ASSESSING FACTORS INFLUENCING FARMERS' ADOPTION OF IMPROVED SOYBEAN VARIETIES: A CASE STUDY OF LILONGWE AND DOWA DISTRICTS

MASTER OF ARTS (ECONOMICS) THESIS

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UNIVERSITY OF MALAWI
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Master of Arts (Economics)

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DECLARATION

I, the undersigned hereby declare that this thesis is my own original work which has not been submitted to any other institution for similar purposes. Where other people's work has been used, acknowledgements have been made.

Eliya Gideon Kapalasa

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Signature

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Date:

CERTIFICATE OF APPROVAL

The undersigned certify that this thesis represents the student's own work and effort and has been submitted with our approval.

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DEDICATION

To my lovely wife and best friend Victoria Kapalasa, my brothers Gerson, Kenan and Gideon Junior and sisters Ireen and Malesi. You are my source of encouragement and a better reason to strive for better things in this world.

To my late mum and dad Gideon and Lucy Kapalasa, I thank God for you and so sad that you never lived to enjoy the fruits of your hard work.

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ABSTRACT

Cultivation of improved varieties is one way of increasing productivity of many crops especially in developing countries where there is pressure of land due to high population growth. Adoption studies have proved to be helpful in giving the picture of the performance of technologies amongst users like farmers and in line with this the study was carried out to assess the factors that influence a farmer to adopt improved soybean varieties using cross-sectional data that was collected from 300 households by International Institute of Tropical Agriculture (IITA) in 2009.

The study used a Hurdle Poisson model in order to effectively assess the socio-economic and demographic characteristics that influence farmers to adopt improved soybean varieties. The results of the study show that amongst the household socio-economic characteristics that were included in the model, age of the household head and farm size were significant at 5 percent level of significance whilst access to information through extension agents and distance to the market were the institutional factors that significantly influence a farmer. The results further show that the variety characteristics that were significant in influencing adoption of improved soybean varieties included high yield, early maturity and taste. Results of the decision on how many soybean varieties individual farmer choses to grow shows that age of the household head, access to information and varieties that are high yielding had a significant influence.

The study recommends that there is a need to conduct adoption studies regularly in order to have a clear picture of the performance of many varieties developed by research institutions as they provide feedback to a number of players in the breeding program. Another policy recommendation is that there is a need to strengthen the extension services as they have proved to be the reliable source of information in the rural areas.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADD	Agricultural Development Division
AERC	African Economic Research Consortuim
CIMMYT	International Centre for Wheat and Maize Improvement
DARs	Department of Agricultural Research Services
EPA	Extension Planning Area
GDP	Gross Domestic Product
IITA	International Institute of Tropical Agriculture
NGO	Non-Governmental Organization
SPSS	Statistical Package for Social Scientists

CHAPTER ONE

INTRODUCTION

1.1 Background

Agriculture still remains the main economic sector in Malawi and contributes significantly to the national development. It is a sector that receives high priority and attention from the Malawian Government. Its importance stems from the fact that it accounts for about 35-40 percent of the Gross Domestic Product (GDP), providing employment to about 84.5 percent of the labour force, contributes to over 90 percent of the export earnings and accounting for 82.5 percent of the foreign exchange earnings (Malawi Government, 2008). Tobacco is the major export earner and contributes to about 65 percent of the country's export earnings, followed by tea at 8 percent and sugar at 6 percent. However, recent trends in the production and prices of tobacco coupled with the global anti-smoking campaign have brought to light the need for diversifying the country's export base and have left the country searching for alternatives to this once main export crop. Malawi Government is putting in place several efforts and policies to diversify the export base like the promotion of livestock and crop sectors through the increase of budgetary allocation every year. Government is also deliberately promoting and facilitating the exportation of potential crops like soybean and cotton as one way of diversifying the export base. According to Department of Agricultural Research Services, DARs (2005) several alternative crops have been identified and are currently being promoted and among them include cotton, paprika, groundnuts and soybeans. This thesis focuses on the soybean as an alternative crop.

The potential of soybean stems from the fact that crop is mainly grown by smallholder farmers who accounts for over 80 percent of the national production of food crops in Malawi. The potential of soybean has also been noted by the increase in trend both in area allocated and production as shown by table 1 below. The table presents trend of area that has been allocated to soybean production in Malawi from starting from 2000 to 2010 and the area and production figures are presented in thousand (1000) that is 1000ha representing 1000 hectares for area and 1000t representing 1000 tons for production. The table further shows that there has been an increase in the area allocated to soybean production over the years which again cement the idea that the crop has attracted the attention of producers due to its relative importance. It is mainly grown as a cash crop by many households and partly as a food crop mainly by female headed households (Malawi Government, 1994; Estrada, 2004).

Table 1: Area, production and yield trend of soybean in Malawi

Year	Area (1000ha)	Production (1000t)	Yield (kg/ha)
2000	52.64	35.90	682
2001	45.43	29.57	651
2002	50.98	38.75	760
2003	47.13	33.76	716
2004	68.52	40.40	589
2005	71.65	55.25	771
2006	75.48	67.33	892
2007	73.94	64.49	872
2008	79.47	71.30	897
2009	91.67	79.75	870
2010	102.58	83.84	818

Source: Ministry of Agriculture and water development (2010)

It is widely grown by smallholder farmers in Malawi because of its multiple uses that it has on the farm enterprise for instance, it is a source of cheap protein at household level at the same time it is used as feed for livestock, and at farm level the crop has the ability to fix nitrogen in the soils (Lungu, 1998). The other reason why soybean is currently being promoted by government is because of the ever increasing demand for the crop both on the domestic and world markets that has resulted in the rising of the world market prices. In response to all these benefits, government is putting more resources towards promoting such crops that have the ability to raise incomes of smallholder farmers by re-orienting farmers to be cultivating crops with higher gross margins and more so move away from subsistence to commercial agriculture.

In order to achieve this, there is a need to raise production of soybean at household level which will translate to increase in national production that will result in having surplus for exports. However, faced by the problem of small land holding sizes emanating from high population pressure, one of the possible solutions of raising production is to raise productivity and just as Estrada (2004) indicated, crop productivity could be increased by a number of factors that include cultivating improved crop varieties, following modern farming practices and using quality inputs. Various studies on the production of soybean in Malawi reveals that productivity of the crop has been very low compared to that of other crops. For instance Lungu (1998) reported that most farmers in Malawi only manage to get 25 percent of the potential yield of the crop and that the average yield has stagnated at 600 kg/ha against the world average of above 2000 kg/ha over a period of 5 years (1993-1997). Lack of high yielding cultivars, poor farming practices, and use of poor quality seeds were some of the major reasons reported. Similar findings were also reported by Estrada in 2004 where in addition to these also mentioned that low productivity was as result of the tendency of many farmers recycling their seed from previous years that keeps on reducing the yielding potential of the crop, a reason attributed to unavailability of soybean seeds in many markets where improved seeds for other crops are sold.

Several efforts have been put in place by Malawi government to promote adoption of modern technologies and raise crop productivity through interventions like developing improved varieties of different crops, promoting use of modern farming techniques like treadle pumps just to mention a few. Efforts made by Malawi government to raise productivity of crops through development of improved varieties will be meaningless if farmers do not use such technologies and such information can only be discovered through adoption studies. For instance the DARS (2008) reported that over 10 varieties of soybeans including Nasoko, Makwacha, Magoye and Ocepara-4 have been released in Malawi since soybean research activities began. In spite of the number of modern soybean varieties available in the country the use of these varieties by smallholder farmers is very low a reason Estrada (2004) indicated to have contributed to the low productivity of the crop. In order to understand the reason that contributes to low usage of modern varieties by farmers, Doss (2006) emphasized on the importance of conducting adoption studies so that results obtained should be channelled to the respective stakeholders in the seed systems. Several adoption studies have been conducted in Malawi and other countries on different crops to establish the reasons that influence a farmer to adopt modern farming technologies. For instance Chirwa (2005) studied adoption of fertiliser and maize in Malawi, Kormawa, Ezedinma and Singh (2004) studied adoption of improved cowpea varieties in Nigeria, Paudel and Matsuoka (2008) studied adoption of improved maize varieties in Nepal and Namwata, Lwelamira and Mzirai (2010) studied adoption of irish potatoes in Tanzania found out that farmers are more likely to adopt and use technologies that are user friendly and more so that are compatible with their existing environment but above all technologies that meet expectations and characteristics of the farmers.

1.2 Problem statement

There are a number of improved soybean varieties that have been released in Malawi since the research activities on the crop started in Malawi around 1970s. Some of the recent released soybean varieties are not only high yielding but also believed to have most of the attributes that farmers look for in an improved variety. However, productivity of many smallholder farmers of the crop is still very low compared to that of other crops according to the 2008 agricultural production report by the Department of Agricultural Research services (DARs). For instance on the same plot area groundnuts would yield an average of 1100kg per hectare, cowpea 700kg per hectare and maize 1850kg per hectare while soybean would only give an average of 600kg per hectare. Kananji (1999) attributed the low productivity of soybean crop by farmers to a number of reasons including use of poor quality inputs, small cultivation areas, and continuous use of unimproved cultivars and recycling of seeds. Kananji (1999) further reported that adoption rate of many improved soybean varieties is still very low hovering around 5 percent.

The Department of Agricultural Research services has been putting in place deliberate efforts to sensitise soybean farmers on the benefits of growing improved varieties following the recent promotion of the crop by government. In order to effectively achieve higher adoption rates of improved varieties there is a need to understand the reason behind adoption of technologies (Doss, 2003). Lack of empirical literature on the factors influencing adoption of soybean varieties in Malawi necessitates this study to be conducted in the two districts where the crop is highly cultivated and the results will provide feedback to the existing gap of knowledge on adoption. It is believed that results of such studies will provide feedback to different players in the soybean seed system including breeders and policy makers.

1.3 Objectives

1.3.1 Main objective

The underlying objective of the study is to assess the factors that influence a farmer to adopt improved soybean varieties in the rural areas of Lilongwe and Dowa districts.

1.3.2 Specific objectives

Specifically the objectives of the study are;

1. To investigate the effect of household demographic and economic characteristics (i.e. gender, age, marital status, household size, education) on adoption of improved soybean varieties among smallholder farmers
2. To examine the effect of the institutional factors (i.e. access to extension services, group membership) on adoption of improved soybean varieties among smallholder farmers
3. To determine how household demographic and economic characteristics influence the number of improved soybean varieties adopted by a farmer
4. To find out the effect of institutional factors on the number of improved soybean varieties adopted by a farmer

1.4 Research questions

The study will answer the following questions

1. Do demographic factors (i.e. gender, age, marital status, household size, education) influence adoption of improved soybean varieties?

2. Do institutional factors (i.e. access to extension services, group membership) influence farmers' decisions to adopt improved soybean varieties?
3. Do socioeconomic factors have an impact on the number of improved soybean varieties adopted by a farmer?
4. Do institutional factors have an effect on the number of improved soybean varieties adopted by a farmer?

