1-1-2015

Adoption of Agricultural Technologies in Malawi in Absence of Subsidies: A Case of Hybrid Maize Technology

Yohane Kabichi Chimbalanga

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Adoption of agricultural technologies in Malawi in absence of subsidies:

A case of hybrid maize technology

By

Yohane Kabichi Chimalanga

A Thesis
Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
for the Degree of Master of Science
in Agricultural Economics
in the Department of Agricultural Economics

Mississippi State, Mississippi
August 2015
Adoption of agricultural technologies in Malawi in absence of subsidies:

A case of hybrid maize technology

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The study revealed that the subsidy programs implemented in Malawi over the years have exposed many farmers to the advantages of using improved farm inputs. Almost 86 percent of the participants had a chance to grow hybrids in their farming career and out of that number 89 percent continues to grow them on a yearly basis and 76 percent indicated that hybrids have turned out to be their preferred variety. It has also revealed that complete removal of subsidy will result in the demand for inputs from subsidy eligible farmers to be removed from the market. This is based on the fact that only 5 percent of the participants were willing to pay for the improved input packages at market prevailing price.
DEDICATION

In dedication to God, my late dad, family members, my advisor Dr. Ardian Harri, committee members and friends for inspiring me to be who I am today
ACKNOWLEDGEMENTS

Thank you all my committee members and my major advisor for your patience and guidance in this work. I also thank my classmates for their academic and moral support during the period. My wife, daughter and family members special appreciation for your understanding and patience as well. May God bless you all.
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CHAPTER I
INTRODUCTION

1.1 Background

Malawi has approximately 4.7 million ha of arable land, out of 9.43 million ha total land area for the country. Almost 70 percent of the cultivated arable land is used by small scale farmers under the customary land tenure system, while estate farmers use the remaining 30 percent of the cultivated arable land. A good amount of the cultivable land (about 2.42 million ha) is subjected to solely rain fed agriculture, as compared to around 40,000 ha of arable land which is irrigated. There is about 30,000 estates cultivating 1.1 million ha and the estate sizes ranges from 10 - 500 hectares (World Bank, 2003).

Malawi is an agro-based economy with over 80 percent of the population engaged in agriculture. The agriculture sector’s contribution is about 35 percent of the GDP and it also contributes over 80 percent of the export earnings (Malawi Government 2002). Smallholder farmers grow a number of crops including maize, cotton, tea, tobacco, sweet potatoes, cassava, sorghum, millet, wheat, ground nuts, beans, peas, pulses and coffee. These crops are grown for subsistence and for cash.

The country’s agricultural system is predominantly characterized by the dominance of maize cultivation. This is the case, because the country’s main staple food is maize. The country’s food security is tantamount to availability of maize grain at national and household level. The government of Malawi’s agricultural policy...
emphasizes hybrid maize production so as to achieve food security because of its high yielding properties (Fisher and Mazunda, 2011). In Malawi, government estimates show that 70 percent of the country’s arable land is used for maize production (Government of Malawi, 2006). Nearly all Malawian households (97 percent by the year 2004), are engaged in maize production either at a small scale or large scale (World Bank report, 2006).

Minten and Barrett (2008) indicated that for farmers to realize an increase in crop productivity and improve their livelihoods then the use of modern seed varieties is of paramount importance. Despite the fact that hybrids have higher expected yield than local varieties (Fisher and Mazunda, 2011), the World Bank report (2006) indicated that only 58 percent of farmers use hybrid maize varieties. This agrees with the findings by Chirwa (2005), who found that close to 60 percent of the farmers, more especially in the southern region of the country have not embraced the use hybrid maize varieties. His observation was that adoption of hybrids rises with an increase in farmers’ incomes, increase in plot size as well as education. Adoption of hybrids in Malawi has lagged behind as compared to the region. It is languishing at 40 percent as compared to other countries’ adoption like Zimbabwe’s (90 percent) Kenya’s (85 percent), and Zambia’s (62 percent) as reported by Smale and Jayne (2003). Existing studies in Malawi have shown the existence of a correlation between hybrid seed use and farmer’s wealth as well as other indicators of household socioeconomic status (Chirwa 2005, Doss 2006, and Udry 2010). The findings of Simtowe and Zeller (2006) indicated that access to credit has a positive impact on hybrid maize adoption among farming households.
1.2 Input subsidy programs

The low adoption of improved farm inputs has been observed for many years in Malawi. Amongst the several factors that are considered to be responsible for low adoption poverty ranks highly. To that effect government increased efforts to support farmers through input subsidies and extension advice. The country implemented credit subsidies and input subsidies from the 1970s to the 1990s. However, they were discontinued following the structural adjustment programs (SAP) recommended by the IMF and the World Bank in the 1990s (Chibwana et al., 2010). The removal of subsidies resulted in major household and national food insecurity problems throughout much of the 1990s, and this caused government to revisit subsidy programs focusing on fertilizer and seeds.

Changes in policy in the early 1990s removed farm input subsidies, resulted in food deficits at both national and household levels (Levy 2005). In the 1998-1999 growing season government introduced the Starter Pack program whose goal was achieving food security at both national and household level (Harrigan 2008). The program gave poor small-scale farmers, free of charge, 15 kgs of fertilizers, and the needed amount of maize seed and legume seeds to be used on a 0.1 ha piece of land. At first, the program was designed as a universal subsidy targeting all smallholder farmers in the country. However, during the early 2000s the program was changed and it only targeted the poorest farmers hence called Targeted Inputs Program (TIP). The year 2005 saw another policy change which brought back the large scale farm input subsidies, and this time the program was named Farm Input Subsidy Program (FISP). The objective of this program was to assist poor smallholder farmers to access improved farm inputs like
fertilizer, hybrid seed as well as pesticides at reduced prices. The FISP targets poor small-scale farmers and vulnerable groups of the communities who have land for cultivation. The main goal of the program is to boost food security by increasing the number of small-scale farmers who access and use improved farm inputs (Malawi Government 2006). It was also hoped that exposing farmers to improved agricultural technologies would enable them to appreciate their desirable characteristics, thereby advancing farmers’ adoption of the new agricultural technologies.

The adoption of improved farm inputs’ plays an important role in the development process. However, even though modern agricultural production systems have significantly increased productivity in agriculture and facilitated economic growth for developing countries, Malawian farmers have not adopted them as has been the case in many place around the world and within the region. Poverty and income fluctuations among the farming communities have been cited as reasons for this trend. In addition to that, other papers have reported that inaccessibility of credit facilities has also negatively affected the adoption of these improved farm inputs. Consequently this has affected economic growth and development of the country as well as smallholder farmers as adoption is positively correlated with wealth (Simtowe & Zeller 2006). Surprisingly Chibwana (2010) observed that some of the beneficiaries who received FISP coupons ended up selling them in exchange for cash. This raises questions pertaining to the effectiveness of FISP in increasing adoption of improved agricultural technologies among the targeted beneficiaries.
1.3 **Problem statement and justification**

Despite of government efforts in stimulating use of new farming technologies and improved farm inputs and modern farming methods, adoption levels of hybrid seeds remain lowest in the region, estimated to be between 35 percent to 45 percent (Smale and Jayne (2003). Due to the increasing costs of farm inputs and dwindling donor budget support, there is an increasing pressure for government to consider discontinuation of the FISP subsidy program. Current literature does not reveal what the impact of phasing out the FISP program would be on the demand for improved farm inputs. As such this study attempts to estimate what the demand for improved farm inputs would be in the absence of subsidies.

