19. How many livestock does this household own? (If none, write 0) **Kodi pa khomo panu pali ziweto zingati?** (Lembani mulingo, ngati palibe lembani 0)	a. Cattle / Ng'ombe	
	b. Goats / Mbuzi	
	c. Pigs / Nkhumba	
	d. Chicken and other poultry / Nkhuku kapena zina za gulu la nkhuku	
	e. Other (specify) / Zina (Tchulani):	
A20. Does this household own a: (1= Yes; 2= No) **Kodi pa banja panu muli ndi zinthu izi:** (Eya=1; Ayi=2)	a. Dimba	
	b. Sprayer / Chopopera mankhwala	
	c. Treadle pump / Thedo pampu	
	d. Ox cart / Ngolo	
	e. Plow / Pulawo	

A21. Does this household own a: (If yes, ask how many, if no write 0) **Kodi pa banja panu muli ndi zinthu izi?** (ngati zilipo, funsani kachulukidwe, ngati palibe lembani 0)	a. Cell phone / Foni ya m'manja	
	b. Bicycle / Njinga	
	c. Radio / Wayilesi	
	d. Television / Kanema	
	e. Sofa set / Mpando wa sofa	
	f. Improved charcoal or wood burning stove Mbaula ya makono ya makala kapena nkhuni	
	g. Kerosene or gas stove / Mbaula ya parafini kapena gasi	
	h. Motorbike / Njinga ya moto	
	i. Car or truck / Galimoto laling'ono kapena lalikulu	
	j. Solar panel / Makina a magetsi a dzuwa	

Sources of income: (Circle one under both A21. and A22. columns)/ **Njira zopezera ndalama:** (Muzungulize imodzi pa A21 komanso pa A22)	**A22.** What is the most important source of income for this household? **Kodi njira yodalilika yoyamba yomwe mumapezera ndalama pa banja pano ndi iti?**	**A23.** What is the second most important source of income for this household? **Nanga njira ina yodalilika yachiwiri yomwe mumapezera ndalama pa banja pano ndi iti?**
Sales of produce from your own fields (not dimba) Zogulitsa za ku munda kwanu (osati za ku dimba)	1	1
Sales from dimba / Zogulitsa za ku dimba	2	2
Ganyu labor / Ganyu	3	3
Salary/wage employment / Malipiro a pa mwezi	4	4
Remittances / Ndalama zochokera kwa abale kutali	5	5
Retirement money / Ndalama za peshoni	6	6
Small business/self-employment Tima bizinesi ting'ono ting'ono	7	7
Other (specify) / Zina (tchulani):	99	99

A24. How many people from within your household usually provide labor on your farm? (Write number of persons) / **Ndi anthu angati panyumba panu amene amakonda kuthandizira nchito za kumunda?** (Lembani nambala ya anthu)	
A25. Do you usually hire anyone from outside your household to provide labor on your farm? (1= Yes; 2= No) **Kodi nthawi zambiri mumalemba aganyu othandizira ntchito zakumunda?** (1=Eya; 2= Ayi)	

A26. Please tell me the name of each group you participate in. Include all agricultural, political, religious, and social groups. (Write in name) **Chonde tchulani magulu onse amene inu mumatenga nawo mbali. A zaulimi, za ndale, za tchalitchi kapena zothandizana.** (Lembani dzina)	**A27.** What type of group is this? (See codes below) **Gulu limeneli ndi lotani?** (Onani mayankho m'munsimu)	**A28.** Do you have a leadership position in this group? (1= Yes; 2= No) **Inu muli ndi udindo uliwonse mu gululi?** (1=Eya; 2= Ayi)	**A29.** How many years have you participated in this group? (Write in years) **Mwakhala membala wa gululi kwa zaka zingati?** (Lembani zaka)
1.			
2.			
3.			
4.			

A27. Codes: 1=Religious group Gulu la mpingo 2=Agricultural coop. Bungwe la zaulimi 3=Crop growers assoc. Bungwe lodzala mbeu 4=Youth group Gulu lachinyamata	5=Savings/Credit cooperative (SACCO, VSAL) Gulu losunga ndi kubwereketsa ndalama 6=Support group Gulu lothandizana za matenda a edzi	7=Village development committee Komiti yowona za chitukuko 8=Irrigation group Gulu lowona za ulimi wa nthilira 9=Group of migrants Gulu la anthu obwera *10=Women's group* Gulu la azimayi	11=Political group Gulu la chipani 12=CBO **Mabungwe a m'midzi** 13=Village committee (specify) **Komiti ya m'mudzi** (tchulani) 99=Other (specify) Zina (tchulani)

A30. Have you heard of the Africa RISING project? (1= Yes; 2= No) (If No, Skip to A33.) **Munamvapo za polojekiti ya Africa RISING?** (1=Eya; 2=Ayi) (Ngati sanamvepo, pitani ku funso A33.)	
A31. How have you heard of Africa RISING? **Munamva kuti za Africa RISING?**	

A31. Codes:	1=Family member /Wachibale 2=Lead farmer Mlangizi wa m'mudzi 3=Other farmer / Alimi ena	4=Extension agent / Alangizi 5=Field day Tsiku la chiwonetsero cha ulimi 6=Other NGO / Mabungwe ena	7=Groups (from question A26.) Magulu (kuchokera pa funso la A26.) 99=Other (specify) Zina (tchulani)

A32. Did you participate in the Africa RISING project by hosting a baby trial on your farm? (1= Yes; 2= No) **Munatenga nawo gawo mu polojekiti ya Africa RISING podzala mbewu zoyeselera mmunda bwana?** (1=Eya; 2= Ayi)	

A33. Did you receive advice about crop selection during this season (2012-2013)? (1= Yes; 2= No) (If No, skip to A35.) **Munalandilako uphungu okhudzana ndi kasankhidwe ka mbewuwa chaka chino (2012-2013)?** (1=Eya; 2= Ayi) (Ngati sanamvepo, pitani ku funso A35.)	
A34. From which sources of information did you get advice about crop selection? (See codes below) **Kodi uphunguwo munawapeza kuti?** (Onani mayankho pansi pa tsamba)	

A35. Did you receive any advice about fertilizer during this season (2012-2013)? (1= Yes; 2= No) (If No, skip to A37.) / **Kodi munalandilako uphungu okhudzana ndi feteleza chaka chino (2012-2013)?** (1=Eya; 2= Ayi) (Ngati sanamvepo, pitani ku funso A37.)	
A36. From which sources of information did you get advice about fertilizer? (See codes below) **Kodi uphunguwo munawupeza kuti?** (Onani mayankho pansi pa tsamba)	

A37. Did you receive any advice about land preparation or spacing during this season (2012-2013)? (1= Yes; 2= No) (If No, skip to A39.) **Kodi munalandilako uphungu okhudzana ndi kakonzedwe ka munda kapene mipata pakati pa mizere/mbewu chaka chino (2012-2013)?** (1=Eya; 2= Ayi) (Ngati sanamvepo, pitani ku funso A39.)	
A38. From which sources of information did you get advice about land preparation or spacing? (See codes below) **Kodi uphunguwo munaupeza kuti?** (Onani mayankho m'munsimu)	

A34., A36., A38. Codes:	3=other farmer / Alimi ena	7=private distributor / Wamalonda

Household Code: ______________

1= family member / Wachibale 2= lead farmer Mlangizi wa m'mudzi	4= extension agent / Mlangizi 5= mother trial (Africa RISING) / Muntha wa chiwonetsero wa Africa RISING 6= other NGO / Mabungwe ena	8= groups (from question A26.) Magulu (kuchokera pa funso A26.) 99= Other (specify) Zina (tchulani)

Section B. Climate

Enumerator (say to respondent): Next, I am going to ask you about the weather and climate of this area.