1.5 Significance of the study

By pointing out the factors that influence adoption of improved soybean varieties, this study will provide the necessary information to the soybean breeding program (that is coordinated by the Department of Agricultural Research together with IITA that is aiming at promoting cultivation of improved soybean varieties through developing improved varieties) and other stakeholders in the agriculture sector in order to come up with successful interventions. The added knowledge of which factors have greatest influence on soybean adoption will help players in the soybean value chain like breeders, policy makers and extension agents to come up with proper interventions that will promote and encourage adoption of the crop. In addition to this, the study will also highlight some of the most critical factors that affect adoption of improved soybean varieties that may require refining or improving if proper promotion of the crop will be successful. Finally just as other studies on adoption of agricultural technologies in Malawi (Chirwa, 2005; Zeller, Diagne and Mataya, 1998, Kabuli, 2004) the study provides empirical reasons behind low adoption rates for the crop and suggests some policy recommendations. Adoption studies can provide research and extension staff, rural development institutions, and policymakers with valuable information that improve the efficiency of communication among them in promoting available technologies. In addition this study will add literature because although there are other studies on adoption of other crops in Malawi, adoption of soybean could be influenced by different factors especially because soybean is unique crop in Malawi as it is mainly a female dominated crop and also as Estrada (2004) reported the proceeds from the crop are mainly controlled by women.

1.6. Organization of Study

This thesis is presented in five chapters and progresses as follows: Literature review is presented in chapter two whilst chapter three presents the methodology and data analysis of the study. In chapter four, results and discussions are presented whilst chapter five concludes with policy recommendations and limitations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter gives an overview of some literature on adoption that has been studied in Malawi as well as in other countries. It starts by giving background on the theoretical literature on adoption in section 2.1, and then gives a definition as well as conceptualization of adoption in section 2.2; in section 2.3 the chapter gives a detailed review of the factors that influence adoption by citing a number of studies on adoption starting with demographic then institutional and concluding with economic factors.

2.1 Modelling Improved soybean variety adoption

2.1.1 Theoretical literature

Adoption model has been studied by making use of various theories coined by a number of scholars. For instance Rodgers (1983) came up with the popular innovation decision model that shows the process through which an individual (or other decision making unit) passes from first knowledge of an innovation to forming an attitude towards the innovation, to a decision to adopt or reject, to implement of the new idea, and to confirmation of this decision. Diffusion is the process by which an innovation is communicated through certain channels overtime among the members of a social system (Rogers, 1983). When new ideas are invented, they are diffused and adopted or rejected. We use the concept of diffusion in our study in terms of understanding how many farmers know and use the technology.

The second model is the economic constraint outlined by Adesina and Zinnah (1993) that contends that economic constraints reflected in asymmetrical distribution patterns of resource endowments are the major determinants of observed adoption behavior. Lack of access to capital or land could significantly constrain adoption decisions. While attempts have been made to assert the 'superiority' of the economic constraint model over the innovation-diffusion model such conclusions have been challenged (Adesina and Zinnah, 1993).

The third one is the adopter perception model by Kivlin and Fliegel (1966) that suggests that the perceived attributes of innovations condition adoption behavior. The limited quantitative studies that have considered farmers' perceptions in the context of adoption decisions have included a perception variable - measuring farmers' perception of a problem (e.g. soil erosion) - in their models. However, by being concerned primarily with only the farmers' perceptions regarding the severity of the problem to be solved, the studies implicitly take the technical innovations (designed to solve the problem) as appropriate for farmers (Adesina and Zinnah, 1993). In the context of soybean some of the perceived attributes include; taste of the crop, yield, cooking time that the variety takes, grain size and colour.

This study adopted the approach of combining adopter perception model and the economic constraint to look at how these influences adoption of improved soybean varieties in Malawi.

The adoption decision can be modeled as a dichotomous choice of whether to adopt a new technology or not to adopt. Since this variable can take on only two values: 1 and 0 (adopt or not adopt), a binary choice model is used to analyze this adoption decision. Assumptions underlying binary choice models are that: (1) the economic agent is faced with a choice between two alternatives e.g. to adopt or not adopt; and (2) the choice the agent makes will depend on his/her attributes or characteristics (Pattanayak et al., 2003). The conceptual framework is then to build a model that will predict the adoption decision of an economic agent with given attributes.

The utility maximization framework can be used to motivate this binary choice model. A household's adoption choice is based on whether the expected net utility derived from adopting the new technology is greater than from not adopting. For a new crop species, a household chooses between whether or not to plant the new crop in order to maximize their utilization of the land. Adoption is treated as an investment choice, where the farm household is seeking to maximize agricultural profit in relation to a chosen set of inputs and outputs. The decision whether to adopt or not is based on whether the new technology will bring more utility to the farm household than the current technology.

2.2 Definition of adoption and conceptualization

Agricultural research focuses on developing new technologies to improve agricultural productivity and farmers' well-being. The rapid adoption of new agricultural technologies in developed and some developing countries has increased agricultural productivity, contributed to overall economic growth, and reduced food insecurity and poverty (Bandiera and Rasul, 2005; Cornejo and McBridgje, 2002). The definition and conceptualization of agricultural technology adoption varies among experts. In their study of adoption of agricultural technology in developing countries, Feder, Just and Zilberman (1985) conceptualize adoption of agricultural technologies at two different levels: aggregate and individual (farm-level) adoption. They define aggregate technology adoption and diffusion as the process of the spread of a new technology within a region. Aggregate adoption is measured at the population level, rather than at the individual level. In contrast, the authors define individual adoption as the degree of use of a new technology in long-run equilibrium, when the farmer has full information about the new technology and its potential.

Several studies (Adesina and Zinnah, 1993; Adesina and Forson, 1995; Chirwa, 2005; Doss, 2006) carried on adoption usually start by defining adopter and proceed by outlining some of the likely factors that affect adoption. However it is worth noting that the definition of adopter varies across studies. For instance Doss (2006) reported that the definition of adopter varies widely even across the 22 studies that the International Centre for Wheat and Maize Improvement (CIMMYT) conducted in East Africa examining the adoption of improved varieties of wheat and maize and fertilizer. In defining "adoption" the first thing is to consider whether adoption is a discrete state with binary variables or whether adoption is a continuous measure. Many studies use a simple dichotomous variable approach. There is a distinction that is made between discrete and continuous technology adopters among typical farmers who use either unimproved or improved inputs. A farmer is classified as an adopter if he/she is found to be cultivating improved varieties or using modern technologies. With respect to the adoption of improved varieties, discrete adoption refers to a farmer who stops using a local (traditional) variety and adopts an improved variety. In contrast, continuous adoption refers to situations where farmers increasingly planting more land to improved varieties, while continuing to grow some local varieties. Thus a farmer may be classified as an adopter and still grow some local varieties (Doss, 2003). Furthermore, Doss (2006) emphasizes that defining agricultural technological adoption is complex. Studies carried out by CIMMYT have used several different adoption definitions to distinguish between, for example, varieties that were originally introduced as improved hybrids, but have been repeatedly recycled (e.g., farmers plant seed from a previous harvest) versus planting new certified seeds. The author also argues that it is necessary to distinguish between farmers who continue to use a newly adopted technology from those who discontinue using it. The rate of adoption is defined as the percentage of farmers who have adopted a given technology. On the other hand, the intensity of adoption is defined as the level of adoption of a given technological package. Put it in a different way, the number of hectares planted with improved seed also tested as (the percentage of each farm planted to improved seed) or the amount of input applied per hectare represent the intensity of adoption of the respective technologies (Nkonya, Schroeder and Norman, 1997).

This study adopted the approach of estimating adoption as a dichotomous variable where a farmer is classified as adopter or non-adopter. Because of several varieties of soybean that are currently grown by smallholder farmers in Malawi, there are a number of varieties that have been categorized as improved and as such farmers are classified as being adopters if they indicate to have grown any of the improved varieties and otherwise classified as non-adopters. Specifically if a farmer reported to have grown any of the following (Nasoko, Makwacha, Ocepara-4 and Magoye) soybean varieties is considered to be an adopter and non-adopter otherwise.

2.3 Factors influencing adoption

The process of adoption is very dynamic and usually a complex process that cannot just be understood by observing a single variable. The decision to adopt is preceded by different steps that farmers normally take before deciding whether to adopt or not. The adoption is a decision-making process, in which an individual goes through a number of mental stages before making a final decision to adopt an innovation. Decision-making process is the process through which an individual passes from first knowledge of an innovation, to forming an attitude toward an innovation, to a decision to adopt or reject, to implementation of new idea, and to confirmation of the decision (Ray, 2001). However, as emphasized by Ray (2001), adoption does not necessarily follow the suggested stages from awareness to adoption; trial may not always be practiced by farmers to adopt new technology. Farmers may adopt the new technology by passing the trial stage. In some cases, particularly with environmental innovations, farmers may hold awareness and knowledge but because of other factors affecting the decision making process, adoption does not occur (Ray, 2001).

Farmers' technological adoption behavior is associated with many factors. In a study of the adoption of agricultural and forestry technologies by smallholder in tropical areas, Pattanayak, Mercer, Sills and Yang (2003), classify factors associated with technological adoption into four categories: preferences and resource endowments, market incentives, biophysical factors, and risk and uncertainty. Doss, Wangi, Verkuijl and De Groote (2003), in the study of the adoption of maize and wheat technologies in Eastern Africa, propose a similar framework. They classify factors associated with farmers' adoption decisions into four categories: farmers' socio-demography characteristics, institutional factors, farmers' perception of the characteristics of technologies, and economic attributes.

2.3.1 Demographic characteristics

Doss et al. (2003) indicated that numerous studies of technologies adoption in developing countries have used farmers' socio-demography characteristics (e.g., household heads' gender, age, education, and household size) to explain household adoption behaviors. A few of these studies report that the rate of technology adoption is higher among male-headed households, compared to female-headed households because of discrimination (i.e., women have less access to external inputs, services, and information due to socio-cultural values). Age is one of the variables that has been widely used to explain adoption, a farmer's age may influence adoption in one of several ways. Older farmers may have more experience, resources, or authority that would allow them more possibilities for trying a new technology. Experience in a particular farming area or with a given crop may not be strictly correlated with age, however, and it may be worth asking more specifically about experience. On the other hand, it may be that younger farmers are more likely to adopt a new technology, because they have had more schooling than the older generation or perhaps have been exposed to new ideas as migrant laborers (CIMMYT, 1993). Adesina and Forson (1995), who studied farmers' adoption of new agricultural technology in Burkina Faso and Guinea, reported that both young and old sorghum farmers in Burkina Faso adopt new technology. Young farmers adopt the technology because they have long term plans and are willing to take risks. On the other hand, old farmers adopt it because they have accumulated capital or have greater access to credit, due to their age. However, the effect of farming experience (measured by the age of the household head) is not always positively associated with farmers' adoption behaviors. For example, Zavale, Mabaya and Christy (2005) report that older farmers in Mozambique are less likely to adopt improved maize variety than younger farmers.