Other researchers who have been measuring adoption of improved maize hybrids in Malawi have been using survey data and secondary data, none of them used experimental design. This study was instituted to measure the adoption of improved maize varieties using a different approach, the experimental method. It is expected that the findings will help government and other stakeholders in the agricultural sector to plan for alternative ways of promoting and boosting adoption of improved maize varieties by helping communities embrace the use of agricultural technologies in absence of subsidies. The study defined adoption as the level at which farmers embraced the use of hybrids in the absence of FISP which has an obligatory effect on the farmers’ part to use hybrids as per the objectives of the FISP. This question was considered as most important, as many stakeholders are advocating for phasing out of the costly and unsustainable (FISP) program.
1.4 Objectives

1.4.1 Main objective

The overall objective of the study is to estimate the adoption of hybrids in the absence of subsidies and understand the effectiveness of FISP in improving adoption of improved farm inputs.

1.4.2 Specific Objectives

- Assess the targeted farmers’ willingness to pay for different packages of fertilizer and maize varieties.
- Assess the factors affecting decision making in adopting maize varieties.
- Assess the effectiveness of subsidies for the long run adoption of the improved maize varieties.
CHAPTER II
LITERATURE REVIEW

2.1 Technology Development

In most developing countries, especially in Africa agriculture contributes a good share of the economy’s GDP, but agricultural productivity remains low (Kotu, 2000). In as far as economic development is concerned in these countries increasing agricultural productivity is critical (Katinila, 1998). In many countries research has shown that use of improved farm inputs increases significantly productivity in agriculture (Harrigan 2008). There are many factors that are responsible for low adoption of improved farm inputs. Some of the reasons include the following: Firstly; lack of information. Simply, those farmers are not aware of the existence of certain technologies and the advantages associated with the use of such technologies. This lack of knowledge may lead to misconceptions of the benefits and costs of using improved farm inputs. Secondly it is lack of access to markets. Even though some farmers know the technologies and their advantages, unavailability of the technologies on the market at a time when they are needed can be another challenge. This can result in farmers opting for alternative available options on the market or resorting to use of local varieties in the case of seeds. A third reason is related to the profitability of the improved technologies in the context of smallholder resource poor farmers, given the complex nature of decision making process resource poor farmers face in allocating their resources like land, and labor in agricultural
and nonagricultural undertakings. Chirwa (2005), noted that as researchers, when we see that farmers haven’t adopted a particular technology it is not advisable to conclude that they would have been better off if they did, because farmers have a lot of challenges that they face which we need to understand. He argued that the focus should be on broader issues of how to increase their agricultural productivity.

The study by Chirwa (2005) in Malawi, also outlined factors that are responsible for low adoption of improved farm inputs by poor small-scale farmers. He observed that the probability of adopting improved farm inputs increased with the level of education, plot size cultivated, and non-farm incomes. Additionally, he also observed that adoption was low in female headed households, and in cases where distance to market places where farmers access the farm inputs was long. Specifically on hybrid maize, he reported that the probability of adopting hybrid maize seeds increased with market-based land tenure systems, membership to a club or an association and also soil fertility. However the probability of adoption decreased with farmers’ age, and distance from the markets.

Stein and Mangison (2013) reported that the susceptibility of maize to droughts, may render the Malawian economy and households vulnerable and the situation may be aggravated with the continued population growth and the increasing climatic variability. They therefore pointed out that developing maize varieties that are drought tolerant may be one way to minimize the effects of climate change. Many researchers including Wiggins and Leturque (2010) have indicated that among the many factors responsible for low agriculture sector performance in Sub-Sahara African countries the major one is limited production potential, as a result of environmental degradation, soil fertility decline, and government and market failures.
2.2 Impacts of subsidies on developing economies

Takeshim and Lee (2012) defined a subsidy as a payment made from a public resource that reduces the price that the buyers pay for goods or services. It is the difference between the seller’s price and what the buyer actually pays. Some analysts consider subsidies as a negative tax. Meaning that the subsidy’s effect on quantity that is produced and consumed in an economy is an opposite of the tax effect in the economy. Generally with subsidies quantity demanded is increased. For instance, farm input subsidies enable farmers to pay prices for commodities like fertilizers, seeds, chemicals and farm equipment at a price lower than their market price.

Most countries have used input subsidies including those in sub-Saharan Africa (SSA). The commonly mentioned objectives of using subsidies include the following:

- Improving the affordability of inputs to targeted poor small-scale farmers who otherwise would not have managed to procure the inputs at the prevailing market price. This increases the quantity demanded of the inputs.

- Increasing farmers’ access to the inputs. Sellers bring their goods to areas where they know that they will sell. With subsidies, sellers have an opportunity that even rural farmers who would otherwise be out of question would be able to buy if the goods are taken to within their proximity. This therefore helps to increase farmers’ access to farm inputs.

- Sensitizing farmers on the use of improved farm inputs which are in most cases more profitable than the traditional ones. Farmers who are exposed to the improved farm inputs get an opportunity to appreciate the advantages of using them.

- Providing social protection to underprivileged groups in the society by increasing the productivity of their farms through and access to improved inputs and food as well as restoring the fertility of their farms.

- Reducing economic burden on vulnerable groups in the society due to the rural-urban income disparities by raising their agricultural productivity and food security.
In many economic circles, subsidies are generally regarded as investments that are less than optimal allocation of scarce resources. Other schools of thought tells us that input subsidies may result in an over-supply of inputs to users who might not be able to use them productively and this results into a deadweight loss to society. This deadweight loss might be explained as a loss of economic efficiency, as a consequence of misallocating scarce resources, where inputs are provided at a cost higher than the value they create or inputs are used by inexperienced farmers who get lower value from the inputs used than the cost incurred in buying the inputs (Fan, Thorat & Rao 2004).

Dorward et al. (2011) indicated that input subsidy inefficiency occurs for a number of reasons. One such a case is when public funds used for distributing subsidized farm inputs are from annual government budgets or grants offered by development partners. These funds usually have an associated opportunity cost like using them in many other ways which may bring greater socio-economic benefits to the society than benefits derived by the society in using the resource through subsidy inputs. Such those alternatives can include using the funds to support research or decrease the tax burden on citizens as well as firms while promoting investment into other productive activities.