Ofunsa (nenani kwa ofunsidwa): Tsopano, ndikufunsani zokhudzana ndi nyengo m'dera lino.

B1. In what month do the first rains usually come? (See codes below) **Kodi mvula yoyamba imakonda kugwa mwezi wanji?** (onani mayankho munsi)	
B2. In what month do the rains usually end? (See codes below) **Kodi mvula imakonda kusiya mwezi wanji?** (onani mayankho munsi)	
B3. In what month did the first rains usually come about 20 years ago? (See codes below) **Kodi mvula yoyamba inkakonda kugwa mwezi wanji nzaka zoposa makumi awiri zapitazi?** (onani mayankho munsi)	
B4. In what month did the rains usually end about 20 years ago? (See codes below) **Kodi mvula imakonda kusiya mwezi wanji nzaka zoposa makumi awiri zapitazi?** (onani mayankho munsi)	

B1.–B4. Codes:	1 = January 2 = February 3 = March	4 = April 5 = May 6 = June	7 = July 8 = August 9 = September	10 = October 11 = November 12 = December

B5. Have you noticed any changes in the rains over the past 20 years? (Yes= 1; No=2) (If no, skip to B7). **Mwaonapo kusintha kuli konse pa kagwede ka mvula nzaka zoposa makumi awiri zapitazo?** (Eya=1, Ayi=2) (ngati yankho ndi ayi pitani ku funso B7)		
B6. Please describe those changes: (Do not prompt; circle as mentioned) **Fotokozani zomwe zasintha?** (musawatsogolere mayankho, zungulizani yankho lawo)	More rain Mvula yambiri	1
	Less rain Mvula yochepa	2
Other (specify) / Zina (tchulani):		99

B7. Which growing seasons in the past 10 have you experienced drought? (See codes below) **Mu zaka khumi zapitazi ndi nyengo ziti za ulimi wa mvula zimene kunali chilala?** (Onani mayankho munsimu)	
B8. Which growing seasons in the past 10 have you experienced flooding? (See codes below) **Mu zaka khumi zapitazi ndi nyengo ziti za ulimi wa mvula zimene madzi anasefukira?** (Onani mayankho munsimu)	

B7. and B8. Codes:	3 = 2005/2006	6 = 2008/2009	9 = 2011/2012
1 = 2003/2004	4 = 2006/2007	7 = 2009/2010	10 = 2012/2013
2 = 2004/2005	5 = 2007/2008	8 = 2010/2011	

Section C. Field by Field / Munda ndi Munda

Enumerator (say to respondent): Next, I would like to ask some questions about your management practices. These questions are about your rainfed fields only, and do not include questions about your dimba or house garden. For these questions, a field is defined as a continuous area of land, and a plot is defined as a section of a field that is dedicated to a specific crop (or intercrops).

Ofunsa (Nenani kwa Ofunsidwa): Tsopano, ndikufuna ndikufunseni mafunso a mmene mumasamalira za kumunda. Mafunsowa ndi okhudzana ndi ulimi wanu wa nthawi ya mvula, ndipo musaphatikize mayankho okhudzana ndi za ku dimba kapena ka munda ka pa khomo. Pa mafunsowa, munda utanthauza malo akulu

amene mumalipapo. Puloti ndi magawo a mmundamo amene mwadzalapo mbewu zosiyana siyana (kapena mbewu zakaphatikiza).

C1. How many fields did you plant this year? (Write in number of fields) **Kodi chaka chino munalima minda ingati?** (Lembani nambala ya minda)	

Enumerator (say to respondent): These next questions will be about your individual fields, and we will discuss them one at a time. As we discuss each field, please point it out to me from your home.
Ofunsa (nenani kwa ofunsidwa): Mafunso otsatirawa akhala okhudzana ndi munda uliwonse paokha paokha, ndipo tikambirana za munda uliwonse mwapadera, pokambirana, mudzindilozela komwe kuli mundawo kuchokera pakhomo pano.

C2. What is the area of this field? (See codes below) **Kodi Mundawu ndiwaukulu bwanji?** (Onani mayankho m'munsimo)	Size / Kakulidwe:	Unit Muyeso:

C2. Codes:	1=acres / ekala	2=hectares / hekitala	3=meters / ma mita

C3. How many years has your household farmed this field? (Write in years) **Kodi banja lanu lalima mundawu kwa zaka zingati?** (Lembani zaka)	

C4. Do you own this land? (1= Yes; 2= No) / **Kodi mundawu ndi wanu wanu?** (1=Eya; 2=Ayi)			
C5. How fertile is the soil on this field? (See codes below) **Kodi mundawu uli ndi chonde chochuluka bwanji** (Onani mayankho m'munsimo)			
C5. Codes:	1= not fertile opanda nthaka	2= average fertility **wa nthaka pang'ono**	3=very fertile wa nthaka kwambiri

C6. What soil preparation method did you use before planting this field this season (2012-2013)? (List all that apply; see codes below) **Munagwiritsa ntchito njira zotani zokonzera munda wanu musanadzale mbeu chaka chino (2012-2013)?** (Tchulani zonse zomwe munachita; Onani mayankho m'munsimo)	

C6. Codes: 1= zero tillage Ulimi wa mtaya khasu	2= level soil / Kusalaza 3= align ridges Kulima m'mizere	4= build mounds Kulima m'milu 5= dig planting basins Kulima m'maenje	6= animal traction Kulima mogwiritsa ntchito ziweto 99= Other (specify) Zina (tchulani)

C7. Do you rotate your maize crop with any other crops? (1= Yes; 2= No) (If No, then skip to C12.) **Kodi mumalima chimanga mosinthanitsa ndi mbewu zina?** (1=Eya; 2=Ayi) (Ngati yankho lanu liri ayi, pitanu ku funso C9.)	
C8. Please list the crops that you rotate with your maize crop? (List all that apply; see codes below) **Chonde tchulani mbewu zonse zimene mumasinthanitsa ndi mbewu zanu za chimanga?** (Tchulani zonse zomwe anasinthanitsa; Onani mayankho m'munsimo)	

C8 Codes: 1= local maize chimanga cha makolo 2= hybrid maize chimanga cha makono 3= OPV/Composite maize 4= tobacco / fodya	5= cotton / thonje 6= pigeonpea / nandolo 7= groundnut / mtedza 8= soya bean / soya 9= common bean / Nyemba 10= velvet bean / Kalongonda	11=cowpea / Khobwe 12=bambara nut / Nzama 13=sorghum / Mapira 14=cassava / Chinangwa 15=sweet potato Mbatata za kholowa	16= Irish potato Mbatatesi 17= millet / Mawere 18= rice / Mpunga 19= pumpkin / Maungu 99= Other (specify) Zina (tchulani)

C9. Did you apply chemical fertilizer to this field this season, and if so which types did you apply and how much of each type did you use? (See type and unit codes below)
Munathira feteleza pa mundawu chaka chino, ndipo ngati munathira, munagwiritsa ncthito mitundu yanji ndipo munathira mulingo wanji? (Onani mayankho a mitundu ya feteleza ndi miyeso m'munsimu)

C9.1 Type / Mtundu	**C9.2** Amount / Kachulukidwe	**C9.3** Unit / Muyeso

C9.1. Type Codes 1 = UREA	2 = NPK compound 3 = CAN	4 = Single Super Phosphate 5 = D compound	6 = Applied but do not know type Anathira koma sakudziwa mtundu 0 = None / Sanathire
C9.3. Unit Codes **Mayankho a miyeso**:	1= kilograms ma kilogalamu	2=50 kg bags matumba a ma kilogalamu 50	