Empirical evidence provided by Feder et al. (1985) emphasized the importance of human capital (e.g. farmers' education) on adoption. They argued that education enhances the ability of farmers to acquire, synthesize, and quickly respond to disequilibria, thereby increasing their likelihood of adoption of new agricultural technologies.

Wealth status of the farmer has also been reported to have an influence on adoption of technologies for instance Doss (2003) indicated that wealthier farmers have greater access to resources and may be more able to assume risk. The challenge here is to find measures of wealth that do not also contain substantial information about other factors related to adoption. For example, size of landholdings are often used to measure farmers' wealth, but this measure also picks up information about whether there are economies of scale in production using improved technologies. Landholdings may also reflect the social status and prestige associated with owning land, and possibly the ability of a farmer to obtain credit.

2.3.2 Institutional factors

Kormawa et al. (2004) reported that access to credit, membership to farmers' club or associations, access to extension services and information on improved technologies as well as information on input and output markets are some of the significant institutional factors affecting adoption of modern technologies by smallholder farmers. Pattanayak et al. (2003) argue that access to extension services provided by the government, NGOs, and other stakeholders play a very important role in the adoption of new agricultural technologies. Farmers who are exposed to information about new technologies by extension agents (through training, group discussion, plots demonstration, and other form of information delivery) tend to adopt new technologies. Capital constraints and limited access to credits hinder the adoption of agricultural technologies. These factors especially apply to new inputs or technologies that require a high initial capital investment and high operational costs (Feder et al., 1985).

2.3.3 Characteristics of technology and farmers' perception

In general, farmers' perceptions of the characteristics of new agricultural technologies are divided into three main categories: yield performance, cost requirements, and risks. Feder et al. (1985) argue that yield performance (or expected yield of new varieties) is one of the characteristics of improved varieties that affect farmers' technological adoption behaviours. Adoption rates of improved varieties are believed to be higher if the varieties meet the expectations of the farmer. An improved variety will be adopted at exceptionally high rates, if the new variety is technically and economically superior to local varieties. Improved varieties are technically superior if they produce higher yield than traditional varieties (Feder et al., 1985).

2.3.4 Economic attributes

Farmers have heterogeneous beliefs about new agricultural technologies and the economic profitability of new agricultural technologies is uncertain. Early adopters are farmers who adopt first, while late-adopters wait and observe the experiences of early-adopters. After obtaining information about the technology from early-adopters, they decide whether or not to adopt the technology based on the economic profitability. According to Feder et al. (1985) farmers who are aware of a certain agricultural technology component will decide whether or not to adopt it by evaluating the expected economic profitability or benefit that they anticipated will be gained, taking into account the initial investment and variable costs. An agricultural technology is more likely to be adopted if the gain or profit exceeds the aggregate investment and variable costs. Furthermore, they argue that the technological adoption rate varies over time because socioeconomic groups have different adoption behaviors and farmers' adoption decisions for the next growing period depends on the initial impact of the technology, profitability, and other farmers previous experience. Researchers of technological adoption studies often use economic attributes variables (e.g., farm size, land tenure, farm location, farmers' growing other cash crops, and adoption of other complementary technologies like fertilizer) to explain farmers' adoption behaviors.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter outlines the empirical approaches employed in the analysis of the collected data in order to meet the four objectives outlined for this study. The research sites, the data collection process and the statistical package used in the analysis are also discussed. Finally the section concludes by giving the modeling process where issues of model used are discussed as well as issues of diagnostic test are also discussed.

3.2 Study area

The study used secondary data that was collected by International Institute of Tropical Agriculture (IITA) for the baseline study on soybean breeding and seed systems in Dowa and Lilongwe districts during the 2008/09 cropping season. Data was collected using a structured questionnaire that was pretested in Lilongwe. Data was collected from 4 Extension Planning Areas (EPAs) in the two districts and specifically, Chitekwere and Nyanja in Lilongwe and Nachisaka and Madisi from Dowa. Lilongwe district is under Lilongwe Agricultural Development Division (ADD) while Dowa is under Kasungu ADD. The two districts were chosen because they are the leading producers of soybean.

3.3 Sample size and sampling Techniques

A multi-stage random sampling was employed when collecting data. At the first stage two districts were purposively selected from a list of major soybean growing districts in Malawi. The second stage involved selection of two EPAs from each district as mentioned above. The next stage was listing of the villages under each of the selected EPA, from where the sampled households were taken. From Chitekwere 6 villages were randomly selected, 4 from Nyanja, another 4 from Madisi and 7 from Nachisaka EPAs. The selection was done proportionately to the number of the villages. The final stage was selection of households where a total of 152 were interviewed from Lilongwe and 148 from Dowa making a total sample size of 300 households.

3.4 Data collection instruments

A household structure questionnaire (Appendix 1) was used to collect a wide range of information including farmer demographic characteristics, farm resource and other economic variables and also information of institutional factors that have been used in the study. The questionnaire was pre-tested during the design phase to assess its effectiveness in the collection of required data at field level. A team of qualified and experienced enumerators were thoroughly trained before commencement of the data collection activities and IITA provided a team leader to lead the process of data collection.

3.5 Data Analysis

Data collected was entered using a common package used by social scientists called Statistical Package for Social Scientists (SPSS) and for the purpose of this study the data was transferred to STATA version 11 for analysis. Analysis included descriptive statistics, and estimation of the hurdle model to analyze the socio-economic variables and institutional factors that influence adoption decisions made by soybean farmers.

3.6 Empirical model specification

Farmers' decision to adopt or not to adopt a technology is assumed to be the outcome of a complex set of factors related to the farmers' objectives and constraints. In other words, there are certain factors – including market forces, social, institutional, and management factors that affect the likelihood that farmers adopt a technology. Thus if each farmer and each technology can be classified based on a core set of variables, then it is possible that the probability of a farmer adopting that technology could be estimated. As earlier indicated in the theoretical model, the study consider binary dependent variable, Y_i to model adoption where it takes the value of 1 if the farmer was found to be growing any of the improved varieties of soybean and 0 if otherwise. It further assumes that the probability to adopt improved soybean variety is influenced by a set of demographic characteristics, economic and institutional factors. For the second hurdle (truncated model), improved variety adoption becomes continuous and the dependent variable is the number of improved soybean varieties grown by a household.

The household characteristics deemed to influence improved soybean adoption in this study include household heads characteristics (age, gender and education) and household size. The conventional approach to adoption study considers age to be negatively related to adoption based on the assumption that with age farmers become more conservative and less amenable to change. On the other hand, it is also argued that with age farmers gain more experience and acquaintance with new technologies and hence are expected to have higher ability to use new technologies more efficiently. Education normally is expected to have positive relationship with adoption as it believed to enhance the allocative ability of decision makers (farmers) by enabling them to think critically and use information sources effectively. However, just as Doss et al. (2003) reported, education in this study is not expected to have strong effects on adoption because soybean is not a new technology.

Institutional and economic factors considered important in this study include access to extension that has been proxied by number of visits by extension agents reported by a household during the study period, membership to any farmer based clubs or associations and farm size owned by the household. The size of landholding is expected to be positively correlated with adoption of soybean, as farmers with bigger farms are assumed to have the ability to purchase improved soybean seeds and the capacity to bear risk if the technology fails and have adequate land for the different varieties (Feder et al., 1985). Exposure to information reduces subjective uncertainty and, therefore, increases likelihood of adoption of new technologies (Doss, 2003). Extension and club membership are thus expected to have a positive correlation with adoption. Distance to the market is expected to have a negative correlation with adoption as longer distances reduces the likelihood of adoption because of the transportation costs that farmers will have to incur in going to purchase inputs.

To capture the influence of agro ecological factors in the two districts on adoption, we include a dummy for district. Lilongwe is used as a base due to the fact that between the two districts, Lilongwe is relatively ideal for most of the improved varieties mainly because most of the trials are conducted at chitedze where most of the research activities are conducted. Agro ecology variables pick up variation in rainfall, soil quality and production potential. These variables may also pick up variation unrelated to agricultural potential, such as infrastructure and availability of markets for inputs (Feder et al., 1985).

Technology specific attributes were captured using dummies because of the limitation in the way data was collected. Farmers were asked to indicate whether the character was an important attribute or not compared to the traditional varieties. The study managed to pick and use three top characteristics indicated by household which are maturity, taste and yield.

A description of these factors and a brief description of the expected relationship between these variables and the adoption of improved soybean is presented in Table 2. The explanatory variables are included in the study based on the nature of the technology itself and a thorough review of the previous literatures on adoption.

3.7 The Double Hurdle model

This study extends the conventional adoption decision modeling of looking at the factors influencing adoption decision by looking further at the factors that influence the number of varieties that a farmer grows. This modeling requires the use of count models of which the most commonly used are the Poisson, Negative Binomial and Hurdle Poisson. As Cameron and Trivedi (1998) noted Poisson model is the simplest and perhaps the most common method for count variables and it is the model that is derived from the Poisson distribution by parameterizing the relation between the mean parameter and covariates (regressors). One of the assumptions of Poisson models is the equidispersion which implies equality of mean and variance and once this assumption is violated it results in overdispersion or underdispersion which is usually common with zero-inflated data (Cameron and Trivedi, 1998). The authors further highlighted that this assumption is similar to homoscedasticity[1] under the ordinary least square and as such statistical test for overdispersion is highly required after running a Poisson model. Presence of overdispersion results in impacts such as invalid conclusions, inaccurate t-statistics and inaccurate standard errors (Cameron and Trivedi, 1998). One frequent manifestation of overdispersion is that the incidence of zero counts is greater than expected for the Poisson distribution and this is of interest because zero counts frequently have special status. An alternative model that can address the problems associated with standard Poisson models is

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1 The error term has a constant variance

the Negative Binomial model (NB2). However, although this model takes care of the problem of overdispersion, it has another weakness in that it does so without knowledge of the possible reason for overdispersion and also it is not ideal for data that has a larger number of zeros (Cameron and Trivedi, 1998). To address the shortfalls of the two models, Hurdle models are usually used. Hurdle models are based on the assumption that zero counts are generated from a different process than are the positive counts in a given data situation. This study used Hurdle instead of the standard Poisson or the Negative Binomial because the count data has a lot of zero (about 27 percent). In order to capture the sequential binary choice decision, a hurdle model or two part model is applied. A hurdle model has the interpretation that it reflects a two-stage decision-making process. Originally formulated by Cragg (1971), the double-hurdle model assumes that households make two sequential decisions with regard to adopting and intensity of use of a technology. Each hurdle is conditioned by the household's socio-economic characteristics. In the double-hurdle model, a different latent variable is used to model each decision process.