The predictable wisdom as regards input subsidies, entails that their use mostly leads to market distortions. It is generally expected that input markets with no subsidies are most likely to enable governments, as well as the private sector to invest in more productive activities which can generate higher returns and more benefits to the society. Other sources and types of inefficiency that arise from subsidies, involve cases where the subsidy amount is aimed at reducing the cost of production for goods that can be
produced even without the subsidy. This results in a very small change in the input demand. At the same time this behavior crowds out purchasing of unsubsidized inputs.

A study by Ricker-Gilbert, Jayne and Chirwa (2011) indicated that input subsidies would be expected to shift out demand curves for affected inputs. This means that at any given price, the quantity demanded of affected inputs would increase compared to the quantity demanded in the absence of subsidies. The paper also pointed out that a shift out of the input demand curve may imply that more farmers are using the inputs and have become more efficient and productive as a result of using the improved farm inputs. In a similar manner, the paper indicated that subsidies can also shift out the supply curve for inputs. This may come about as a result of enlarged scale of business by agro-dealers as they strive to meet their growing demand of inputs. Dorward A. (2009), reported that in certain instances, more especially where land and labor are scarce, inputs (fertilizer and seed) subsidies can at initial stages increase demand for land and labor thereby raising their prices and at a later stage the higher the prices of these complementary inputs the more they inversely affect input demand. And under such circumstance the benefits of subsidies are partly transferred to land owners and labor providers.

Ricker et al. (2011) gave an illustration of potential deadweight loss that can be observed in subsidy implementation due to factors like poor beneficiary identification, corruption, and inexperience of farmers in using improved farm inputs. They used an example from the 2006/07 Malawi inputs subsidy program. They made an illustrative example based on simplified assumptions regarding how the fertilizer market works in Malawi. In their illustration they only showed the case of government distributed fertilizer and they applied a subsidy rate of 25 percent. A Government of Malawi (2006)
report indicated that 185,000 metric tonnes (mt) of fertilizer was used in the subsidy program. The researchers assumed a fertilizer elasticity of supply of 4.0 which was consistent with estimates from other papers like that of Quizón J & H Binswanger (1986). They also used the exchange rate of US$ 1.00 equivalent to MK 130 in that year. The paper assumed that in absence of subsidy (zero subsidy) and also where government distributed fertilizers just like private firms, then fertilizer amount of 167,060 mt would be supplied and bought by farmers at US$ 525/mt. But putting the subsidy rate at 25 percent, then the demanded quantity of fertilizers increases to 185,000 mt, while the price of fertilizer that farmers pay drops to US$ 404/mt. This consequently, leads to an increase in the supplying cost for the unsubsidized fertilizer to US$ 538/mt. As a result total cost of subsidy program was estimated to be US$ 24.9 million where farmers captured US$21.4 worth of subsidized fertilizer, while suppliers of fertilizer captured $2.3 million from the increased quantity supplied and price. The amount captured by farmers and the suppliers added was less by US$ 1.2 million from the total amount incurred in subsidy program. This amount represented an economic loss to the society which was referred to as deadweight loss.

In view of these various aspects surrounding subsidy effects on economies Dorward et al. (2009) recommended that input subsidy programs should be designed and implemented with a good understanding of issues like: the strategic development objective that government would like to achieve with the subsidy program (i.e., enhancing productivity to achieve food security through increased use of improved farm inputs; poverty reduction in poor farming families through reduced costs of improved farm inputs; private sector development through enhanced input supply network.
Similarly Ricker et al. (2011) emphasized that in designing the subsidy programs it should be taken into consideration whether firstly, the subsidy will result into an outward shift of demand curve or not and secondly if demand is increased whether there will be sufficient capacity to supply the inputs. This is a very important aspect in the case of Malawi as input supplies tend to be low at peak periods when farmers have received their subsidy coupons which results in farmers buying farm inputs not of their choice but for convenience.

2.3 Malawi farm input subsidy program

The policy of subsidizing commodities has been debated ever since the end of colonial era in Sub-Saharan Africa (SSA). The challenge is that a large proportion of the population in these countries are engaged in agricultural sector. The debate has been around two conflicting policies where the first one is about increased protectionism of the strategic sectors of the economy while the second policy is about the free market model where an invisible hand is regarded as the best in achieving market efficiency. Both these theories have availed a big challenge for developing countries to support.

Malawi introduced input subsidies as part of an agricultural based development policy around early 1960s. Malawi’s main staple food crop continues to be Maize, for the rural as well as urban consumers. Maize preference as the main source of food continues to grow and this may partially explain why the (FISP) appears to have been consistently offered over the years since the 2005/6 agricultural season. Higher domestic maize production has reduced the need to import maize as used to be the case in previous years due to low production which was unable to meet the country’s demand.
Agricultural growth in Malawi is seriously constrained by prevailing poverty levels. The implementation of initiatives like the starter pack program (SPS) initiated in 1998 changed the track record of previous development programs (Dorward, Andrew and Chirwa, 2009). In 2002, the program was changed into the Targeted Input Program (TIP) which was further refined and transformed into the current Farm Input Subsidy Program (FISP) in the year 2005/06 growing season. Implementation of these programs is a clear testimony that government recognizes that poverty is the dominating factor influencing low adoption levels of improved agricultural inputs and diversified agricultural technologies. The country’s Welfare Monitoring Survey report (2009) indicated that 52% of the Malawian population is categorized as poor, consuming less than a dollar per day. The input subsidy programs implemented by government have been aimed at promoting the adoption of improved farm inputs i.e. hybrid varieties, fertilizers and modern farming methods. However, due to partly diminishing land holdings, productivity by smallholder farmers remains low.

If significant improvements in agricultural production are to be achieved then the use of improved inputs by Malawian farmers is of great importance. Failure to adopt improved inputs by large numbers of poor farmers will leave them exposed to hunger or worse (Melinda and Phiri 1998). It is against this background that the Government of Malawi demonstrated significant efforts to invest in agriculture as a necessary condition

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1 This is evidence that the government believes farmer willingness to pay for improved inputs is often less than the market price. The assumption is that the low willingness to pay is due to poverty. This is a reasonable assumption but there are other possible explanations. For example, farmers’ concern about the risk of drought may be another reason. This topic can be the subject of future research.
for the growth of the economy. This resulted in the initiation of FISP in the year 2005/06. In recent years, FISP implementation coupled with good rains has significantly led to an increase in maize production at national and household level i.e. increased maize production from 1.2 million metric tons in 2004/05 to 3.7 million metric tons in 2008/09 (Malawi Government 2009). The country achieved notable differences in production as it transformed the country from a net importer of maize to a net exporter of maize in the year 2008/09, and this resulted in achieving household food security. This also brought about some price stabilization for maize.