C10. Where did you obtain the majority of the chemical fertilizer for this field? (See codes below) **Kodi feteleza wambiri amene munathira pa mundawu nthawi ya mvula munamutenga kuti?** (Onani mayankho m'munsimo)	

C10. Codes: 1= Purchased / Anagula 2= Subsidized purchase (starter pack) Feteleza wa makuponi otsika mtengo	3= Gift from family / other farmer Anapatsidwa ndi achibale/ alimi ena 4=Received from NGO Analandira kuchokera ku mabungwe omwe si a boma	5= Received from farmer group/association / Analandira ku magulu kapena mabungwe a alimi 99= Other (specify) Zina (tchulani)

C11. Did you apply livestock manure this season, and if so, how much did you apply? (See unit codes below) **Munathira manyowa a ziweto chaka chino, ngati munatero, munathira ochuluka bwanji?** (onani mayankho a miyeso m'munsimu)	Amount Kachulukidwe:	Unit Muyeso:
C12. Did you apply compost manure this season, and if so, how much did you apply? (See unit codes below) **Munathira manyowa a kompositi chaka chino, ndipo ngati munatero, munathira ochuluka bwanji?** (onani mayankho a miyeso m'munsimu)	Amount Kachulukidwe:	Unit Muyeso:

C11.and C12. Unit Codes: 1= kilograms/ kilogalamu	2=50 kg bags matumba a makilogalamu 50 3=90 kg bags matumba a makilogalamu 90	4= Ox carts / Ngolo 99=Other (specify) Zina (tchulani)

(Enumerator Instruction: For questions C13.-C23., see codes below unless otherwise specified)
(Malangizo kwa ofunsa: pa mafunso a pa C13-C23., **Onani mayankho m'munsimo** kapena lembani zomwe simunapatsidwe.)

Plot Gawo la munda	**C13.** Who is responsible for managing this plot? **Amasamalira gawo la mundawu ndi ndani?**	**C14.** What is the main crop on this plot? **Kodi mbewu yomwe inatenga gawo lalikulu mgawo la mundawu ndi iti?** (Cp1)	**C15.** What intercrops are grown on this plot? (Cp 2–3) **Kodi mbewu za kaphatikiza zomwe zimadzalidwa pa gawoli ndi ziti?** (Cp 2–3)		**C16.** How did you obtain the seed for each of the crops planted on this plot? **Kodi mbewu iliyonse yomwe munadzala mgawoli munayipeza bwanji?**			**C17.** In what month did you plant the main crop on this plot? **Kodi mbewu yomwe inatenga gawo lalikulu mgawo la mundawo, munayidzala mwezi wanji?**	**C18.** How did you arrange plant spacing on this plot? **Kodi kadzalidwe ka mbewuzi ndi kotani?**	**C19.** Did you apply chemical fertilizer to this plot? (1=Yes; 2=No) **Kodi munathira feteleza?** (1=Eya, 2=Ayi)	**C20.** Did you apply livestock manure to this plot? (1=Yes; 2=No) **Munathira manyowa a ziweto pa gawoli?** (1=Eya, 2=Ayi)	**C21.** Did you apply compost manure to this plot? (1=Yes; 2=No) **Munathira manyowa a kompositi pa gawoli?** (1=Eya, 2=Ayi)	**C22.** What methods did you use to control insect pests on this plot? **Ndi njira ziti zimene munagwiritsa ntchito kuti muthane ndi tizilombo mu gawoli?**	**C23.** How do you plan to manage the crop residues on this plot? **Kodi zotsalira za mbewu m'gawoli mudzazigwiritsa ntchito yanji?**
			Cp2	**Cp3**	**Cp1**	**Cp2**	**Cp3**							
a.														
b.														
c.														
d.														
e.														
f.														

Section C. Codes

C11., C14., C15. Crop Codes: 1=local maize chimanga cha makolo 2=hybrid maize chimanga cha makono	3=OPV/Composite maize 4=tobacco / fodya 5=cotton / thonje 6=pigeonpea nandolo	7=groundnut / mtedza 8=soya bean / soya 9=common bean Nyemba 10= velvet bean Kalongonda 11=cowpea / Khobwe 12=bambara nut Nzama	13=sorghum / Mapira 14=cassava / Chinangwa 15=sweet potato Mbatata za kholowa	17=millet / Mawere 18=rice / Mpunga 19=pumpkin / Maungu 99=Other (specify) Zina (tchulani) 16=Irish potato / Mbatatesi

C12. Codes: 1=zero tillage Ulimi wa mtaya khasu	2=level soil / Kusalaza 3=align ridges Kulima m'mizere	4=build mounds / Kulima m'milu 5=dig planting basins Kulima m'maenje	6=animal traction Kulima mogwiritsa ntchito ziweto	99=Other (specify) Zina (tchulani)

C13. Codes:	1=household head Mutu wa banja	2= household head spouse Wokondedwa wa mutu wa banja	3=Both Onse awiri	99=Other (specify) Zina (tchulani)

C16. Codes:	1=own seed (saved) mbewu zosunga 2=purchased zogula	3=subsidized purchase (starter pack) mbewu za makuponi / zotsika mtengo 4=gift from family/other farmer anapatsidwa ndi achibale	5=received from Africa RISING Analandila ku bungwe la Africa RISING 6=received from other NGO Analandira ku mabungwe ena	7=received from farmer group/association / Analandira ku magulu/mabungwe a alimi 99= Other (specify) / Zina (tchulani)

C17. Codes:	11=November	12= December	1=January	2=February

C18. Codes:	1=1-1-1	2= multiple seeds per planting station mbewu zambiri pa phando	99=Other (specify) / zina (tchulani)

C19. Codes:	1=UREA 2=NPK compound	3=CAN 4=Single Super Phosphate	5=D compound 6=Applied but do not know type Anathira koma sakudziwa mtundu	0=did not apply sanathire

C22. Codes:	1=pesticides mankhwala a mbewu	2=ash Phulusa	3=Tephrosia Katupe	4=hand picking Kutola ndi manja	99=Other (specify) zina (tchulani)	0=none palibe

C23. Codes: 1=fodder Zakudya za ziweto	2=remove to thresh Kukachotzsapo mbewu 3=remove for construction Kumangira	4=remove for compost Kupangira manyowa 5=leave, incorporate early Kuzisiya kuti ziwolerane koyambilira	6=leave, incorporate late Kuzisiya kuti ziwolerane ku mapeto 7=burn in field Kuotcha m'munda	8=burn for fuel Kupanga nkhuni 99= Other (specify) Zina (tchulani)

Household Code: ______________

Section D. Crops and Food Security / Mbewu ndi Chakudya chokwanira nthawi zones
Enumerator (say to respondent): Next, I am *going to ask you about this year's harvest.*
Ofunsa (nenani kwa ofunsidwa): Tsopano, ndikufunsani za mbewu zomwe mwakolora chaka chino.