The decisions to adopt improved soybean variety and subsequently plant a number of improved varieties over time are examined using a hurdle count model (Cameron and Trivedi, 2005). Hurdle models are typically applied to attend to problems arising from sample selection bias and the discrete, non-negative nature of the outcome (i.e., the number of improved soybean varieties a farmer reported to have planted). In the study, a producer must have grown soybean as a crop to answer the question: how many improved varieties did the farmer planted during the previous growing season? Thus, the first stage of the model (the "hurdle") explains the decision to adopt improved soybean variety using a logit regression that models the adoption decision (1 = yes, 0 = no) to use improved soybean varieties. Given the decision to adopt improved soybean variety (a binary outcome), the number of varieties grown (a positive, discrete variable; $k = 1, 2, \ldots, K$) is subsequently modeled using a Poisson regression. The hurdle model is widely used, and the hurdle negative binomial model is quite flexible.

Farmers usually make rational decisions when it comes to adoption of any particular technology. Since the objective of the farmer is to maximize expected (discounted) profits over time horizon subject to input and commodity prices and technology constraint, farmers will usually weigh the benefits associated with a particular technology before they decide to adopt. Rationally a farmer will adopt a technology if the expected (discounted) utility of profits of using that technology is greater than utility from the old technology (Adesina and Forson, 1995).

The Poisson model is the simplest and perhaps the most common method for modeling counts variables (Cameron and Trivedi 1999). The Poisson probability distribution is given as

$$\Pr\left(Y = y\right) = \frac{\exp(-\mu)\mu^{y}}{y!}, \quad y = 0,1,2..., \tag{1}$$

where Y is the number of soybean varieties grown by the household and μ is mean parameter. The Poisson regression model is derived from the Poisson distribution by parameterizing the relation between the mean parameter μ and covariates (regressors) x. The standard specification for the mean parameter is $\mu = \exp(\mathrm{x}\beta)$, where β is a vector of the unknown parameters. In applications, however, the Poisson model is usually restrictive. In particular, it imposes the restriction that the mean and variance are equal, but for most observed count data, the variance usually exceeds the mean, a feature called overdispersion. This makes the Poisson model deficient.

A common alternative to the Poisson model in case of overdispersion is the negative binomial model which is given as

$$f(y \mid \mu, \alpha) = \frac{\Gamma(y+\alpha^{-1})}{\Gamma(y+1)\Gamma(\alpha^{-1})} \left(\frac{\alpha^{-1}}{\alpha^{-1}+\mu}\right)^{\alpha^{-1}} \left(\frac{\mu}{\alpha^{-1}+\mu}\right)^{y}, \quad (2)$$
$$\alpha \geq 0, \quad y = 1, 2, 3...$$

where the function $\Gamma(.)$ is the is the gamma function.

However, both the Poisson and negative binomial models are not suitable for data with excess of zero (Cameron and Trivedi, 1998). This is the case with data used in this study. The 300 households used in this study were soybean farmers who were growing soybean and they include those growing traditional varieties and those growing improved. In this case, the zeros are coming from households that grew soybean but did not grow improved varieties due to other factors like preference of traditional varieties or lack of access to seed of improved varieties. From the study about twenty seven percent of the sample households did not grow improved soybean varieties during the study period.

To handle data sets that contain excess zero, two part models have been used, with the hurdle Poisson and Zero Inflated Poisson (ZIP) models being the common ones. Each of these two models consists of an equation for participation and a model for the event count that is conditioned on the outcome of the first decision (Cameron and Trivedi, 2005).

The hurdle Poisson model combines a binary model (participation part) to predict zeros and a zero-truncated Poisson model (count part) to predict non-zero counts (Cameron and Trivedi, 1998). In this way, the hurdle Poisson relaxes the implicit assumption in the Poisson and the negative binomial models that the zeros and the positives come from the same data generating process. The advantages of using a hurdle Poisson are two-fold; firstly, the hurdle Poisson model is suitable for taking into account the overdispersion or underdispersion of the data (Cameron and Trivedi, 1998). Secondly, hurdle Poisson model controls for data selection.

The starting point of the hurdle Poisson model is a binary process, which determines whether the variable takes on the value zero or a positive value (Cragg, 1971). The probability mass function is given as;

$$\Pr(Y=y)=\begin{cases}\pi, & y=0\\ 1-\pi & \mathrm{y}=1,2,3,\ldots\end{cases} \qquad (3)$$

The zero-truncated Poisson process has probability mass function;

$$\Pr(Y=y \mid Y\neq 0)=\begin{cases}\dfrac{\lambda^{y}}{(e^{\lambda}-1)y!}, & \mathrm{y}=1,2,3,\ldots\\ 0, & 0\mathrm{therwise}\end{cases} \qquad (4)$$

This gives the following unconditional mass function for Y;

$$\Pr(Y=y)=\begin{cases}\pi, & y=0\\ (1-\pi)\dfrac{\lambda^{y}}{(e^{\lambda}-1)y!}, & \mathrm{y}=1,2,3,\ldots\end{cases} \qquad (5)$$

The log likelihood for the t^{th} observation, assuming the observations are independently and identically distributed, is

$$\ln \mathrm{L}(\pi_i, \lambda_i, y_i) = \begin{cases} \ln(\pi_i), & y=0 \\ \ln\{(1-\pi)\dfrac{\lambda^y}{(e^{\lambda}-1)y!}\}, & y=1,2,3,... \end{cases} \tag{6}$$

Therefore, the log likelihood function of the hurdle Poisson can be viewed as the sum of the log likelihoods from two separate models: a binomial probability model and a truncated-at-zero Poisson model. As such, the hurdle model log likelihood can always be maximized, without loss of information, by maximizing the two components separately. This feature allows estimation of the hurdle Poisson model in two separate steps. In the first step, binomial probability model is estimated followed by truncated Poisson model (McDowell, 2003).

Zero-inflated Poisson model provides another way to model excess zeros. In ZIP regression, the counts Y_i equal 0 with probability φ_i and follow a Poisson distribution with mean $\mu_i = \mu(\mathrm{x},\beta)$ with probability $1-\varphi_i$. The probability mass function for the zero-inflated Poisson is given as

$$\Pr(Y = y) = \begin{cases} \varphi_i + (1-\varphi_i)\exp(-\mu_i), & y=0 \\ (1-\varphi_i)\dfrac{\exp(-\mu_i)\mu_i^{\,y}}{y!} & y=1,2,3,... \end{cases} \tag{7}$$

The probability φ_i is parameterized as a logistic function of the observable vector of covariates z_i, thereby ensuring nonnegativity of φ_i, that is

$$\varphi = \frac{\exp(\mathbf{z}_i\alpha)}{1-\exp(\mathbf{z}_i\alpha)}$$

where $\mathbf{z_i}$ is a vector of covariates while α is a vector of coefficients. Let $1(y_i = 0)$ denote an indicator variable that takes value 1 if $y_i = 0$, and zero otherwise. The log-likelihood function for the double hurdle model is:

$$LogL = \sum_{0} \ln\left[1 - \phi(Z_i'\alpha)\phi\left(\frac{x_i'\beta}{\delta}\right)\right] + \sum \ln\left[\phi(Z_i'\alpha)\frac{1}{\delta}\phi\left(\frac{y_i - x_i'\alpha}{\delta}\right)\right]$$

Empirical results by both Cragg (1971) and Moffat (2003) reveal that the double-hurdle model gives superior results to those obtained from Tobit model. Thus in this study we estimated the decision to adopt improved soybean variety and the intensity of adoption (number of improved varieties grown) using a double-hurdle model.

After adoption, the producer decides how many improved soybean varieties to grow in a particular season. Because the choice set is observed as number of varieties (a discrete, countable decision), the decision is appropriately modeled using a count regression model such as the Poisson or negative binomial models (Cameron and Trivedi, 2005). The model was estimated using full information maximum likelihood estimation (FIML). Maximum likelihood estimation of the hurdle model involves separate maximization of the two terms in the likelihood, one corresponding to the zeros and the other to the positives. This is straightforward (Cameron and Trivedi, 2005).The statistical software program STATA 11 was used to run the model with the help of the STATA user written program *hplogit*. A heteroskedastic robust covariance matrix was estimated using the survey weights (Wooldridge, 2004), which was subsequently used to make inferences about the covariates explaining adoption of improved soybean varieties.

3.8 Explanatory variables and expected signs

The following are the explanatory variables and their expected signs as taken from literature that has been reviewed in this study

Age of the household head (AGE): In this study age was used as a continuous variable. The expected sign of age is negative because the expectation is that older farmers are usually risk averse as such they tend to be very skeptical whenever there is a new technology. However, suffice to mention here that this is one of the variables that has given conflicting results with other studies reporting to have positive influence on adoption (Doss, 2003).

Sex of the household head (GEN): Sex of the household head has been used as a dummy variable having a value of 1 if the head is male and 0 otherwise. In terms of expected sign, the study predicts a negative relationship because the crop in question is a female dominated.

Education of the household head (EDU): Education in this study has been used as a continuous variable and expected to have a positive influence on adoption. CIMMYT (1993) reported similar results and further indicated that education has an influence on adoption of agricultural technologies.

Size of cultivated land owned by the household (LAN): Cultivated land has a positive influence on adoption of agricultural technologies because farmers with larger farm sizes are able to diversify the risk associated with new technologies by trying the new technology on a small plot area on their farm (Doss, 2003) therefore the study expects land to have a positive influence on adoption of improved soybean varieties.

Extension (EXT): Access to information has been proxied by number of visits by extension agents reported by the farmer during the study period and the expectation is that information access positively influences adoption decisions made by farmers. Extension agents provide and demonstrate the importance and advantages of improved technologies over traditional methods and as such encourage farmers to adopt and try new technologies (Cornejo and McBridge, 2002).

Household size (HHSIZE): This is measured as a continuous variable and is predicted to have positive sign. The size of the household determines the amount of labour available at household level and just as Feder et al. (1985) reported that households with more labour are more likely to adopt agricultural innovations, the study expects households with larger family sizes to have higher probabilities of adopting improved soybean varieties.

Membership to farmer club/group (CLUB): This has been taken as a dummy variable having 1 if a farmer belongs to a club and 0 otherwise. The expected sign is positive because farmers that are members of a particular group are more likely to adopt a particular technology because they share information and encourage one another to adopt a technology especially those that give positive results (Kabuli, 2005).

Distance to the nearest market (MKT DIST): The distance to the nearest market has been assumed to have a negative influence on adoption because of the fact that longer distances act as disincentive to the farmers who have to walk longer distances just to get to the market to sell their commodities. The variable has been treated as a continuous in this study. The explanation for this is that farmers who are closer to markets are more likely to adopt improved varieties because they have better access to information on prices and also they do not incur transportation costs when taking their produce to the market of which most of them are bulky (Kabuli, 2005).

Household income (HHINCOME): This is measured as a continuous variable and is expected to have a positive influence on adoption. Farmers with higher income are more likely to adopt new technologies because they are able to contain risk and other shocks that may arise due to adoption of new technologies (Doss, 2003).

Location where a farmer is (DISTRICT): this is taken as a dummy variable having 1 if the farmer lives in Lilongwe and 0 otherwise. The expectation is that farmers who are in Lilongwe are more like to adopt improved soybean varieties because most of the varieties that were released over the last 10 years were all tried under the conditions of Lilongwe districts as such making them more ideal for the district than compared to other districts.