Stein and Mangison (2013) assessed the effects of drought on the performance of different maize varieties in Malawi. They observed that impacts of the dry spells were that maize yields on average was reduced by about 400 kg/ha. They noted that most of the commonly used hybrid varieties in Malawi performed considerably better than the local variety, with the hybrid varieties yielding around 600 kg/ha more than that of local variety. They also observed that another hindrance to adoption was inaccessibility of the preferred varieties of maize, with about 35 percent of the sampled farming households stating that they were unable to get their preferred seed varieties in the 2011/12 season.

Ellis (1992) noted that in agricultural development common arguments pertaining subsidies mostly focus on the increasing productivity in the agriculture sector productivity through the use of new and improved farm inputs. In the early days of the 2011/12 rainy season the country was hit by a dry spell and this resulted in the scaling down of the FISP program due to shortage of foreign exchange which was channeled for other national programs. The high cost of the FISP program driven by high fuel prices on the international market as well as fertilizer prices makes the FISP a heavy load to carry
for the Malawian government. Worse still donor support for the program has decreased as many donors see the program as unsustainable temporary solution and have since asked the Government of Malawi (GoM) to develop an exit strategy. However, the high demand within the country for continuing the program has made it very difficult for the country’s politicians to commit to such an exit strategy.

Bates (1981) postulated that failure of agricultural sectors to reach their full potential in Sub-Saharan Africa is partly because of the political atmosphere where governments’ and farmers’ interests conflict. The paper further reported that there has been a general observation that subsidies results into market equilibrium disturbances, strain government budgets and lead to problems in developing economy’s ability in repaying its debts. Denning et al., (2009) noted that subsidies were only successful in Kenya where there was a significantly level of infrastructure development and also farmers were at a certain threshold of financial stability. However, other studies revealed that subsidies increased farm inputs uptake. Recently, agricultural input subsidies have regained popularity in several African countries after several decades of condemnation by the World Bank and other international institutions. Denning et al. (2009) reported that Malawi within a short period of time managed to turn the country from perennial food deficit into a food surplus nation. This prompted other countries like Ghana, Kenya, Nigeria, Zambia, and Tanzania to adopt similar programs (Dorward, Andrew and Chirwa, E. (2009). In addition to the fact that subsidies seem to be helping in achieving food security, these nations noted that developed countries have not stopped subsidizing their farmers. Furthermore, the policy of baring subsidies assumed that African countries
would invest the resources saved from subsidies in key sectors like roads and infrastructure, which did not take place.

Ricker-Gilbert and Jayne (2008) assessed the impacts of the FISP in Malawi and how the program affected the commercial market price of farm inputs. They found out that subsidies had a crowd out effect on commercial fertilizer such that a 1 kilogram increase in subsidy fertilizer reduces the quantity of commercial fertilizer purchase by 0.61 kilogram. Similarly, Dorward et al. (2008) found that subsidies displaced about 30 – 40 percent of commercial fertilizer in the 2006/7 growing season. They recommended that the GoM should make sure that subsidies were strictly targeted to households without effective demand so that the program does not crowd out commercial fertilizer purchases. Peters (2004) raised a concern that an increased input subsidy program would cause a risk of beneficiary dependency. He therefore, recommended that the program should be used as a temporary solution and it should as much as possible target the neediest farmers who on their own could not otherwise afford to purchase the farm inputs.

2.4 Types of crops

The Integrated Household Survey I (2010) reported on the types of crops cultivated in Malawi and it revealed that 35 percent of the acreage in Malawi is cultivated to local maize, followed by 32 percent used for OPV or hybrid maize cultivation. Traditionally, maize production among smallholder farmers in Africa has been based on retaining and using the OPV seeds from year to year. Breeding of improved OPVs targets achieving certain special characteristics among which include drought tolerance as well as disease resistance. Normally farmers can recycle seed for up
to three years before substantial loss in yield can be observed, which usually range between 10%–25% less than hybrids. In OPVs seed production is usually through random pollination of silking plants by pollen from the tassels of other plants. This process can include farmers’ varieties as well as improved varieties developed by seed companies through synthetic or composite breeding strategies.

Unlike the OPVs, hybrid maize is developed through breeding programs that target certain traits or attributes in maize. This process results in seeds that display hybrid vigor, which is not the case with hybrid seeds that have been recycled as they do not breed true to type. In succeeding years recycled hybrids result in yield losses of 30 percent or more. This consequently reduces or perhaps eliminates any potential hybrid yield advantage in subsequent planting. The breeding program of hybrid maize in Malawi was launched by the GoM in the year 1950s, after the country was severely hit by drought in 1949. By 1958, first hybrid seed was released on the market and by early 1990s the adoption rate was 25% by the smallholder farmers. Since then, various research papers have indicated that at all rates of fertilizer application hybrids perform better than all other varieties even under low soil fertility conditions and in a drought year.

During the second year of FISP implementation in Malawi, coupon beneficiaries had a chance to choose between OPVs and hybrid packages which were packed in 2 kg pack for hybrid seed and 3 kg for improved OPVs. Smale et al, (2013) reported that based on coupon redemption, hybrids were favored over OPVs as 76% of farmers choices were for hybrids over OPVs. This observation clearly indicated that most farmers in Malawi strongly prefer hybrids over improved OPVs as long as the prices for both seed varieties and fertilizers are subsidized.
But worth noting is the fact that Malawians have a distinctive preference in consumption towards the flinty varieties of maize which is commonly known as “local maize variety.” This variety is preferred by many because of its attributes and can efficiently be processed and produce fine white flour, normally preferred for Msima (thick porridge) consumed in the country. The preferred attributes include hardness of the grain which is known to be resistant to weevil attack in storage than most of the other varieties (i.e. hybrids). For this reason, until recently hybrid variety was promoted as a cash crop, but due to increasing cases of food insecurity among many Malawians some substitution of hybrid maize for local varieties in consumption is becoming common.

2.5 Fisp Implementation

The administration of the FISP is done through coupons that are given to eligible smallholder farmers to enable them to purchase fertilizer, pesticides and maize hybrid seed at reduced prices (Malawi Government 2006). The program beneficiaries are poor small-scale farmers who own land and are residents of their particular villages within Malawi (Malawi Government 2006). Selection of beneficiaries involves village heads and members of Village Development Committees (VDCs). The criterion is that priority should be given to “vulnerable” groups in the community. FISP reaches about 50% of farmers in the country with hybrid maize seeds and fertilizers. In other instances, vouchers are issued for fertilizers to be used in tobacco production (Wadonda Consultant 2008). In 2008, two coupons were provided for maize fertilizers, one coupon for a 50kg bag of 23:21:0 +4S basal fertilizer and another for a 50kg bag of urea. Initially the program supported the use of (OPVs) maize seeds but subsequently emphasis is going towards the use of hybrid maize varieties (Malawi Government 2006).
During the 2008–2009 season, the identified beneficiaries received two coupons, which enabled the households to purchase 100 kilograms of fertilizer, and two kilograms of free hybrid maize seed or four kilograms of OPVs. During the same period some farmers received coupons which they used to purchase 100 kilograms of fertilizer used for tobacco cultivation. A total fertilizer amount of 150,000 tons was made available for maize growing farmers, while a total of 20,000 tons were set aside for tobacco growing farmers in the 2008/09 growing season. These fertilizer quantities were procured by the GoM to distribute to poor small-scale farmers through the FISP (Wadonda Consultant 2008). The total cost of this program in that year was estimated at US$221 million and 95 percent of this cost was borne by the GoM while the remaining 5 percent was shouldered by the country’s development partners.