D1. Of the crops grown in this season (2012-2013) how much of each crop did you produce or do you expect to produce? (See codes below) **Pa mbewu zonse zomwe munalima chaka chino (2012-2013) munakolola kapena mukuyembekezera kukolola zochuluka bwanji?** (onani mayankho m'munsimu)			**D2.** Of the crops grown in this season (2012-2013) how much of each crop did you sell or do you expect to sell? (See codes below) **Pa mbewu zonse zomwe munalima chaka chino (2012-2013) munagulitsa kapena mukuyembekezera kugulitsa zochuluka bwanji?**	
Crop code Mtundu wa mbewu	Amount Kachulukidwe	Units Muyeso	Amount Kachulukidwe	Units Muyeso

D1. and D2. Crop Codes Mayankho a mbewu a pa D1 ndi D2. 1 = maize / Chimanga 2 = tobacco / Fodya 3 = cotton / Thonje 4 = pigeonpea / Nandolo	5 = groundnut / Mtedza 6 = soya bean / Soya 7 = common bean / Nyemba 8 = velvet bean/ kalongonda 9 = cowpea / Khobwe 10 = bambara nut / Nzama	11 = sorghum / Mapira 12 = cassava /Chinangwa 13 = sweet potato Mbatata ya kholowa 14 = Irish potato /Mbatatesi	15 = millet / Mawere 16 = rice / Mpunga 17 = pumpkin Maungu 99 = Other (specify) Zina (tchulani)
D1. and D2. Unit Codes *(Note "shelled" or "unshelled")* Mayankho a muyeso a pa D1 ndi D2 (wokuswa kapena wosaswa / chotonola kapena chosatonola)	1=kilograms Makilogalamu 2=50 kg bags Matumba a makilogalamu 50	3=90 kg bags Matumba a makilogalamu 90 4=20 L bucket Ndowa	5=ox carts / Ngolo 99=other (specify) Zina (tchulani)

D3. What methods do you plan use to control pests in stored grain? (See codes below)
Mukokonzekera kudzagwiritsa ntchito njira zanji zotetezera mbewu zanu ku tizilombo towononga mbewu zosungidwa?

D3. Codes:	1=pesticide Mankhwala a mbewu	2=ash Chipala	3=Tephrosia Katupe	99=Other (specify) Zina (tchulani)	0=none Palibe

D4. *In what month did your stored supplies of last year's (2011-*2012) maize crop run out? (See codes below)
Ndi mwezi uti umene chimanga chomwe munakolora chaka chatha (2011-2012) chinatha? (Onani mayankho m'munsimu)

D4. Codes:				
	1 = January	4 = April	7 = July	10 = October
	2 = February	5 = May	8 = August	11 = November
	3 = March	6 = June	9 = September	12 = December

D5. How many months do you expect your own food supply from all of your rainfed fields to last this season (2012-2013) (not including dimba produce)? (Specify number of months)
Mukuyembekeza kuti chakudya chimene munakolola ku minda yanu nthawi ya mvula chaka chatha chidzakutengerani miyezi ingati kuti chithe (osaonjezerapo za ku dimba)? (lembani nambala ya miyezi)

Section E. Experimentation
Enumerator (say to respondent): Now I would like to ask you about the new crops, varieties, techniques and technologies that you have tried in the last two seasons.(Enumerator Instruction: See codes at bottom of page unless otherwise specified)
Ofunsa (Nenani kwa oyankha): Tsopano ndikufunsani zokhudzana ndi mbewu zatsopano, mitundu ya mbewu, komanso njira zamakono za ulimi zimene mwakhala mukugwiritsa ntchito zakaziwiri zapitazo. (Langizo kwa ofunsa: Onani mayankho pansi pa tsambali pokhapokha mutafunsidwadwa kutsata njira zina)

Household Code: ______________

Crops and varieties grown last season (2011-2012) **Mbewu ndi mitundu ya mbewu imene inadzalidwa (2011-2012)**			
E1. What new crops did you grow last season (2011-2012) for the first time ever (list all that apply)? (If none, skip to Question E6.) **Kodi ndi mbewu ziti zatsopano zimene munadzala (2011-2012) koyamba?** (Ngati yankho palibe pitani ku funso E6.)	Crop 1 Mbewu 1	Crop 2 Mbewu 2	Crop 3 Mbewu 3
E2. How did you learn about this new crop? **Kodi munadziwa bwanji za mbewu yatsopano imeneyi?**			
E3. How was the seed obtained for this new crop? **Kodi mbewu yatsopanoyi munayipeza bwanji?**			
E4. Who planted the seed for this new crop? (1=HH head; 2=spouse of HH head; 3= Both; 99= Other (specify)) **Kodi anadzala mbewu yatsopanoyi ndi ndani?** (1= mutu wa banja; 2= okondedwa wake; 3= Onse awiri; 99= zina (tchulani))			
E5. Who managed this new crop (e.g. weeding and harvesting)? (1=HH head; 2=spouse of HH head; 3= Both; 99= Other (specify)) **Kodi ankasamalira mbewu yatsopanoyi m'munda ndi ndani (monga kupalira ndi kukolola)?** (1= mutu wa banja; 2= okondedwa wake; 3= Onse awiri; 99= zina (tchulani))			

E6. What new crop varieties did you grow last season (2011-2012) for the first time ever (list all that apply; write in variety name(s))? (If none, skip to Question E11.) **Kodi ndi mitundu iti ya mbewu yatsopano imene munadzala chaka chatha (2011-2012) koyamba** (lembani onse oyenera; lembani dzina la mtundu uliwonse)? (Ngati yankho palibe pitani ku funso E11.)	Var. 1 Mtundu1	Var. 2 Mtundu2	Var. 3 Mtundu3
E7. How did you learn about this new variety? **Kodi munadziwa bwanji za mtundu wa mbewu watsopano imeneyi?**			
E8. How was the seed obtained for this new variety? **Kodi mbewu yamtundu watsopanowu munayipeza bwanji?**			
E9. Who planted the seed for this new variety? (1=HH head; 2=spouse of HH head; 3= Both; 99= Other (specify)) **Kodi anadzala mtundu wa mbewu watsopanowu ndi ndani?** (1= mutu wa banja; 2= okondedwa wake; 3= Onse awiri; 99= zina (tchulani))			
E10. Who managed this new variety (e.g. weeding and harvesting)? (1=HH head; 2=spouse of HH head; 3= Both; 99= Other (specify)) **Kodi ankasamalira mtundu wa mbewu yatsopanoyi m'munda ndi ndani (monga kupalira ndi kukolola)?** (1= mutu wa banja; 2= okondedwa wake; 3= Onse awiri; 99= zina (tchulani))			

E1. Crop Codes: 1 = maize / chimanga 2 = tobacco / fodya 3 = cotton / thonje 4 = pigeonpea / nandolo	5 = groundnut / mtedza 6 = soya bean / soya 7 = common bean nyemba 8 = velvet bean kalongonda 9 = cowpea / khobwe 10 = bambara nut / nzama	11 = sorghum / mapila 12 = cassava / chinangwa 13 = sweet potato / mbatata 14 = Irish potato / mbatatesi 15 = millet / mawere	16 = rice / mpunga 17 = pumpkin mawungu 99 = Other (specify) Zina (fotokozani) 0 = none / palibe
E2. and E7. Codes: 1=family / banja 2=lead farmer / mlangizi wa kumudzi 3=other farmer / mlimi nzanga	4=extension agent / mlangizi 5=mother trial (Africa RISING) munda wachitsanzo (Africa RISING) 6=other NGO mabungwe ena omwe si aboma	7=private distributor / wamalonda 8=groups (from question A26.) magulu (kuchoka pa funso A26.) 9= independent idea / ganizo langa 99=Other (specify) / Zina(fotokozani)	
E3. and E8. Codes: 1=purchased Ndinagula 2=subsidized purchase (starter pack) zipangizo zotsika mtengo	3= gift from family/other farmer mphatso kuchoka kwa achibale/mlimi nzanga 4=received from Africa RISING Kuchokera ku Africa RISING 5=received from other NGO / Kuchokera ku mabungwe ena omwe si aboma	6=received from farmer group/association Kuchokera ku magulu a zaulimi 99=Other (specify) Zina (fotokozani)	