Variety specific attributes (Yield, Taste and Maturity): These variables have been included as dummies, having 1 if an individual indicated that yield, taste, and maturity is an important attribute and 0 otherwise and the expected signs were positive because of the understanding that varieties that had any of these attributes were more likely to be adopted.

Table 2: Definition of variables used in the Double Hurdle model and their expected signs

Variable name	Symbol in the equation	Description	Type of variable	Expected sign
Adoption	Y	Dependent variable: Adoption of improved soybean variety	Dummy, 1 if adoption, 0 otherwise	
Age	AGE	Age of the household head	Continuous	-
Gender	GEN	Gender of the household head	Dummy, 1 if Male, 0 otherwise	-
Education	EDU	Number of years in formal education	Continuous	+
Land	LAN	Amount of total land owned	Continuous	-
Extension	EXT	Number of extension visit the farmer had in the agricultural season	Continuous	+
Household size	HHSIZE	Number of individuals living in the house	Continuous	+
Membership	CLUB	Membership to any farmer club or association	Dummy, 1 if Yes, 0 otherwise	+
Market distance	MKT DIST	Distance to the nearest market in Km	Continuous	-
Income	HHINCOME	Total value of household income	Continuous	+
District	DISTRICT	District where the farmer lives	Dummy, 1 if Lilongwe, 0 Dowa	+
Yield	YIELD	Yield is an important character	Dummy, 1 if Yes, 0 otherwise	+
Maturity	MATURE	Maturity is an important character	Dummy, 1 if Yes, 0 otherwise	+
Taste	TASTE	Taste is an important character	Dummy, 1 if Yes, 0 otherwise	+

CHAPTER FOUR

EMPIRICAL RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents descriptive information of socio-economic, institutional and farm level characteristics of the respondents in the study areas. Section 4.2 presents the descriptive analysis of the above factors whilst section 4.3 and 4.4 presents results for diagnostic tests and 4.5 presents the adoption regression results showing the effect of selected independent variables on adoption of improved soybean varieties. For the descriptive analysis, the results presented in the tables are based on an average sample size of 300 households by adopters and non-adopters.

4.2 Descriptive Statistics of the study area

Table 3 below presents results of the descriptive statistics of the variables used in the analysis and as shown, out of 300 household heads interviewed during the study period 72 were female representing 24 percent. The figure is not surprising especially when one considers that in Malawi the household is mainly headed by male adults or husband and more so because of the control of most productive resources by males. The results further show that 180 households reported to have adopted at least one of the improved soybean varieties released by the Department of Agricultural Research representing a 60 percent adoption rate. The mean income which was estimated as the sum of all household assets is MK127 459 for all households and MK140 158 and MK 108 409 for adopters and non-adopters respectively. Thus adopters had a higher mean income than non-adopters. The table also indicates that the on average about 30 percent of the sampled households reported to have been members of farmer club or association and there appears to be the same proportion of adopters as well as non-adopters. The results further indicate that about 57 percent of the adopters were from Lilongwe compared to 41 percent from Dowa district. This result may not be surprising because farmers who are in Lilongwe have relatively better access to some of the improved soybean seeds from Chitedze research station as they are closer to the place and also some of the trials on these varieties were conducted in their locations and as a result some farmers ended up retaining some seeds for the use.

Table 3: Descriptive statistics of variables used to model adoption

Variable	Adopter		Non adopter		All	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Income	140158	113190	108409	82942	127459	103203
Age	44.32	13.88	41.93	13.84	43.36	13.89
Gender	0.69	0.46	0.87	0.34	0.76	0.43
Land	1.92	1.36	1.56	0.74	1.78	1.16
Education	5.58	3.38	4.81	3.10	5.26	3.28
Household size	5.07	2.17	5.61	2.13	5.29	2.16
Membership	0.31	0.46	0.33	0.47	0.32	0.47
District	0.57	0.50	0.41	0.49	0.51	0.50
Market distance	11.84	5.07	13.00	5.68	12.30	5.34
Extension	45.33	79.87	25.52	55.90	37.41	71.82

Source: Computed from the study data

Adopters of soybeans had on average higher land size (1.92 ha) compared to that of non-adopters (1.56 ha) whilst education, household size and distance to the nearest market are almost equal for the two groups. Access to information was proxied by number of contacts with extension agents and the results above reveals that adopters of soybean had a higher access to information with an average of 45 days in year compared to 25 for non-adopters. This difference could have an impact on the decision to adopt or not because as Doss (2003) reported extension agents plays a vital role in creating awareness to farmers and also demonstrating the benefits associated with modern technologies as such farmers with higher access to information are more likely to adopt than those with less access.

4.3. Results for model specification tests

Table 4 below gives results of log likelihood test for model specification. The results show that we reject the null hypothesis that the parameters are simultaneously equal to zero. This implies that there is at least one variable that is not equal to zero hence variations in the dependent variable is explained by at least some of the independent variables.

Table 4: Log likelihood test

LR chi2(14)	56.95
Prob > chi2	0.000

4.4 Results for Multicollinearity test

Test for multicollinearity was done to test whether there was any linear association among the explanatory variables and results are presented in the table below. The rule of thumb is that correlation becomes a worrisome problem once the coefficient exceeds 0.8 (Gujarati, 2004). The results in the table below indicate that no serious problem of multicollinearity exits amongst the variables.

Table 5: Correlation matrix for explanatory variables

	Taste	Maturity	Yield	Extension	Age	Market	District	Club	Land
Taste	1.00								
Maturity	0.06	1.00							
Yield	0.08	0.36	1.00						
Extension	0.04	-0.06	0.01	1.00					
Age	-0.02	0.06	0.08	-0.04	1.00				
Market	-0.05	-0.03	0.07	0.04	-0.02	1.00			
District	0.06	0.16	0.07	-0.10	0.03	-0.45	1.00		
Club	-0.04	0.06	0.11	0.04	0.01	-0.02	0.03	1.00	
Land	0.04	0.11	0.21	0.31	0.06	0.14	-0.28	0.06	1.00
Household size	-0.03	-0.13	-0.05	0.08	0.03	0.05	-0.32	0.08	0.19
Income	0.11	-0.01	0.25	0.30	-0.15	0.12	-0.23	0.15	0.47
Education	-0.07	-0.03	0.12	0.10	-0.19	-0.07	-0.03	0.13	0.13
Sex	-0.21	-0.17	0.08	0.15	-0.04	0.12	-0.14	0.06	0.26

	Household size	Income	Education	Sex
Household size	1.00			
Income	0.22	1.00		
Education	-0.01	0.24	1.00	
Sex	0.19	0.24	0.14	1.00

4.5. Double Hurdle Poisson model results

Table 6 presents coefficients and standard errors (in parenthesis) results from the Hurdle Poisson model of improved soybean adoption. The results of the model are presented in two ways, firstly the participation part where the farmer decides to adopt improved soybean variety or not and then the second part of the model where a decision is made on how many of the improved varieties to grow. The results of the model show that amongst the household socio-economic characteristics that were included in the model, age of the household head and farm size were significant at 5 percent level of significance showing that they have an influence on the farmers decision to adopt improved soybean varieties whilst education level and sex, although positively related with adoption do not significantly influence the decision to adopt. Further to this it is also clear from the results that amongst the institutional factors that were hypothesised to influence adoption, extension, market distance and the district where the farmer resides are significant factors that influence a farmer to adopt soybean varieties just like the technology specific variables such as taste, yield and earliness to maturity. However, the second decision on how many varieties to adopt is influenced by age of the household head, access to information that was proxied by the number of extension visits and also by the yielding potential of the variety.

Table 6: Hurdle Poisson regression results of the factors influencing adoption of improved soybean varieties

Variable	Logit (Deciding to Adopt or not)	Poisson (Number of varieties grown
	Coefficient (Robust std errors)	Coefficient (Robust std errors)
Age	0.027	0.206**
	(0.090)	(0.089)
Age^2	-0.001	-0.002**
	(< 0.001)	(0.001)
Education	0.056	-0.058
	(0.056)	(0.058)
Sex	0.422	0.040
	(0.545)	(0.497)
Household size	-0.183	-0.068
	(0.104)	(0.085)
Wealth	-0.001	-0.001
	(< 0.001)	(0.010)
Land	0.603**	0.041
	(0.211)	(0.125)
Extension	0.006**	0.004**
	(0.003)	(0.002)
Club	0.027	0.478
	(0.407)	(0.427)
Market	-0.157**	0.077
	(0.070)	(0.056)
District	1.178**	-0.280
	(0.433)	(0.379)
Yield	1.029**	1.137**
	(0.392)	(0.510)
Taste	1.889**	0.335
	(0.711)	(0.488)
Maturity	1.370**	-0.290
	(0.456)	(0.371)
Constant	-3.457	-6.795
	(2.107)	(2.532)

Source: Computed from study data
Note: ** (p-value < 0.05)

Table 7 presents the odds ratios and standard errors (in parenthesis) and Incidence rate ratios (IRR) and standard errors (in parenthesis) results of the hurdle Poisson model. In case of land, the results show that a unit increase in land size owned by a farmer increases the odds of adopting improved soybean variety by 1.8 whilst a unit increase in the number of visits by extension agents increases the odds of farmers adopting improved soybean variety by 1. As expected, distance to market center has also a negative and significant relationship (at 5 percent level of significance) with probability of adoption of improved soybean varieties. The odds-ratio of 0.9 for market distance implies that other things being kept constant, the odds-ratio in favor of adopting improved soybean varieties decreases by a factor of 0.9 as the market distance increase by one kilometer. The results further show that agro-ecological differences have an influence on the decision to adopt and also on the number of varieties to grow. For instance farmers who are located in Lilongwe increases the odds of adopting by a probability of about 3. In terms of variety specific attributes, the results show that varieties that are higher yielding, mature earlier and also have a pleasant taste have a higher odds (3, 7 and 4 respectively) of being adopted. Detailed results and interpretation of the double hurdle Poisson model for the 8 significant variables on adoption are presented in the following paragraph.

Table 7: Odds ratio and Incident Rate Ratio of the factors influencing adoption of improved soybean varieties

Variable	Logit (Deciding to Adopt or not)	Poisson (Number of varieties grown
	Odds ratio (Robust std errors)	IRR (Robust std errors)
Age	1.027	0.206**
	(0.092)	(0.089)
age^2	1.000	-0.002**
	(0.001)	(0.001)
Education	1.058	-0.058
	(0.059)	(0.058)
Sex	1.526	0.040
	(0.831)	(0.497)
Household size	0.833	-0.068
	(0.087)	(0.085)
Wealth	1.000	0.001
	(0.001)	(< 0.001)
Land	1.827**	0.041
	(0.385)	(0.125)
Extension	1.006**	0.004**
	(0.003)	(0.002)
Club	1.027	0.478
	(0.418)	(0.427)
Market	-0.855**	0.077
	(0.060)	(0.056)
District	3.248**	-0.280
	(1.405)	(0.379)
Yield	2.797**	1.137**
	(1.097)	(0.510)
Taste	6.616**	0.335
	(4.701)	(0.488)
Maturity	3.935**	-0.290
	(1.793)	(0.371)

Source: Computed from study data
Note: ** (p-value < 0.05)

4.5.1. Age of the household head

The positive sign on the coefficient of age show that there is a positive correlation between age and adoption. However, age appears to have a significant impact on the second decision level especially when a farmer is deciding how many of the improved varieties to grow, i.e. showing that age does not matter at the extensive margin but rather at the intensive margin. In other words this means that age minimal influence on the decision of whether to grow improved soybean varieties but rather have more influence on the number of improved to be grown. The implication of this is that as farmers are aging they tend to gather experience with the crop and as such realizes the benefits associated with it hence they are able to grow a number of varieties. Similar results were reported by Cornejo and McBridge (2002) where it was argued that experience with technology is one of the critical factors that determines the number of technology that a farmer will adopt and this is usually captured by age of the farmer in situations where information on the period since the farmer started cultivating the crop is not known.