2.5.1 Fisp administration

During FISP coupons distribution government officials go through all the districts in two rounds in a growing season. The second round mostly attempts to respond to unmet demand for coupons after the first distribution round (Wadonda Consultant 2008). Dorward and Chirwa (2009) reported that the staff of Ministry of Agriculture and Food Security (MoAFS), Traditional Authorities (TAs) and local government officials carry out different roles in FISP implementation at national and village level. These officials work with VDCs and other stakeholders at community level to identify beneficiaries of the coupons. Beneficiaries redeem the coupons for the improved farm inputs specified on the coupon at a highly discounted price. Over time there has been a huge disparity in the criteria for determining priorities, beneficiary selection and also numbers of beneficiaries for the coupons. The systems used to determine the amount and distribution of
supplementary coupon distribution rounds, intended to supplement the unmet demand in
the first round are not clear (Dorward et al. 2009). The 2005/6 program which was an
inception year for the FSP was widely considered as a success and it was politically very
popular and accordingly continued in following years, with some changes in the design,
implementation and even scale of the program.
CHAPTER III
CONCEPTUAL FRAMEWORK

Assume farmers are expected utility maximizers. Assume also that there is only one output, and farmer’s production set can be described by a production function \( f(z) \), where \( f(z) \) represents the quantity of output \( q \) produced after using input vector \( z = (z_1, \ldots, z_m) \). Therefore, the connection between output \( q \) and inputs \( z \) can be given as \( q = f(z) \).

If we let \( p > 0 \) represent the price of output and \( w = (w_1, \ldots, w_m) \geq 0 \) be the prices of the \( m \) inputs, then \( (w \cdot z) \) is the cost of using input vector \( z \) and \( (p \cdot q) \) is the farmer’s revenue. Thus a farmer’s maximization problem can be written as

\[
\max_z EU(A + pq - w \cdot z)
\]  
\[
n.s.t: q = f(z)
\]  

where \( A \) is initial wealth. We assume that marginal utility of wealth is positive, i.e. \( \partial U/\partial A > 0 \), however we allow for risk averse, neutral, or loving behavior as the sign for \( \partial^2 U/\partial A^2 \) is left unrestricted. The farmer’s problem can be written in terms of the unconstrained maximization problem as

\[
\max_z EU[A + pf(z) - w \cdot z]
\]

The first order conditions then are

\[
\frac{\partial E[U]}{\partial z} = E[U'(pf_z - w)] = 0
\]
where \( f_z \) indicates the first derivative of the production function with respect to input \( z \).

Given that \( U' > 0 \), this leads to \( p f_z - w = 0 \) or \( p f_z = w \). The left side of the last equality is the marginal value of the product (MVP). The right side of the last equality is the marginal factor cost (MFC). Thus, the last equality is the well-known condition \( \text{MVP} = \text{MFC} \).

Input subsidy programs reduce the cost of inputs, \( w \) thus reducing MFC. The requirement that \( \text{MVP} = \text{MFC} \) then means, that in the presence of input subsidy programs and reduced MFC, MVP will also need to be reduced. A reduced MVP can be achieved by increased usage of the input. As a result, farmers would use more inputs when the cost of inputs is subsidized.

The focus of our research is to determine farmers’ WTP for improved inputs in the absence of subsidies. One way to address this question is to think of farmers as consumers of inputs and use consumer theory to derive willingness to pay (WTP) measures. Lusk and Hudson (2004) indicated that WTP is a Hicksian surplus measure which can be expressed in a number of equivalent ways. One way of expressing WTP is to consider utility maximization problem of consumers subject to a budget constraint. The other alternative is expenditure minimization (Hanemann, 1991) subject to a utility constraint. In this scenario, farmers are the consumers of farm inputs, regular and improved inputs. The farmer is faced with preferences for a variety of farm inputs. Assume the consumption of inputs is denoted by a vector \( x \) and one additional input denoted by \( r \). In agribusiness applications Lusk and Hudson (2004), argue that \( r \) is more relevant to be considered as a measurement of the quality of the farm inputs. Further, it is assumed that the consumption of \( r \) is exogenously fixed, and farmers can vary the
consumption of $x$ freely (Hanemann, 1991). In other words, farmers take the level of $r$ as given however they choose the level of the inputs $x_n$ that maximizes their utility, there by yielding an ordinary Marshallian demand function $x_n(s, y, r)$ with $s$ being the vector of input prices and $y$ income. An indirect utility function can be derived as $\nu(s, y, r)$ (Lusk and Hudson, 2004; Hanemann, 1991). Now assume that the input $r$ is available in two qualities, a regular quality, $r_0$ and an improved quality $r_1$. The value that farmers place on quality improvement can be determined by measuring the willingness to pay in such a way that the following holds: $\nu(s, y - \text{WTP}, r_1) = \nu(s, y, r_0)$.

Alternatively, one can derive the farmer’s WTP for an improvement in the quality of an input as follows. Assume that a subsidy program covers the difference $C$ in the cost between the improved quality input, $r_1$ and the regular quality input $r_0$. For farmers who adopts the improved quality input means that an improvement in their maize yield from $q^0$ to $q^1$ while output price and cost of other inputs remain constant ($s, w$). Then the farmer’s utility changes from $u^0 \equiv (s, w, q^0)$ to $u^1 \equiv (s, w, q^1) \geq u^0$ (Hanemann, 1991). In that case, a measure which aims at making the farmer as well off as they were before the change in quality ($u^0$) can be represented by $\nu(s, y - C, q^1) = \nu(s, y, q^0)$. The measure $C$ is also referred to as compensating variation. In other ways, this denotes a measurement of the value an individual attaches on improving quality of the produce, and can be obtained by determining the extent of WTP that will enable the following equality hold (Lusk and Hudson, 2004): $\nu(s, w - \text{WTP}, q^1) = \nu(s, w, q^0)$. In this case the farmer should be willing to pay $C$ so as to gain the quality change.