Crops and varieties grown this season (2012-2013) **Mbewu ndi mitundu ya mbewu yomwe inadzaliwda chaka chino (2012-2013)**			
E11. What new crops did you grow this season (2012-2013) for the first time ever (list all that apply)? (If none, skip to Question E16.) **Kodi ndi mbewu ziti zatsopano zimene munadzala chaka chino (2012-2013) koyamba?** (Ngati yankho palibe pitani ku funso E16.)	Crop 1 Mbewu 1	Crop 2 Mbewu 2	Crop 3 Mbewu 3
E12. How did you learn about this new crop? **Kodi munadziwa bwanji za mbewu yatsopano imeneyi?**			
E13. How was the seed obtained for this new crop? **Kodi mbewu yatsopanoyi munayipeza bwanji?**			
E14. Who planted the seed for this new crop? (1=HH head; 2=spouse of HH head; 3= Both; 99= Other (specify)) **Kodi anadzala mbewu yatsopanoyi ndi ndani?** (1= mutu wa banja; 2= okondedwa wake; 3= Onse awiri; 99= zina (tchulani))			
E15. Who managed this new crop (e.g. weeding and harvesting)? (1=HH head; 2=spouse of HH head; 3= Both; 99= Other (specify)) **Kodi ankasamalira mbewu yatsopanoyi m'munda ndi ndani (monga kupalira ndi kukolola)?** (1= mutu wa banja; 2= okondedwa wake; 3= Onse awiri; 99= zina (tchulani))			

E16. What new crop varieties did you grow this season (2012-2013) for the first time ever (list all that apply; write in variety name(s))? (If none, skip to Question E21.) **Kodi ndi mitundu iti ya mbewu yatsopano imene munadzala chaka chatha (2012-2013) koyamba** (lembani onse oyenera; lembani dzina la mtundu uliwonse)? (Ngati yankho palibe pitani ku funso E21.)	Var. 1 Mtundu1	Var. 2 Mtundu2	Var. 3 Mtundu3
E17. How did you learn about this new variety? **Kodi munadziwa bwanji za mtundu wa mbewu watsopano imeneyi?**			
E18. How was the seed obtained for this new variety? **Kodi mbewu yamtundu watsopanowu munayipeza bwanji?**			
E19. Who planted the seed for this new variety? (1=HH head; 2=spouse of HH head; 3= Both; 99= Other (specify)) **Kodi anadzala mtundu wa mbewu watsopanowu ndi ndani?** (1= mutu wa banja; 2= okondedwa wake; 3= Onse awiri; 99= zina (tchulani))			
E20. Who managed this new variety (e.g. weeding and harvesting)? (1=HH head; 2=spouse of HH head; 3= Both; 99= Other (specify)) **Kodi ankasamalira mtundu wa mbewu yatsopanoyi m'munda ndi ndani (monga kupalira ndi kukolola)?** (1= mutu wa banja; 2= okondedwa wake; 3= Onse awiri; 99= zina (tchulani))			

E11. Crop Codes:	5 = groundnut / mtedza	11 = sorghum / mapila	16 = rice / mpunga
1 = maize / chimanga	6 = soya bean / soya	12 = cassava / chinangwa	17 = pumpkin mawungu
2 = tobacco / fodya	7 = common bean nyemba	13 = sweet potato / mbatata	99 = Other (specify)
3 = cotton / thonje	8 = velvet bean kalongonda	14 = Irish potato / mbatatesi	Zina (fotokozani)
4 = pigeonpea / nandolo	9 = cowpea / khobwe	15 = millet / mawere	0 = none / palibe
	10 = bambara nut / nzama		

E12. and E17. Codes:	4=extension agent / mlangizi	7=private distributor / wamalonda
1=family / banja	5=mother trial (Africa RISING) munda wachitsanzo (Africa RISING)	8=groups (from question A26.) magulu (kuchoka pa funso A26.)
2=lead farmer / mlangizi wa kumudzi	6=other NGO mabungwe ena omwe si aboma	9= independent idea / ganizo langa
3=other farmer / mlimi nzanga		99=Other (specify) / Zina(fotokozani)

E13. and E18. Codes:	1=purchased Ndinagula	3= gift from family/other farmer mphatso kuchoka kwa achibale/mlimi nzanga	6=received from farmer group/association Kuchokera ku magulu a zaulimi
	2=subsidized purchase (starter pack) zipangizo zotsika mtengo	4=received from Africa RISING Kuchokera ku Africa RISING	99=Other (specify) Zina (fotokozani)
		5=received from other NGO / Kuchokera ku mabungwe ena omwe si aboma	

Household Code: ____________

Techniques and technologies implemented this season (2012-2013) **Njira zamakono za ulimi zimene mwakhala mukugwiritsa ntchito chaka chino (2012-2013)**			
E21. What new techniques or technologies did you try this season (2012-2013) for the first time ever? (List all that apply; If none, skip to Section F.) **Kodi ndi njira zanji zamakono za ulimi zimene mwagwiritsa ntchito chaka chino (2012-2013) koyamba?** (Lembani zonse zoyenera; ngati yankho palibe pitani ku funso F.)	Tech. 1 Njira 1	Tech. 2 Njira 2	Tech.3 Njira 3
E22. How did you learn about this technique/technology? **Kodi munadziwa bwanji za njira zaulimi zamakono zimenezi?**			
E23. Who implemented this technique/technology? (1=HH head; 2=spouse of HH head; 3=Both; 99=Other (specify)) **Kodi amene anagwiritsa ntchito njira za tsopano zimenezi ndani?** (1= mutu wa banja; 2= okondedwa wake; 3= Onse awiri; 99= zina (tchulani))			

E21. Codes:			
1= fertilizer tech. njira zothilira feteleza 2=residue management tech. kasamalidwe ka zinyalala zotsalira mmunda	3= weeding tech. njira zopalilira 4= pest control tech. njira zotetezera mbewu ku tizilombo	5=plant spacing tech. kutalikilana kwa mapando 6=land preparation tech. njira zokonzera mmunda pokonzekera kudzala	7=irrigation tech. njira zanthirira 99=Other (specify) Zina (tchulani)

E22. Codes:		
1=family / banja 2=lead farmer / mlangizi wa kumudzi 3=other farmer / mlimi nzanga	4=extension agent / mlangizi 5=mother trial (Africa RISING) munda wachitsanzo (Africa RISING) 6=other NGO mabungwe ena omwe si aboma	7=private distributor / wamalonda 8=groups (from question A26.) magulu (kuchoka pa funso A26.) 9= independent idea / ganizo langa 99=Other (specify) / Zina(fotokozani)

For Local Control and Distant Control Households, END OF SURVEY.
Mafunso atela pompa kwa alimi amene sakutenga nawo gawo mu ntchito ya Africa RISING

Enumerator (say to respondent): Thank you for participating in this survey.
Ofunsa (nenani kwa oyanka): Zikomo potenga nawo gawo mukafukufukuyu.

For Intervention Households, continue to Section F.
Kwa alimi amener akutenga nawo mbali mu ntchito za Africa RISING, pitani ku gawo F.

Section F. Africa RISING
Enumerator (say to respondent): Finally, I would like to ask you some questions about your involvement with the Africa RISING project.
Gawo F. Africa RISING
Ofunsa (nenani kwa oyankha): Pomaliza ndikufunsani mafunso okhudzana ndi kutenga nawo mbali kwanu pa ntchito za Africa RISING.