4.5.2. Land owned by the household

As expected, the variable has a positive and significant relationship (at 5 percent level) with probability of adoption of improved soybean varieties. The odds-ratio in favor of adopting improved soybean varieties, other factors kept constant increases by a factor of 1.8 as land increases by one unit. This implies that a farmer who has more land will be more likely to adopt improved soybean varieties. The implication for this is that farmers with more land should not be ignored when promoting cultivation of improved varieties as they are the ones that are likely to adopt. Several studies have reported similar findings for instance Adesina and Zinna (1993) argued that farmers with larger farm size are more likely to adopt agricultural technologies because they are able to bear the risk associated with trying new things because of land area where they can diversify by growing a number of crops, Doss et al. (2003) reported that households with larger farm size adopts improved varieties because they usually have better access to credit and information that have been widely documented to influence adoption.

4.5.3. Access to information (Extension)

The positive coefficient on extension indicates that there is positive and significant (at 5 percent) relationship between adoption of improved soybean varieties and access to information that has been proxied by the number of contacts with extension agents. This implies that soybean farmers with access to information through contacts with extension workers are the ones who are more likely to adopt improved varieties. Access to information is significant both at the first (deciding to adopt improved soybean varieties or not) and second (deciding how many varieties to grow) decision level indicating that information plays a crucial role in decision making by farmers just as reported by Feder et al. (1985) where it was argued that farmers who have access to information about a particular technology are more like to adopt. The implication of this finding is that extension should really be intensified to promote the adoption of improved soybean varieties. Similar findings were also reported by a number of scholars like Chirwa (2005) argued that farmers with access to information through extension services adopt modern technologies faster because they are well informed about the advantages associated with modern technologies as such they make informed decisions based on the information given. Kaliba et al. (2000) reported that extension visits have a positive influence on adoption because farmers are exposed to new technologies and in the process get convinced to adopt them.

4.5.4. Distance to the market

The results have shown that there is a negative but significant relationship between adoption and the distance to the nearest market. This implies that as the distance to the nearest market increases/reduces the probability of farmers adopting improved varieties is reduced/increased hence showing that farmers who are close to the markets are more likely to adopt soybean varieties. The implication for this is that there is a need to open up more markets in the rural areas so as to achieve higher results of adoption. The results concur with what was found by Kabuli (2005); Namwata et al. (2010); Paudel and Matsuoka (2008). Kabuli (2005) argued that farmers closer to markets adopt improved technologies because they do not have to travel long distance with their produce to sell hence incur no costs on transport unlike those that are far and have bulky and a lot of harvest. In the case of soybean, being partly a cash crop entails that farmers have to think of the markets where they will sell their crop once it matures and as such there is higher likelihood that farmers closer to the market will adopt improved varieties because they have access to market. Namwata et al. (2010) argued that farmers closer to markets have higher probability of adopting improved varieties because they have access to information about the availability of market and also prices prevailing on the market and this informs the farmers when deciding what to grow for the next growing season. Paudel and Matsuoka (2008) reported that distance to the market is an important determinant of adoption for farmers producing bulky commodities because of transportation and infrastructure challenges. Poor infrastructure like roads raises transportation costs and as such farmers closer to markets are more likely to adopt improved technologies of bulky crops like soybeans.

4.5.5. Household location (district)

Location where a farmer lives was used to capture the agro-ecological differences existing between the two districts where the study was conducted. Results have shown that farmers located in Lilongwe are more likely to adopt improved soybean varieties than those in Dowa. The interpretation of this is that most of the existing varieties of soybean are short duration varieties and as such they are very conducive for Lilongwe that receives relatively less rainfall compared to Dowa that enjoys longer rain durations. Another explanation for the result is that all the varieties were developed and released at Chitedze Research Station that is located in Lilongwe as such they are more suitable for Lilongwe conditions than Dowa. The results then demonstrate the need for having more work done on research so that other variaties are developed that will be ideal under different agro-ecological zones. Similar result was reported by Kabuli (2005) where it was argued that farmers are more likely to adopt technologies that are matching the existing agro-ecological conditions.

4.5.6. Variety specific characteristics

Yielding potential had positive and significant influence on adoption of improved soybean varieties at 5 percent level of significance. Similar results were also obtained for the other variety specific characteristics like earliness to maturity and the taste of the variety. The results implies that farmers are likely to adopt soybean varieties that are high yielding, early maturing and having a pleasant taste when cooked. The results are in agreement with what Adesina and Zinnah (1993) found where they argued that technologies that meet the characteristics that farmers look for when selecting a particular crop variety have higher probability of being adopted. The report further reveals that some of the characteristics are usually associated with individual's perceptions for instance attribute like taste is very subjective as what is pleasing to a single farmer may not please everyone. Adesina and Forson (1995) argued that technologies that raise agricultural production like improved varieties and fertilizer have higher probability of being adopted because of the problem of land sizes. The report ague that most developing countries have land problem as a challenge due to higher population and as such the only way farmers increases output is to adopt technologies that are higher yielding, and resistant to drought (early maturing) which is another serious problem in developing countries.

CHAPTER FIVE

CONCLUSIONS

5.1. Summary

The main objective of the study was to examine the factors that influence the adoption of improved soybean varieties among smallholder farmers in Dowa and Lilongwe districts. The study adopted the approach of combining adopter perception model and the economic constraint to look at how socio-economic and variety specific characteristics influences adoption decision of improved soybean varieties in Malawi using cross sectional data collected by IITA in 2008 for a baseline study of soybean breeding program. Double Hurdle Poisson model was used to identify the variables that influence a farmer to adopt improved soybean varieties as well as the number of varieties to grow.

In general, the study concludes that socio-economic factors such as age of the household head significantly influence farmers' decision to adopt improved soybean varieties in the study areas. Institutional factors such as access to extension services, distance to the nearest market and location where a farmer lives are very important determinants of adoption of improved soybean varieties. The study also finds that farm level characteristics such as farm size play a crucial role in influencing the farmers' decision to adopt improved soybean varieties. The study further finds that variety specific characteristics like earliness to maturity, higher yielding and pleasant taste are significant attributes that influence a farmer to adopt improved soybean variety. The study also indicates that the decision to adopt a number of varieties is influenced by age of the household head, access to information (access to extension services) and the yielding potential of the variety. However, the study finds that certain farm level characteristics and socio-economic factors such as club membership, gender, total household income, education, and household size do not influence the adoption decision at household level.

5.2. Policy Implications

The study has shown that adoption rate of soybean varieties has increased from around 5 percent in 1999 to 60 percent during the 2008 growing season. However, this result may not represent the realities on the ground because most of the varieties considered during the study were released longtime ago with the most recent one being in 2004. It is therefore worthy noting that there are some varieties that have been released after 2004 but were not considered in the study because of other reasons beyond the scope of this study. Based on the findings of the study, the following are some of the policy implications to government;

1. Government should continue increasing resources to the Department of extension as it has been shown in the study that as the source of information to farmers', extension visits to farmers have a bearing on the adoption decisions taken by farmers because by visiting farmers, extension agents demonstrate and inform farmers of the advantages associated with modern varieties.
2. There is a need for more rural markets to be opened up closer to farmers if adoption of modern technologies is to be successful because farmers will have a clear picture on what crops are being demanded on the market and also which varieties are fetching better prices on the market.
3. There is a need to focus more research and breeding to come up with more varieties that are suitable under different agro-ecological zones.
4. There is a need to have deliberate efforts to target specific farmers with different attributes like age, farm sizes.

5.3. Limitation of the study

The study used the already existing data that was collected during the 2008 IITA baseline survey which was primarily designed to answer specific questions in relation to the IITA and DARs projects. As such, the study has failed to examine the effect of certain variables deemed to have significant influence on the adoption of soybean. For instance, price and gross margins specifically those from the preceding season associated with a particular crop are some of the variables that have been widely used to select a crop or variety to grow and this information was unavailable in this study. Other information that could also been useful is the attributes that is variety specific like to know which variety is high yielding compared to the other. In addition, lack of resources made it impossible to follow up the study areas with an aim of collecting qualitative information which could have assisted in explaining some of the odd findings that were observed in the districts.

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APPENDIX 1 RESEARCH QUESTIONNAIRE

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE (IITA)

Targeting soybean breeding, utilization, and seed delivery efforts

Baseline survey in Malawi

SITE IDENTIFICATION & DATA QUALITY CONTROL

Province/Region		
District		
Village		
GPS coordinates for homestead	Latitude: Longitude:	Altitude:
Interviewer name		
Quality check 1: IITA Supervisor	Date:	Rating* (Good, Poor)
Quality check 2 : IITA Supervisor	Date:	Rating** (Good, Poor)

* If the rating of Quality Check 1 is poor, the enumerator must re-do at his/her own cost.
******Any final form MUST be rated GOOD to pass through.