Aryal et al. (2009), indicated that farmers’ WTP for agricultural goods or services is influenced by factors like knowledge, intentions and attitudes (see Figure 1 below). In
reality, knowledge and attitude towards a commodity are influenced by available information. They mentioned that attitude toward an agricultural service is affected by socioeconomic factors such as gender, age and one’s income which shape their WTP. Additionally, characteristics of available markets such as their accessibility and prevailing prices also affect the purchase behavior and consequently farmers’ WTP.

Figure 3.1 Farmers’ WTP for agricultural services

Source: Adapted from Aryal et al. (2009)
4.1 Experimental Procedure

The experiment was designed to elicit producer’s *value preferences* for three input packages. Each of the three packages consisted of maize seed and fertilizer. The maize varieties include hybrid varieties, open pollination varieties (OPVs) and local varieties while the fertilizers include basal dressing and top dressing fertilizers. Therefore, the first package consisted of 5 kgs of hybrid maize, 50 kgs of basal dressing fertilizer and 50 kgs of top dressing fertilizer. The second package consisted of 8 kgs of OPV, 50 kgs of basal dressing fertilizer and 50 kgs of top dressing fertilizer, and the third package consisted of 10 kgs of local maize variety, 50 kgs of basal dressing fertilizer and 50 kgs of top dressing fertilizer. Participants were given an endowment in the amount of MK40,000 (US$100) they could use in bidding for each of the three packages.

All the packages were displayed and shown to the participants. Participants were asked to submit a single bid per package. They were also informed that even though they would be submitting three bids, they could only win up to one package. After participants submitted theirs bids, a random price was determined for each of the three packages. Possible prices per package were determined in MK100, ranging from MK0.00 to MK40,000. Any given price within this range had an equal chance of being drawn. Participants whose bids were higher than the randomly determined price would
be eligible and required to buy that package. If a participant was eligible to buy more than one package the moderator determined the package the participant would buy. After the experiment an exit questionnaire was administered.

The BDM mechanism has been shown to be incentive compatible by many researchers and is one of the most popular methods for revealing WTP (Lusk, Alexander and Rousu 2007a; Lusk, Feldkamp and Schroeder, 2004b; Morone 2010; Marette and Roosen, 2010; Corrigan and Rousu, 2011). The phrase “incentive compatible” means that each of the bidders has a weakly dominant strategy for determining the value they place on the product, which leads to more accurate true values of products. As long as the market price is free from the consumer’s bid in the experiment, then the auction methods can fulfil the incentive properties.

The BDM mechanism is differentiated from other auction mechanisms by a number of factors which include the following: bidders do not compete against each other; all bidders are qualified to win numerous products they bid on; and participants are informed that they may buy a product at the bid \( b_i \), and the winner of the auction is determined as follows. If \( b_i \) is greater than or is equal to a randomly drawn market clearing price \( r \) determined by experimenter, then the bidder wins the auction and acquires the product by paying the randomly drawn price \( r \) and not the bid price and retains the remainder of their allowance. If \( b_i \) is smaller than the randomly drawn market clearing price \( r \), the bidder does not acquire the product but retains their endowment allowance. Participants are assumed to maximize utility by bidding the price which represents their true value of the product. If they understate their true WTP for a product, they jeopardize their chance of obtaining the product and thus are not maximizing their
utility \((b_i < r < WTP)\). If bidders overstate their WTP, they increase their chances of purchasing the product but at a price that exceeds their true WTP, which is also not utility maximizing \((WTP < r < b_i)\) (Wertenbroch and Skiera, 2002).

Three basic methods have been used in eliciting consumer’s willingness to pay. These methods include experimental auctions, personal interviews as well as mail surveys (Umberger et al., 2002). Among these methods, the commonly used method in finding WTP estimates are conjoint analysis, contingent valuation as well as experimental auctions. The contingent valuation and conjoint analysis methods are said to be hypothetical methods of valuation because they use responses form a survey questionnaire to estimate consumer’s willingness to pay. Different from that, experimental auctions can be used to determine consumer’s WTP for a good or service in a more or less real condition.

Originally contingent valuation methods were used in determining environmental as well as public goods value. Later on the method was extended to be used in determining willingness to pay for private goods particularly goods whose markets do not yet exist. Maynard and Franklin (2003) indicated that contingent valuation measures WTP for non-market goods by constructing an imaginary market for that good. They also mentioned that the method is very good at estimating people’s WTP for food attributes. The main challenge associated with this method (contingent valuation) is hypothetical bias. However, Lusk and Hudson (2004) pointed out that the method can work properly in agribusiness applications which makes them to be incentive compatible since the products involved or being valued mostly are deliverable. To that effect, experimental auction techniques are considered to have potential to provide more reliable estimates of
WTP as compared to the hypothetical survey method (Umberger et al., 2002). There are two ways one can conduct an experimental auction. In the first instance consumers are endowed with a pre-existing good which they desire and are asked next to bid to exchange this good with a another (new) good. In the second instance consumers are asked to directly and simultaneously bid for competing goods. Following this a random draw is used to determine which bid is binding (Lusk and Hudson, 2004).

Many stated preference methods involve individuals ranking, rating or choosing between competing products or alternatives hypothetically. This is so because it is assumed that people perceive no gain or loss from stating their preferences strategically as they think that their responses are inconsequential. As a result many applied economists have turned to experimental auctions to elicit consumer valuations of goods (Bohm, 1972; Lusk et al., 2001a).

In conducting an experiment, one of the most important thing is selecting the auction mechanism type. The commonly known auction mechanisms for measuring willingness to pay include: Dutch auction, English auction, \(n^{th}\) price auction, Vickery second price auction and the Becker-Degroot-Marschak (BDM) mechanism. Among them all, the English auction is the most widely used, where bidders place bids as long as someone is willing to pay higher than others. In a Vickery auction, the process is similar to the English auction only that in this case the winner pays the second highest bid price (Vickery, 1961). The Dutch auction, starts with a higher price and bidders gradually lower their bids and the auctioneer lowers the price until when a bidder’s desired price is reached and announces “buy”. At that point the auction ends and the bidder wins the bid at that price. In the random \(n^{th}\) price auction all bids are arranged from high to low and
the experimenter chooses a random number \( n \), then the \((n-1)\) highest bidder wins and pays the \(n^{th}\) price (Shogren et al., 2001). One unique thing about this auction type is that “market-clearing price” is decided endogenously (Shogren et al., 2001). Bidders are given an endowment to use in bidding, but they do not compete against each other (Becker et al., 1964). Perhaps this is the reason why Becker (1964) called it a mechanism and not an auction. A bidder wins the bid when their price is equal to or greater than the randomly drawn market clearing price. Similar to the random \(n^{th}\) price auction, the market price is determined by the experimenter with a pre-specified distribution (Lusk and Shogren, 2007b). This gives a chance to see each participant’s preferences and the value they place on each product.