F1. Where was the mother trial that you participated in? / **Kodi munda wachionetsero umene manatengapo mbali uli kuti?**
1 = Mkuwazi; 2 = Mbidzi; 3= Msamala; 4= Kalumo; 5=Amosi; 6= Malinda; 7= Dauka; 8= Kasese

Treat-ment **Ndondomeko**	**F2.** What treatments did you host on your baby trial plots? (See code sheet) **Ndondomeko zakadzalidwe zomwe munayesera pa munda wanu oyeselera?** (onani pa pepala la mayankho)	**F3.** Who is responsible for managing this treatment? 1 = household head 2 = spouse of household head 3 = both 99 = other **Kodi amene amasamalira munda wanu oyeselera ndi ndani?** (1= mutu wa banja; 2= okondedwa wake; 3= Onse awiri; 99= zina (tchulani))	**F4.** In what month did you plant this treatment? 11=November 12=December 1 = January 2 = February **Munadzala mwezi wanji?** 11=November 12=December 1 = January 2 = February	**F5.** How did you arrange plant spacing in this treatment? 1 = 1-1-1 2 = multiple seeds per planting station 99= other **Mapando anu anali otalikilana bwanji mmundamu?** 1=1-1-1 2=mbewu zingapo pa phando 99= zina	**F6.** Did you apply chemical fertilizer to this treatment, and if so what types and amounts did you apply? (See code sheet) **Kodi munathita feteleza, ngati ndi choncho anali wamtundu wanji, komanso ochuluka bwanji?** (onani tsamba la mayankho)						**F7.** Did you apply livestock manure to this treatment, and if so how much did you apply? (See code sheet) / **Kodi munathila manyowa a ndowe mmundamu, ngati ndi choncho anali ochuluka bwanji?** (onani tsamba la mayankho)		**F8.** Did you apply compost manure to this treatment, and if so how much did you apply? (See code sheet) **Kodi munathila manyowa a kompositi mmundamu, ngati ndi choncho anali ochuluka bwanji?** (onani tsamba la mayankho)		**F9.** What methods did you use to control insect pests on this treatment? (See code sheet) **Kodi munagwiritsa ntchito njira zanji zotetezera mbewu zanu kutizilombo ommunda wanu oyeselera** (onani tsamba la mayankho)	**F10.** How do you plan to manage the crop residues on this treatment? (See code sheet) **Kodi mwakonza ndondomeko yanji ya kasamalidwe ka zinyalala zotsala mmunda wanu oyeselera?** (onani tsamba la mayankho)	
					F6.1 Type **Mtundu**		**F6.2** Amt **Kachulukidwe**		**F6.3** Units **Muyeso**								
					1	**2**	**1**	**2**	**1**	**2**	**F7.1** Amt **Kachulukidwe**	**F7.2** Units **Muyeso**	**F8.1** Amt **Kachulukidwe**	**F8.2** Units **Muyeso**		Maize/ **Chimanga**	Legume/ **Zanyemba**
a.																	
b.																	
c.																	
d.																	

Household Code: ________________

Section F. Codes

F2. Codes:	**7**=soya bean / soya	**15**=maize + bean + fertilizer chimanga + mtedza + feteleza	**23**=groundnut +bean / nandolo + nyemba
1=maize control chimanga chokhachokha	**8**=soya + fertilizer / soya + feteleza	**16**=maize + Tephrosia + fertilizer chimanga + katupe + feteleza	**24**=groundnut + cowpea nandolo + khobwe
2=maize + fertilizer chimanga + feteleza	**9**=cowpea / khobwe	**17**=soya + pigeonpea / soya + nandolo	**25**=pigeonpea + groundnut + fertilizer nandolo + mtedza + feteleza
3=maize + compost chimanga + manyowa a kompositi	**10**=cowpea + fertilizer kkhobwe + feteleza	**18**=soya + cowpea / soya + khobwe	**26**=pigeonpea + soya + fertilizer nandolo + soya + feteleza
4=maize + fertilizer + compost chimanga + feteleza+ kompositi	**11**=pigeonpea / nandolo	**19**=soya + bean / soya + nyemba	**27**=pigeonpea + cowpea + fertilizer nandolo+ khobwe+ feteleza
5=groundnut / mtedza	**12**= bean / nyemba	**20**=soya +groundnut / soya + mtedza	**28**=groundnut + cowpea + fertilizer mtedza + khobwe + feteleza
6=groundnut + fertilizer mtedza + feteleza	**13**= maize + groundnut chimanga + mtedza	**21**=pigeonpea + bean / nandolo + nyemba	**99**=other (specify) / zina (tchulani)
	14= maize + pigeonpea+ fertilizer chimanga + nandolo + feteleza	**22**=pigeonpea + groundnut nandolo + mtedza	

F6.1. Codes:	1=UREA	3=CAN	5=D compound	0=did not apply sanathire
	2=NPK compound	4=Single Super Phosphate	6=Applied but do not know type / Anathira koma sakudziwa mtundu	

F6.3 F7.2 and F8.2 Codes: 1=kilograms / makilogalamu; **2**=50 kg bags / matumba a makilogalamu 50; **3**=90 kg bags / matumba a makilogalamu 90

F9. Codes:	1=pesticides mankhwala a mbewu	2=ash Phulusa	3=Tephrosia Katupe	4=hand picking Kutola ndi manja	99=Other (specify) zina (tchulani)	0=none / palibe

F10. Codes:	2=remove to thresh Kukachotzsapo mbewu	4=remove for compost Kupangira manyowa	6=leave, incorporate late Kuzisiya kuti ziwolerane ku mapeto	8=burn for fuel Kupanga nkhuni
1=fodder Zakudya za ziweto	3=remove for construction Kumangira	5=leave, incorporate early Kuzisiya kuti ziwolerane koyambilira	7=burn in field Kuotcha m'munda	99=Other (specify) Zina (tchulani)

Treatment **Ndondomeko**	**F11.** How much knowledge did you have about this treatment before seeing it in the mother trial? 1 = I had seen it before (but not planted it) 2 = I had planted it before 0 = no knowledge **Kodi munkadziwako chani chokhudzana ndi ndomeko ya kadzalidwe imeneyi musanayiwone mmunda wachitsanzo** 1= Ndidayiwonapo penepake (koma sindinayibzalepo) 2= Ndinayibzalapo 3= Sindikudziwa	**F12.** What was the main reason that you chose this treatment? (See code sheet) **Kodi chifukwa cheni cheni chimene munasankhira ndondomekoyi ndichani** (onani patsamba lamayankho)	**F13.** How likely are you to choose this baby trial treatment again next season? 1=not likely 2=likely 3=very likely **Kodi mungadzayibwerezenso ndondomekoyi chaka chamawa?** 1= zokayikitsa 2= nzotheka 3= nzotheka kwambiri	**F14.** How satisfied were you with this baby trial treatment? 1 = not satisfied 2=satisfied 3=very satisfied **Kodi ndondomeke ya kabzalidwe imeneyi munakhutila nayo bwanji?** 1= sitinakhutile nayo 2= tinakhutila nayo pang'ono 3= tinakhutila nayo kwambiri	**F15.** What were some good qualities of this baby trial treatment? (See code sheet; list all that apply. For intercrop treatments, specify relevant crop) **Kodi ndondomeko ya kabzalidwe imeneyi ili ndi zinthu ziti zabwino?** (onani tsamba lamayankho; lembani zonse zoyenera. Kwambewu zonse zobzalidwa mwakasakaniza, tchulani)	**F16.** What were some bad qualities of this baby trial treatment? (See code sheet; list all that apply. For intercrop treatments, specify relevant crop) **Kodi ndondomeko ya kabzalidwe imeneyi ili ndi zoyipa zanji?** (onani tsamba lamayankho; lembani zonse zoyenera. Kwambewu zonse zobzalidwa mwakasakaniza, tchulani)
a.						
b.						
c.						
d.						