A. HOUSEHOLD DEMOGRAPHY AND RELATED INFROMATION

1. Name of the household head: ___________________________ (ONLY the HEAD should respond to questions)

2. Gender of the household head: ______ **1**=Male; **0**=Female

3. Age of the household head: ______________years

4. Does the head have formal education? ----------- **1**=Yes; **0**=No

5. If yes, what is the number of years of schooling? _________years

6. Household size (total) ________persons

7. Number of adults (>=15 years old): Male: ___ Female: ___

8. Number of members between 5 and 15 years of age (>5 & <15): ______

8. Number of children (<=5 years): ________________

9. How many adult male members of the household completed:

(**a**) Primary school _______ (**b**) Secondary School_______(**c**) Tertiary __________

10. How many adult female members of the household completed:

(**a**) Primary school _______ (**b**) Secondary School_______(**c**) Tertiary __________

B. FARM AND HOUSEHOLD ASSETS

1. Land holding this cropping season (2007/2008)

	Category	**Cultivated (ha)**	**Fallow (ha)**	**Total (ha)**	**Irrigated?** (**1**=Yes; **0**=No)	**Rent** (MK)
1	Total farm size					
2	Own land					
3	Rented land					
4	Borrowed land					

2. Livestock ownership

	Type	**Number owned**		**Type**	**Number owned**
1	Oxen		7	Pigs	
2	Bulls		8	Rabbits	
3	Dairy cows		9	Chicken	
4	Other cows		10	Guinea fowl	
5	Donkeys		11	Doves/pigeons	
6	Goats		12	Other (specify as footnote)	

3. Number and estimated value of assets other than land and livestock

	Asset	**Number**	**Estimated value per unit** (MK/unit)	**Total value** (MK)
1	Hoe			
2	Machete			
3	Spade			
4	Sprayer			
5	Cart			
6	Irrigation pump			
7	Wheel barrow			
8	Plough			
9	Tractor			
10	Radio			
11	Television			
12	Bicycle			
13	Motorcycle			
14	Vehicle			
15	Mobile phone			
16	House	Wall type (**Codes A**)------- Roof type (**Codes B**)------- Floor type (**Codes C**)-------		

Codes A: **1**=Thatched; **2**=Wood (timber); **3**=Bricks; **4**=Stone; **5**=Cement blocks; **6**=Other (Specify………..…)
Codes B: **1**=Thatched; **2**=Iron sheet; **3**=Tiles; **4**=Asbestos**;** **5**=Other (Specify………..…)
Codes C: **1**=Earth; **2**=Wood; **3**=Cement; **4**=Tiles; **5**=Other (Specify………..…)

C. INPUT USE AND CROP PRODUCTION

1. Please provide information on input use and crop production this cropping season (2007/2008)

Crop	**Land (ha)**	**Fertilizer**		**Seed**				**Chemical**		**Hired labor cost**	**Total Labor (person days)***				**Production**
		Amount (kg)	Cost (MK)	Dominant variety **1**=Modern **0**=Local	Own saved (kg)	Bought/Gift		Amount (liter or kg)	Cost (MK)	(MK)	Land preparation & planting	Weeding	Harvesting	Threshing	(kg)
						Amount (kg)	Cost if bought (MK)								
Soybean															
Cowpea															
Cassava															
Maize															
Beans															
Pigeonpea															
Sorghum															
Millet															
Rice															
Groundnuts															
Bambara nuts															
Sesame															
Potatoes															
Sweet potatoes															
Tobacco															
Cotton															
Cashew															
Tomatoes															
Onions															
Pepper															
Paprika															
Cabbage															

***Person days** = Number of persons × Number of days worked.

Q. No. ------

D. MARKETING OF CROPS AND LIVESTOCK PRODUCTS

1. Please provide information on crops and livestock products you **sold** since the last harvest in 2007

	Quantity sold (kg)*	Quantity sold (% of output)	Revenue (MK)	Month (for highest sales)	Buyer (Codes A)**	Relation to buyer (Codes B)**	Mode of transport (Codes C)**	Transport cost (MK)
Soybean								
Cowpea								
Cassava								
Maize								
Beans								
Pigeonpea								
Sorghum								
Millet								
Rice								
Groundnuts								
Bambara nuts								
Sesame								
Potatoes								
Sweet potatoes								
Tobacco								
Cotton								
Cashew								
Tomatoes								
Onions								
Pepper								
Paprika								
Cabbage								
Milk*								
Chicken*								
Beef cattle*								
Goat*								
Sheep*								

* Unit of measure for quantity of milk sales should be **liters**, whereas livestock sales should be in terms of the **number sold**. ** See Codes next page.

Q. No. ------

Codes A
1. Farmer Union or Cooperative
2. Consumer or other farmer
3. Rural assembler / middlemen / traders
4. Processors
5. Other (specify…………….)

Codes B
1. Relative
2. Friend
3. Preferred customer
4. Other (specify……)

Codes C
1. Bicycle / Motorcycle
2. Hired truck
3. Public transport
4. Donkey
5. Cart
6. Back load
7. Other (Specify…………………)

2. Please provide information on grains and other product purchases since the last harvest in 2007

	Quantity bought (kg)	**Cost** (MK)	**Month** (for highest purchases)	**Seller** (Codes A)	**Mode of transport** (Codes B)	**Transport cost** (MK)
Soybean						
Cowpea						
Cassava						
Maize						
Beans						
Pigeonpea						
Sorghum						
Millet						
Rice						
Groundnuts						
Bambara nuts						
Sesame						
Potatoes						
Sweet potatoes						
Tobacco						
Cotton						
Cashew						
Tomatoes						
Onions						
Pepper						
Paprika						
Cabbage						

Codes A
1. Farmer Union or Cooperative
2. Other farmer
3. Retailers
4. Input dealers (specify--------------)
5. Processor (e.g. RAB processors)
6. Other (specify…………….)

Codes B
1. Bicycle / Motorcycle
2. Hired truck
3. Public transport
4. Donkey
5. Cart
6. Back load
7. Other (Specify…………………)

Q. No. ------

E. NON-FARM ACTIVITIES AND INCOMES

1. Please provide information on non-farm employment and incomes in 2007

Activity	**No. of members engaged**	**No. of working months**	**No. of days worked per week**	**Total income per year*** (MK)
Artisan/handicraft				
Firewood and charcoal				
Unskilled wage labor (e.g. daily laborer)				
Skilled wage labor (e.g. Carpentry)				
Grain mill				
Petty trade (e.g. retail shop, vending)				
Tailoring				
Drought relief (food aid)				
Food for work				
Remittance				

* Convert in-kind income to its cash equivalent

F. ACCESS TO CREDIT

1. Please provide information on demand for and access to credit this cropping season (2007/2008)

Credit for	**Did you borrow in 2007?** **1**=Yes **0**=No	**If No, why?** (Codes A)	**If Yes, did you get the amount needed?** **1**=Yes **0**=No	**If Yes, how much did you borrow?** (MK)
1. Seed				
2. Fertilizer				
3. Farm equipment/implements				
4. Livestock				
5. Business or trade				
6. Food				
7. Children’s education				
8. Family health/medical				
9. Land				
10. Social obligations				

Codes A
1. I did not need credit
2. Interest rate is too high
3. I have no access to any credit source
4. Other (specify……………………)

G. ACCESS TO EXTENSION AND MARKET INFORMATION SERVICES

1. Access to extension services and market information this cropping season (2007/2008)

	Did you receive information on…? **1**=Yes **0**=No	**If Yes, Major source** (Codes A)	**If Yes, Number of contacts with extension agents** (days/ season)
New varieties of crops			
Pest and disease control			
Output markets and prices			
Input markets and prices			
Livestock husbandry			
Irrigation			
Family health			
Family planning			
Soil and water conservation			

Codes A
1. Extension agent
2. Research centre
3. Newspaper
4. Seed traders/Agro-dealers
5. Radio/TV
6. Neighbor/other farmers
7. NGOs
8. Farmer Cooperatives or groups
9. School
10. Other (Specify………………..

2. Please provide information on your participation in improved technology evaluation/transfer

	Ever participated in technology evaluation/transfer? **1**=Yes **0**=No	**If Yes, what was the mode of your participation?** (Codes A)	**If Yes, what was the nature of the technology** (Codes B)	**If Yes, Year of first participation**
Soybean				
Cowpea				
Cassava				
Maize				
Beans				
Sorghum				
Millet				
Rice				
Groundnuts				
Sweet potatoes				
Tobacco				
Cotton				
Cashew				
Vegetables				

Codes A
1. Hosted demonstrations/on-farm trials/variety selection
2. Attended farmer field days for technology evaluation
3. Multiplied and/or distributed improved seed
4. Other (Specify………………………)

Codes B
1. High-yielding variety
2. Drought-tolerant variety
3. Disease-resistant variety
4. Bio-fortified variety
5. Soil fertility management
6. Post harvest technology
7. Mechanization
8. Other (Specify………………………)

H. FARMER GROUPS AND SOCIAL CAPITAL

1. Do you belong to a farmer group—a club, an association, or committee? ------ **1**=Yes; **0**=No

2. If Yes, please provide the following information

Name of farmer group	Number of members		Services provided **1**= Input-output marketing **2**= Safety net (risk sharing, etc) **3**= Labor exchange **4**=Credit and savings **5**= Other (Specify…………..)
	Male	**Female**	

3. How long does it take to your parents' residence? --------------------- Walking minutes

4. How long does it take to your in-laws' residence? --------------------- Walking minutes

I. VULNERABILITY AND COPING STRATEGY

1. What is the most important source of vulnerability? ----------

1=Drought; **2**=Pests/diseases; **3**=Flood; **4**=Other (Specify-----------------------)

2. How often does this occur? Once in ------------- years

3. What is your most important risk management strategy prior to the event? -------------

1=Planting more cassava than maize; **2**=Planting drought tolerant maize

3=More non-farm work; **4**=Crop diversification **5**=Other (Specify---------------------------)

4. What is your most important coping strategy after the event? ------------

1=Selling livestock; **2**= Selling land; **3**=Eating cheaper food than the staple (specify ---------)

4=Reducing the number and quantity of meals; **5**=Migration to urban centers in search of non-farm jobs

6= Other (Specify ------------------------)

J. INFRASTRUCTURE AND MARKET ACCESS

1. Distance to the nearest village market (km)…..…………..Walking minutes…….…………….…………

2. Type of road to major market: …. ...1=Non-paved dirt road; 2=Paved dirt road; 3=Paved gravel road; 4= Tarmac

3. One-way transport cost to the village market using a bus or a pick-up (MK/person)………..……….

4. Distance to the nearest main market (km)……………………Walking minutes……….……..…..……

5. One-way transport cost (per person) to the main market using a bus or a pick-up (MK/person)………..…………

6. Distance to cooperative (farmer group) collection center (km)…..……………Walking minutes……....

7. How long does it take to the nearest tarred road? (Walking minutes) ------------

8. How long does it take to the nearest health center? (Walking minutes) ------------

9. How long does it take to the nearest bus stop or public transport? (Walking minutes) ------------

10. How long does it take to the nearest clean water supply? (Walking minutes) ------------

11. How long does it take to the nearest public telephone? (Walking minutes) ------------

12. Do you have electricity? ------------ **1**=Yes; **0**=No

13. What is the wage rate in this area? (MK/day) --------

K. FOOD & NON-FOOD CONSUMPTION EXPENDITURES

1. Please provide information on food and beverage consumption during the last 7 days

Item	**Own production consumed** (kg)	**Bought**		**Other sources** (kg)
		Quantity (kg)	Cost (MK)	
Soybean				
Cowpea				
Cassava				
Maize				
Beans				
Sorghum				
Millet				
Rice				
Groundnuts				
Potatoes				
Sweet potatoes				
Paprika				
Cashew				
Beef				
Sheep meat				
Goat meat				
Chicken				
Fish				
Milk				
Eggs	(Number)			
Pepper				
Tomatoes				
Onions				
Cabbage				
Cooking oil				
Sugar				
Salt				
Spice				
Prepared meals				
Coffee				
Tea leaves				
Alcoholic beverages				
Nonalcoholic beverages				
Cigarettes/tobacco				