Various studies have compared these mechanisms to see how they perform in terms of bidding methods. Shogren et al. (2001) reported that on-margin bidders from a random \(n^{th}\) price auction and Vickery second price auction winners set relatively similar product values when compared with off-margin bidders (i.e., bidders who bid too low or too high compared with the market price). Lusk and Shogren (2007b) indicated that the BDM mechanism, the Vickery \(n^{th}\) price auction, and the random \(n^{th}\) price auction provide accurate bids, but the BDM mechanism was a strong indicator of incentive compatibility. In the BDM mechanism, bidders do not bid against one another and this gives bidders a better chance of winning a bid (Lusk and Shogren, 2007b). Noussair et al. (2004a) compared the BDM mechanism and the Vickery auction based on three standards (biases, truthful bid and dispersion of bids). They concluded that Vickery auction was effective in revealing consumers WTP. However, Lusk et al. (2004) revealed that the BDM mechanism provides reasonable results because bidders have only one round of bidding.
In this research, the BDM mechanism was selected for many reasons. Among these are that the method is easy to understand bearing in mind that we are working with farmers with little or no education and also the fact that practice rounds are not necessary (Lusk et al., 2001b). Additionally, Rustrom (1998) indicated that the BDM mechanism is viewed by many researchers as incentive compatible, realistic and clearly understood by respondents, and in theory the respondent’s bid is equal to their value for the good (Shogren et al., 1994; Melton, Huffman, and Shogren, 1996., and Lusk et al., 2001). Furthermore, the BDM mechanism brings about fewer non-responses which results in less bias as compared to contingent valuation (Lusk et al., 2001b). It has also been widely used by many researchers like: Noussair, Robin and Ruffieux (2004b) who elicited consumers’ valuations on genetically modified food products in France; Evans (2008) who studied consumer perceptions and WTP for Appalachian grass-fed beef; and Xue et al. (2010) who estimated the consumer WTP for grass-fed beef in-store.

The BDM method involves engaging people to take part in the investigational session in which they play a part in several bidding rounds. In some instances, participants are cognizant of the distribution from which the values are drawn, but in other instances they are not informed. Players are notified that winning bidder(s) will receive an equivalent amount to the difference between their allocated endowments and the market price. The winning bidder(s) and market price may hinge on the particular auction mechanisms in question. In our case in BDM, people with bids higher than a randomly drawn price pay the random price and not the bidding price. Bidders whose bids are below the randomly drawn price do not win the auction but instead they earn US$100 (MK40, 000) endowment.
The principal incentive in risk neutral bidders, is the expected utility derived from submitting the bid, $bi$: $E[\pi_i] = (v_i - E[\text{Price}|(\text{winning}|bi)]) (\text{Probability of winning}|bi)$, where $E$ is the expectations operator and $\pi_i$ is individual $i$'s benefit or payoff from submitting $bi$ in an auction (Lusk 2004). Bidders expect to earn the change between their value for the good and the expected price paid conditional on winning the auction, which is conditional on $bi$. Assume we let each of $i \in [1, N]$ bidders values be drawn from a continuous distribution $v \in [0, \bar{v}]$ and cumulative distribution $F(v) = \text{Prob}(V \leq v)$.

Assuming unit demand bidders each report $b_i = v_i$, the complementary cumulative distribution of reported bids is $1 - F(b) = \text{Prob}(B \geq b)$. Assuming each unit demand bidder is willing to pay any price offered $p \leq b_i$, the corresponding density of $N$ willing buyers is $N(p) = \text{Prob}(B \geq p)N$. As discussed before, in the BDM framework, price is randomly drawn from a distribution $p \in [0, \bar{p}]$. Therefore, the aggregate demand of unit demanders facing a multiunit seller in the BDM auction framework is $Q(p) = N(p)$, where $Q(0) = N$, $Q(p) = \text{Prob}(b \geq p)N \forall p \in (0, \bar{p})$ and $Q(\bar{p}) = 0$ if all $N$ bidders $v < \bar{p}$ otherwise $Q(\bar{p}) = n \subset N(v \geq \bar{p})$. Because the true density of bidder valuations for a given product are unknown, the econometrician estimates $Q(p)$ from the sample bidding data. As censoring of bids from above does not appear to be a significant issue, a $4^{th}$ degree polynomial is a close and simple approximation for $Q(p)$ given the current sample data. Furthermore, fitting simple polynomial aggregate demand does not require choosing among numerous more complicated distributional functions (Laffont and Maskin, 1980).
4.2 Experimental Organization

The research was conducted on the 21st December 2014, a date prior to the planting season. This date was chosen so as to run the experiment concurrently with the normal government subsidy program to ensure that decisions were not affected by the influence of the government subsidy. The project was funded by USAID and the experiment was authorized by Mississippi State University Institutional Review Board for the protection of Human Subjects; reference (Protocol number 14-262). All participants were farmers who were selected using government criteria for selecting subsidy beneficiaries and an official from the Ministry of Agriculture was engaged to assist in the selection of participants. A picture of some of the participants participating in the experiment is shown in figure 1. The stages followed in the experiment are detailed below.

4.2.1 Stage 1

Participants identities were verified by the Ministry of Agriculture officer from the sample sheet.

4.2.2 Stage 2

The moderator distributed all forms which included the consent form, payment form, auction instructions and bidding form. A consent form ensures that all participants agreed to participate in the BDM experiment. When subjects arrived at the bidding room, they were asked to read through and sign the consent and the payment forms. Then, the moderator gave each participant a subject number to use in the experiment. They were also told the experiment had only one stage of bidding.
4.2.3 Stage 3

A moderator described the experiment and read through instructions for the study. According to Lusk et al. (2001b), the BDM mechanism does not require practice rounds. Instead, the research team gave examples, explaining how the experiment works. After that, the moderator answered participants’ questions. The moderator told participants that they can use the $100 (MK40,000) endowment given for bidding. According to the BDM mechanism, monetary allowances should be provided to all participants to stimulate participants’ WTP. During the experiment, participants were expected to submit three bids for the three maize packages. The bid range was set from $0.00 to $100 (MK0.00 MK40,000) per package. Such that a maximum bid of $100 (MK40,000) for any one maize package would utilize the entire $100 (MK40,000) endowment amount.

4.2.4 Stage 4

The three different types of packages were displayed on the table in the bidding room for all participants to see the products see Figure (4.1, 4.2 & 4.3) below.
Figure 4.1  Hybrid maize; Top and Basal Dressing Fertilizer

Figure 4.2  OPV maize; Top and Basal Dressing Fertilizer
4.2.5 Stage 5

After observing each package, participants placed bids for each of the three different packages of maize varieties. The bids were in Malawi Kwacha ranging from MK 0.00 to MK40,000. After all participants had finished placing bids the moderator collected all bidding forms.