Household Code: _______________ Page 16

F12. Codes: **1**=good for soil Zoonjezera chonde mnthaka **2**=good for other crops Zabwino ku mbewu zina **3**=expected high yield Kuyembekezera zokolola zochuluka **4**=drought tolerant/ zopilira ku chilala	**5**=flood tolerant Zopilira ku madzi osefukila **6**=disease resistant zopilila ku matenda **7**=pest resistant Zopilira ku tizilombo **8**=did not take much labor sizimatenga nthawi kulima	**9**=early maturity zimacha msanga **10**=family nutrition zopereka thanzi labwino ku banja **11**=curiosity/experiment amangoyeserera **99**=other (specify) / Zina (Tchulani) **0**=do not know / samadziwa

F15. Codes: **1**=crop was good for other crops Mbewuyi ndi ya bwino kwa mbewu zina **2**=crop had high yield Mbewuyi ibabereka kwambiri **3**=crop was drought tolerant Mbewuyi ndi yopilira ku chilala	**4**=crop was flood tolerant mbewuyi ndi yopilira ku madzi osefukira **5**=crop was disease resistant Mbewuyi ndi yopilira ku matenda **6**=crop was pest resistant Mbewuyi ndi yopilira ku tizilombo	**7**=crop grew well Mbewu zimakula bwino **8**=field did not require much weeding / Mundawu sunafunike kupalira kwambiri **9**=crop was easy to harvest Mbewuyi sinavute kukolora **99**=other (specify) / zina (tchulani)

F16. Codes: **1**=crop interfered with other crops / Mbewuzi zimapikisana ndi mbewu zina **2**=crop yield too low / zokolola za mbewuzi ndi zochepa **3**=crop was not drought tolerant mbewuyi imapilira ku chilala	**4**=crop was not flood tolerant mbewuyi imapilira ku madzi osefukira **5**=crop had disease problems Mbewuyi inali ndi vuto la matenda **6**=crop had pest problems Mbewuyi inali ndi vuto la tizilombo	**7**=crop did not grow well mbewuyi simakula bwino **8**=field required a lot of weeding Mbewuyi imafuna kupalira kwambiri **9**= crop was difficult to harvest Mbewuyi imavuta kukolola **99**=other (specify) Zina (Tchulani)

F17. What is the main reason you decided to participate in the Africa RISING project this season? (See codes below) **Kodi cheni cheni chinakupangitsani kutenga nawo mbali mu ntchito ya Africa RISING chaka chino ndi chiti?** (onani mayankho pansi patsamba)	

F17. Codes:	1=To acquire knowledge/learn Kudzaphunzira	2=For seed provision Kudzalandila mbewu	3=To enhance food security Kuti ndidzakhale ozidalira pa chakudya	4=Peer pressure Kutengeka ndi zomwe ena akupanga	99=Other (specify) Zina (tchulani)

F18. Where did you obtain the majority of the chemical fertilizer for the baby trial treatments on your farm? (See codes below) **Kodi gawo lalikulu la feteleza amene munathira pa munda wanu oyeselera munamupeza bwanji?** (onani mayankho m'munsi mwatsamba)	

F18. Codes:	1=Purchased / Ndinagula 2=subsidized purchase (starter pack) Zipangizo zotsika mtengo 3= Gift from family/other farmer Mphatso kuchoka kwa achibale/ mlimi nzanga	4=Received from Africa RISING Kuchokera ku Africa RISING 5=Received from other NGO Kuchokera ku mabungwe ena omwe si aboma	6=Rreceived from farmer group/association Kuchokera ku magulu a zaulimi 99=Other (specify) Zina (fotokozani)

F19. Will you share seed that you harvested from your baby trial plot with anyone who farms a separate plot than yours? (1=Yes; 2=No) (If No, skip to F22.) **Kodi mbewu zomwe mudzakolore pa munda wanu oyeselera mudzagawako kwa anzanu amene akulima omwe siwanu?** (1=Eya; 2= Ayi) (Ngati yankho ndi Ayi, pitani pa F22)	
F20. If yes, whom will you share seed with? (1=family member; 2=other farmer; 99= Other (specify)) **Ngati yankho ndi Eya, kodi mbewu mudzagawa kwa ndani?** (1= achibale; 2= alimi anzanga; 99= Zina (Tchulani))	
F21. Did they participate in Africa RISING? (1=Yes; 2=No) **Kodi anatenga nawo mbali mu ntchito ya Africa RISING?** (1=Eya; 2=Ayi)	

F22. Have you shared (or do you plan to share) techniques that you learned in the Africa RISING program with anyone who farms a separate plot than yours? (1=Yes; 2=No) (If No, skip to F25.) **Kodi munawuzako (kapena mudzawawuza) anzanu olima munda osiyana ndiwanu njira zamalimidwe zomwe munaphunzira mu ntchito ya Africa Rising?** (1= Eya; 2= Ayi) (Ngati yankho ndi ayi, pitani pa F25.)	
F23. If yes, whom did you share (or do you plan to share) techniques with? (1=family member; 2=other farmer; 99= Other (specify)) **Ngati yankho ndi Eya, kodi munawuzako (kapene mudzawuzako) ndani za njira zamalimidwezo)** (1=achibale; 2=alimi anzanga; 99= Zina (tchulani)	
F24. Did they participate in Africa RISING? (1=Yes; 2=No) **Kodi anatengako mbali mu ntchito ya Africa RISING?** (1= Eya; 2= Ayi)	

F25. How likely are you to participate in Africa RISING again next season? (1=Not likely; 2=Likely; 3=Very likely) **Kodi mukudziwona mukutenga nawonso mbali mu ntchito imeneyi ya Africa RISING chaka chamawa?** (1= zokayikitsa; 2= nzotheka; 3= nzotheka kwambiri	
F26. If not likely, please explain why: **Ngati yankho ndi Zokayikitsa, fotokozani chifukwa chake:**	

Enumerator (say to respondent): Thank you for participating in this survey.
Ofunsa (nenani kwa oyankha): Zikomo potenga nawo mbali mu kafukufukuyi.

APPENDIX B

In-depth Interview Question Guide

Farmer Interview Questions **HHID:**

Date of Interview: ________________ Oral Consent Received?_____________

District: ___________________ EPA: ___________________________

Sub- Village: ____________________ Head Village: _____________________

GPS Coordinates: (S) _______________________; (E) ________________________

Name of Respondent: ____

Gender of Respondent: ______________ Age of Respondent: __________________

Household head? _________________ Household type (MHH/FHH): __________

Did Respondent participate in Africa RISING this season? _____________

"Experimentation" Processes and Attitudes

M: First, I want to talk with you about the ways in which you try out new things on your farm.

1. To you, what does it mean to "experiment" with new crops, techniques, or technologies?
2. Do you do "experiments" on your farm?
3. When you want to try out something new on your farm, how do you do it?
    a. Why do you do it this way?
4. Why do you try new things on your farm, and how often do you try something new?
5. *(For RISING participants)*: Besides Africa RISING, have you ever participated in another agriculture project?
    a. Tell me about your participation with Africa RISING and with the other project:
6. *(For non-RISING participants)*: Have you ever participated in an agriculture project? *(If "No", skip to next section)*
    a. Tell me about your participation with this project:

7. Before you started participating in RISING/__________ agriculture project, did you try new things on your farm?
    a. If so, how did you go about trying new things?
8. Did working with RISING/__________ agriculture project motivate you to try new things on your farm more often?
9. Did working with RISING/___________ agriculture project give you any new ideas of how to go about trying new things on your farm?
10. Do you think you farm differently now than before you started participating in RISING/ ________agriculture project?

Crops: Last Season (2011-2012) thru This Season (2012-2013) thru Next Season (2013-2014)

M: These questions are about the crops/varieties you grew last season for the first time.

11. Did you plant any new crops/varieties last season for the first time ever?
12. Why did you decide to plant this crop/variety?