2. Please provide information on non-food expenditure during the last 3 months

Item	**Expenditure** (MK)
Clothing	
Shoes	
Blankets	
Bed sheets	
Detergents (Soap, etc)	
Electricity	
Firewood	
Charcoal	
Kerosene	
Cell phone units	
Church contributions	
Contribution to sports	
Contributions to other associations	
Dowry	
Guard/security	
Newspapers	
Travel expenses	
School fees	
School books and supplies	
Medical expenses	
Milling	
Cassettes	

L. SOYBEAN SEED SYSTEMS

1. Adoption of new soybean varieties and sources of information and seed

Do you know of any improved variety? **1=**Yes **0=**No	If Yes, provide the names of the varieties **1=**Ocepara-4 **2**=427/5/7 **3**=747/6/8 **4**=Other ………..	If Yes, main source of variety information **Codes A**	Ever planted? **1**=Yes **0**=No	If No, Why? **Codes B**	If Yes**,** year first planted	**First seed** Main source of first seed **Codes C**	**First seed** Quantity (kg)	Rate of seed replacement with fresh seed from seed producers or distributors **Once in -----years**	Did you plant the variety this season? **1**=Yes **0**=No
-------------									

Codes A
1. Government extension
2. Farmer Cooperative/Union
3. NGO/CBO
4. On-farm trials, demos, field days
5. Seed/grain stockist
6. Another farmer/neighbor
7. Radio/newspaper/TV
8. Other, specify…...……

Codes B
1. Cannot get seed at all
2. Lack of cash/credit to buy seed
3. Susceptible to diseases/pests
4. Poor taste
5. Low yielding variety
6. Low output prices
7. No market
8. Requires high skills
9. Seeds are expensive
10. Other, specify…………

Codes C
1. Researchers (e.g. during participatory variety selection)
2. Extension demonstration plots
3. Bought from farmer cooperatives
4. Bought from local seed producers
5. Bought from local trader or agro-dealers
6. Provided free by other farmers (relative, friend, etc)
7.Provided free by NGOs
8. Provided free by other govt agency
9. Inherited from family
10. Other (specify)……

2. Sources and quantity of soybean seed used (local and improved) last cropping season—2006/2007

Variety planted	**Total amount of seed** (kg)	**Quantity of seed from major sources**							
		Source 1		**Source 2**		**Source 3**		**Source 4**	
		Codes A	Amount (kg)	Codes A	Amount (kg)	Codes A	Amount (kg)	Codes A	Amount (kg)

Codes A
1. Researchers (e.g. during participatory variety selection)
2. Extension demonstration plots
3. Bought from farmer cooperatives
4. Bought from local seed producers
5. Bought from local trader or agro-dealers
6. Provided free by other farmers (relative, friend, etc)
7.Provided free by NGOs
8. Provided free by other govt agency
9. Inherited from family
10. Other (specify)……

3. Rank the traits of soybean based on your preference and then rank the varieties you have grown so far

Traits	**Rank**	**Local variety** (Name………..)	**Improved varieties** (Table L1) Ocepara-4	427/5/7	747/6/8	Other 1………..	Other 2………..
Grain yield							
Drought tolerance							
Pest & disease resistance							
Early maturity							
Soil fertility enhancement							
Biomass							
Grain color							
Grain size							
Price							
Cooking time							
Taste							
Overall variety score							

4. Can you distinguish between soybean seed and grain from external sources? ----- **1**=Yes; **0**=No

5. What is the maximum price you would pay for soybean seed with desirable traits? (MK/kg) ------

6. How often would you buy fresh improved soybean seed to replace your recycled seed? Once in -----years

7. How many kilograms of improved soybean seed would you buy every time you replace old seed? (kg) ---

8. If you grow local soybean varieties, what is your major seed source? -----------------

1=Own seed saved from previous harvest
2=Buy from other farmers with surplus seed saved from previous harvest
3=Buy from open market
4=Get free from other farmers (relative, friend, etc)
5=Get free from NGOs
6=Other (Specify----------------------------)

9. If you grow improved soybean varieties, what is your major seed source? -----------------

1= Own seed saved from previous harvest
2= Buy from other farmers with surplus seed saved from previous harvest
3= Buy from other farmers who are engaged in seed production
4= Buy from local traders or agro-dealers
5=Buy from open market
6=Get free from other farmers (relative, friend, etc)
7=Get free from NGOs
8=Other (Specify----------------------------)

10. If you save soybean seed, when do you select the seed? --------- **1**=Before harvest; **2**=During harvest; **3**=After harvest

11. Please describe what you would select as seed? 1---------------------------- 2-------------------------- 3--------------------

12. How do you store your saved soybean seed? -------- **1**=Treated with ash; **2**=Treated with insecticide; **3**=Untreated

13. Where do you store your soybean seed? -------**1**=Own store; **2**=Community store; **3**=Other (Specify……………)

14. Do you often run out of your own soybean seed? -------- **1**=Yes**; 0**=No

15. If Yes, how often do you run out of soybean seed? ----- **1**=every year; **2**=once in 2 years; **3**=once in 3-5 years

16. If Yes, what is your alterative soybean seed source? -----------------

1= Buy from other farmers with surplus seed saved from previous harvest
2= Buy from other farmers who are engaged in seed production
3= Buy from local trader or agro-dealers
4=Buy from open market
5= Get free from other farmers (relative, friend, etc)
6=Get free from NGOs
7= Other (Specify---------------------------)

17. Have you ever been trained in soybean seed production? -------- **1**=Yes; **0**=No

18. If Yes, who provided the training? ----**1**= Research institute; **2**=Seed company; **3**= NGOs; **3**=Other (…………)

19. Are you involved in soybean seed production and distribution as a business? ----- **1**=Yes; **0**=No

20. If Yes, please provide the following information

a) Year of first seed production -----------
b) Annual seed production? (kg) --------------
c) Annual seed sales (kg) -------------------
d) Selling price? (MK/kg) ----------------
e) Seed price relative to cowpea grain price -------- **1**=lower; **2**= same; **3**=higher
f) Buyers --------- **1**= Farmers; **2**= Agro-dealers/traders; **3**= Seed company; **4**=Other (Specify--------)
g) Distance to the point of sale (km) ---------------- Walking minutes ----------------
h) Rank and comment on the following possible soybean seed production constraints

Constraint	**Rank**	**Comment**
Lack of basic or foundation seed		
Low seed multiplication ratios		
Start-up capital (credit)		
Technical knowledge		
Storage and processing (cleaning, grading, and packaging)		
Transport (infrastructure)		
Market demand		
Other -------------------------		

M. SOYBEAN PROCESSING AND UTILIZATION

1. What do you produce soybean for? ------**1**=Cash; **2**=Food; **3**=Cash and food; **4**=livestock feed; **5**=for all

2. If you eat soybean, in what form do you eat it? ------- **1**=Grain; **2**= Processed; **3**= Both

3. If you eat processed soybean, what is the major source? -----------

- **1**=Own production processed in the household
- **2**=Own production processed by a processing group in the community
- **3**= Purchased grain processed in the household
- **4**= Purchased grain processed by a processing group in the community
- **5**=Purchased processed product from the market
- **6**=Other (Specify…………………)

4. If you process soybean in the household, how many hours does it take you per meal for all members? -----

5. What are the major processed soybean products? 1----------; 2----------; 3---------

6. Are you aware of food processing farmer groups in this area? ----- **1**=Yes; **0**=No

7. If Yes, which food crop does the group process? -----------------

8. What is the grain-to-product conversion ratio for each product? 1----------; 2----------; 3---------

9. Have you ever sold soybean grain and/or processed product? ----- **1**=Yes; **0**=No

10. If Yes, please provide the following information based on the last transaction

	Quantity sold (kg)	**Revenue** (MK)	**Buyer** (Codes A)	**Relation to buyer** (Codes B)	**Transport means** (Codes C)	**Distance to market** (km)	**Transport cost** (MK)
Grain							
Product 1 (--------)							
Product 2 (--------)							
Product 3 (--------)							

Codes A
1. Farmer Union or Cooperative (e.g. NASFAM)
2. Consumer or other farmer
3. Rural assembler / middlemen / traders
4. Processors (e.g. RAB processors)
5. Other (specify…………….)

Codes B
1. Relative
2. Friend
3. Preferred customer
4. Other (specify……)

Codes C
1. Bicycle / Motorcycle
2. Hired truck
3. Public transport
4. Donkey
5. Cart
6. Back load
7. Other (Specify…………)

11. What is the frequency of consumption of soybean and soybean products in the household?

	Months/year	**Days per week**	**Quantity consumed** (kg/day)
Soybean grain			
Product 1 (----------------------)			
Product 2 (----------------------)			
Product 3 (---------------------)			

N. GENDER ROLES AND ACCESS TO RESOURCES (ask **only women**)

1. Role of gender in the production and marketing of legumes and other crops

Activity	**Responsibility**				
	1= Primarily done by men **2**= Primarily done by women **3**= Primarily done by children **4**= Joint activity (men & women)				
	Soybean	**Cowpea**	**Maize**	**Vegetables**	**Cotton/Cashew**
Selection of variety					
Land preparation					
Planting					
Chemical fertilizer application					
Weeding					
Harvesting					
Threshing					
Transport					
Storage of produce					
Seed selection and storage					
Marketing of produce					

2. Resource access and use

Resource	**Resource owned by the woman** **0=**None **1=**less than half **2=**about half **3=**more than half **4=**all	**Major use of the resource**
Land		
Livestock		
Implements		
Machinery		
Cash from crop sales		
Cash from livestock sales		
Others		

Thank you very much for your cooperation!!!

APPENDIX B: Hurdle Poisson regression results

Variable	Binary outcome Coefficient (Robust std errors)	Binary outcome P-value	Zero Truncated Poisson Coefficient (Robust std errors)	P-value
Age	0.027 (0.090)	0.765	0.206 (0.089)	0.020**
Age^2	-0.000 (< 0.001)	0.682	-0.002 (0.001)	0.046*
Sex	0.422 (0.545)	0.438	0.040 (0.497)	0.936
Household size	-0.183 (0.104)	0.080	-0.068 (0.085)	0.423
Education	0.056 (0.056)	0.315	-0.058 (0.058)	0.320
Land	0.603 (0.211)	0.004**	0.041 (0.125)	0.746
Income	-0.001 (0.010)	0.818	-0.001 (0.010)	0.351
Extension	0.006 (0.003)	0.046**	0.004 (0.002)	0.058*
Market	-0.157 (0.070)	0.026**	0.077 (0.056)	0.169
District	1.178 (0.433)	0.006**	-0.280 (0.379)	0.461
Club	0.027 (0.407)	0.947	0.478 (0.427)	0.263
Yield	1.029 (0.392)	0.009**	1.137 (0.510)	0.026**
Taste	1.889 (0.711)	0.008**	0.335 (0.488)	0.492
Maturity	1.370 (0.456)	0.003**	-0.290 (0.371)	0.435
Constant	-3.457 (2.107)	0.101	-6.795 (2.532)	0.007

Note: ** (p-value < 0.05)
Number of observations = 300
Wald chi2 = 36.58
Prob > Chi2 = 0.000