    Possible probes:
    Where did you hear about it?
    How much did you know about it prior to planting?
    How did you get seed for it, and how much did you plant?

13. Tell me about how you planted, managed, and used this crop/variety last season:

    Possible probes:
    Where, when, and how did you plant?
    Tell me about your management practices and any changes in those practices:
    How did you use it post-harvest?

14. Overall, were you pleased with the crop/variety?
15. Did you decide to grow it again this season? *(If "No", skip to next section after probe)*
    a. Why or why not?

16. Tell me about how you planted, managed, and used this crop/variety this season:

Possible probes:
Did you do anything differently this season?
How did those changes seem to affect the crop/variety?
How did you get seed for it, and how much did you plant?
Where, when, and how did you plant?
Tell me about your management practices and any changes in those practices:
How did you use it (or how do you intend to use it) post-harvest?

17. Overall, were you pleased that you grew the crop/variety again?

18. Are you planning to grow it again next season? *(If "No", skip to next section after probe)*

    a. Why or why not?

19. Will you do anything differently next season?

Crops: This Season (2012-2013) thru Next Season (2013-2014)

M: These questions are about the new crops/varieties you grew this season for the first time.

20. Did you plant any new crops/varieties this season for the first time ever?

21. Why did you decide to plant this crop/variety?

Possible probes:
Where did you hear about it?
How much did you know about it prior to planting?
How did you get seed for it, and how much did you plant?

22. Tell me about how you planted, managed, and used this crop/variety this season:

Possible probes:
Where, when, and how did you plant?
Tell me about your management practices and any changes in those practices:
How did you use it (or how do you intend to use it) post-harvest?

23. Overall, were you pleased with the crop/variety?

24. Are you planning to grow it again next season?

    a. Why or why not? *(If "No", skip to next section after probe)*

25. Will you do anything differently next season?

Techniques and Technologies: This Season (2012-2013) thru Next Season (2013-2014)

M: These next questions are about the new techniques/technologies you tried on your farm for the first time this season.

26. Tell me about the new techniques or technologies you tried this season for the first time:

27. Why did you decide to try this technique/technology?

    Possible probes:
    Where did you hear about it?
    How much did you know about it before you tried it?

28. What was the result of this technique/technology?

    Possible probes:
    Did it work as you expected or cause any unexpected problems?
    Would you say this technique/technology was "successful"?

29. Overall, were you pleased with the technique/technology?

30. Are you planning to try it again next season? *(If "No", skip to next section after probe)*

    a. Why or why not?

31. How will you adjust it for next season?

Techniques and Technologies: Not new to the Respondent, but novel or unorthodox in the area
(The following questions only apply to certain Respondents)

M: From the survey we did with you a few weeks ago, I learned that you are using a very unique technique/technology on your farm, and that you've been using it for several years. I'd like to ask you a few questions about that technique/technology.

32. Please describe the technique/technology in detail:

33. For how long have you been using this technique/technology?

34. Why did you first decide to try this technique/technology?

Possible probes:
Where did you hear about it?
How much did you know about it before you tried it?

35. Over the years, how have you adjusted it?
36. Why have you kept using this technique/technology?
37. Have you tried using this technique/technology on other parts of your farm/with other crops?
38. Have you taught this technique/technology to anyone else?

M: This is the end of the interview. Thank you for taking the time to speak with me today. Do you have any questions?

APPENDIX C

Qualitative Coding Audit Trail

Table 22. Qualitative Coding Audit Trail

Node Name	Description
Themes	Thematic coding done by hand
Dissatisfaction	R was NOT satisfied with the results of an experiment
Experimentation Types	Different examples of experimenting--this node is mainly a heading folder, as specific experiments will be detailed in sub-nodes
Legumes	Instances where R experimented with legume crop or variety (this node is where instances of legume experimentation are listed, but NOT methods, source of ideas, etc.)
Results- Legumes	Results of legume experiments (how 2 compared to each other, the yield, etc.), also how the crop was used post-harvest
Source- Legumes	Where R got idea for experiment (this node is mostly a place holder, as all sources will be coded in sub-nodes under this heading)
Copy- Legumes	R experimented with legume that they saw or that was suggested elsewhere and copied or adapted it (from peers, lead farmers, family, cheifs, etc.)
Independent- Legumes	Experiment was Rs own idea (including radio)
Promoted- Legumes	R experimented with legume that was actively promoted by an AEDO, non-profit (e.g. RISING), subsidy program, etc. The experiment was placed in their hands!
Maize	Instances where R experimented with maize crop or variety (this node is where instances of maize experimentation are listed, but NOT methods, source of ideas, etc.)
Results- Maize	Results of maize experiments (how 2 compared to each other, the yield, etc.)
Source- Maize	Where R got idea for experiment (this node is mostly a place holder, as all sources will be coded in sub-nodes under this heading)
Copy- Maize	R experimented with maize that they saw or that was suggested elsewhere and copied or adapted it (from peers, lead farmers, family, cheifs, etc.)
Independent- Maize	Experiment was Rs own idea (including ideas they got from radio but never knew anyone personally who had tried it)
Promoted- Maize	R experimented with maize that was actively promoted by an AEDO, non-profit (e.g. RISING), subsidy program, etc. The experiment was placed in their hands!
Other crop or variety	Instances where R experimented with other non-legume and non-maize crop or variety (this node is where instances of other crop or variety experimentation are listed, but NOT methods, source of ideas, etc.)
Results- Other	Results of other crop or variety experiments (how 2 compared to each other, the yield, etc.)
Source- Other	Where R got idea for experiment (this node is mostly a place holder, as all sources will be coded in sub-nodes under this heading)
Copy- Other	R experimented with other crop or variety that they saw or that was suggested elsewhere and copied or adapted it (from peers, lead farmers, family, cheifs, etc.)
Independent- Other	Experiment was Rs own idea

Table 22. (cont'd)

Promoted- Other	R experimented with other crop or variety that was actively promoted by an AEDO, non-profit (e.g. RISING), subsidy program, etc. The experiment was placed in their hands!
Tech	Instances where R experimented with technique or technology (this node is where instances of tech experimentation are listed, but NOT methods, source of ideas, etc.)----- IF R experimented with a new crop or var AND a new tech, code to both places (2 experiments!)
Results- Tech	Results of tech experiments (how 2 compared to each other, influence on the yield, etc.)
Source- Tech	Where R got idea for experiment (this node is mostly a place holder, as all sources will be coded in sub-nodes under this heading)
Copy- Tech	R experimented with tech that they saw or that was suggested elsewhere and copied or adapted it (from peers, lead farmers, family, cheifs, etc.)
Independent- Tech	Experiment was Rs own idea (including radio)
Promoted- Tech	R experimented with tech that was actively promoted by an AEDO, non-profit (e.g. RISING), subsidy program, etc. The experiment was placed in their hands!
Failure	R claims that an experiment failed (and reasons why they think so); R didn't plant a crop again or use a tech again because the result was poor
Memorable Quotes	To pull for thesis
Methods	Experimental methods used -- field size, amount planted, sole or intercrop, comparitive planting techniques between 2 plants
Motivation	Reasons Rs name for why they experiment (or barriers to experimentation)
RISING	R discusses working with Africa RISING
Satisfaction	R was satisfied with results of experiment
Self-identify	Answers to the question: Do you do experiments on your farm? [yes and no answers should be coded here] and also Did you do experiments before working with an agriculture project (e.g. RISING)? [again, include both yes and no answers]
Success	R claims that an experiment was successful (and reasons why they think so)
Theories	Rs theories about why things are the way they are, why an experiment resulted the way it did, etc.
WFC Fields	Word Freq Count of "field" or "field"-related words in all interviews
WFC Land	Word Freq Count of "land" or "land"-related words

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