4.2.6 Stage 6

Participants attended an exit interview administered by the research team comprised of the author and two additional MSc in Agricultural Economics students from Mississippi State University (see figure 3 below).
Figure 4.4  Research team conducting the exit interviews

Figure 4.5  Research team conducting the exit interviews
The interview questionnaire administered elicited information such as demographic characteristics, farmers’ variety preferences, farming experience, and also cropping patterns (see appendix). The demographic section included questions regarding age, gender, income, and education. The exit interview questionnaire was aimed at examining how farmers’ values for the maize varieties was affected by different individual characteristics. After finishing the experiment, participants were treated with snacks and soft drinks.

4.2.7 Stage 7

To determine the BDM winners, the moderator entered the bids in an excel sheet with pre-determined random market clearing prices for the packages. If an individual had more than one winning bid the moderator determined randomly which package the bidder would be allowed to purchase. For each participant’s winning bid the random market price was subtracted from their MK40, 000 endowment and bidder went away with the remaining balance plus the package.
4.3 Empirical Model

4.3.1 Factors affecting producer’s WTP for different maize varieties

The Tobit model (Tobin, 1958) will be employed to analyze factors that affect producer’s WTP for the maize variety packages. The Tobit model is specified as follows:

\[
V_{ij} = \beta_{ij0} + \sum_{k=1}^{K} \beta_{ijk} \text{Pref}_{ijk} + \sum_{h=1}^{H} \beta_{ijh} \text{Exp}_{ijh} + \sum_{l=1}^{L} \beta_{ijl} \text{Farm}_{ijl} + \sum_{m=1}^{M} \beta_{ijm} \text{Dem}_{ijm} + \epsilon_{ij}
\]

(4.1)

\[
B_{ij} = \begin{cases} 
0 & \text{if } V_{ij} \leq 0, \\
V_{ij} & \text{if } 0 < V_{ij} < 40,000, \\
40,000 & \text{if } V_{ij} \geq 40,000 
\end{cases}
\]

(4.2)

where \(i\) represents individuals (\(i = 1, \ldots, I\)), \(j = 1, \ldots, 3 \in \{\text{hybrid maize package, OPV maize package, local maize package}\}\), \(V_{ij}\) and \(B_{ij}\) denote the value (a latent variable) and the bid (the observed variable) of individual \(i\) for package \(j\) respectively, \(\text{Pref}\) is a vector of dummy variables of individual \(i\)'s preferences for package \(j\), like yield preferences,
response to fertilizer and ability to move participants’ households standard of living closer to the standard of living of well-off households, \( \text{Exp} \) is a vector of dummy variables controlling for individual \( i \)'s experience in growing maize, experience growing each of the three types of maize varieties, and use of the different maize varieties in the previous year, \( \text{Farm} \) is a vector of continuous and dummy variables capturing individual \( i \)'s farm characteristics like farm size and use of fertilizer for different maize varieties, \( \text{Dem} \) is a vector of dummy variables controlling for individual \( i \)'s demographics like age, gender, education, and family size, \( \beta \)'s are the parameters to be estimated, and \( \varepsilon_{ij} \) are the error terms which are assumed to follow \( \varepsilon_{ij} \mathcal{N}(0, \Sigma) \) where \( \Sigma \) is a block-diagonal matrix, \( \Sigma = I \Omega \), \( I \) is an \( I \)-dimensional identity matrix, and \( \Omega \) is 3x3 matrix of cross-equations correlations.

4.3.2 Aggregate demand analysis

In the auction experiment, bidders (experimental subjects) were presented with three maize variety package products and then bid to purchase at the price they value the product. Therefore, product demands are independent and quantity demanded represents the number of units subjects were willing to purchase at a particular price. From the BDM auction data, quantity demanded for each of the three product packages was determined by adding up the number of bids greater than the randomly determined price level. The price levels were from MK0 to MK40, 000 in increments of MK100. Lusk and Hudson (2004) suggest estimating linear aggregate demand functions where the quantity demanded at each price increment is simply regressed against a trend variable representing the price increments. To allow for nonlinearity the subject pool’s
independent aggregate demand was estimated for each product package by fitting up to 4\textsuperscript{th} degree polynomial equations using ordinary least square (OLS) estimation

$$Q_j(P_j) = \alpha_{oj} + \alpha_{1j}P_j + \alpha_{2j}P_j^2 + \alpha_{3j}P_j^3 + \alpha_{4j}P_j^4 + \varepsilon_j,$$  \hspace{1cm} (4.3)

where $j \in \{\text{hybrid variety package, OPV variety package, local variety package}\}$ and $P_j$ is the set of prices $P \in [$MK0, MK40,000$]$ in increments of MK100.
CHAPTER V
RESULTS AND DISCUSSION

5.1 Survey summary statistics

5.1.1 Exit questionnaire

The exit questionnaire (Appendix C) was administered after the auction session. Of interest were some demographics questions like age and gender. The other questions were aimed at eliciting anchoring biases and participants experience in farming that may affect their bidding behavior. The subjects indicated if they had ever grown the three maize varieties in question, their preferred varieties, the varieties they would wish to continue growing, as well as the varieties which they planted the previous season.

A total of 38 farmers participated in the experiment. Table 1 below contains summary statistics from the exit interview questionnaire. The income level was not of great interest because the eligibility criteria for FISP (and thus the criteria for being selected to participate in the study) caused the sample to have fairly homogeneous income levels. The experiment recruited farmers who qualify to be on the list of subsidy beneficiaries due to their socio-economic status but were not benefiting in this particular year as government only manages to provide input subsidies to about 50 percent of possible beneficiaries.

The study results showed that the average bids offered by participants for the hybrid maize variety was MK14656.42. This was higher than the average bid offered for
OPVs which was MK12346.42. This agrees with what participants reported in exit interview where it was noted that 78 percent of participants prefer hybrids as compared to 10 percent who reported that they prefer OPVs. However surprisingly the average bid for local maize variety was the highest, reported at MK17092.37. This partly could be as a result of differences in qualities, specifically milling, resistance to pests, and taste preferences, between hybrid and OPV packages and local packages.

Looking at preference variables for the participants, the results indicate that 98 percent of the participants reported that hybrids yields higher than all varieties while only 2 percent reported that OPVs yields higher and none reported that local maize variety yields higher than hybrids and OPVs. Asked on their variety preference 78 percent indicated that they prefer hybrids, 10 percent prefer OPVs and 28 percent reported that they prefer local variety as well. Some participants indicated that even though they grow hybrids on a big part of their farms they cannot do away with local variety hence they reported that they prefer both hybrids and local varieties. Looking at whether growing hybrids is bringing them closer to well off farmers who do not depend on government subsidy, only 34 percent reported that they have noted some changes on their family welfare even though the closeness to well off farmers is not very big. Looking at the experience variables, the average number of years in farming for the participants was 24 with a minimum of 3 years and a maximum of 64 years.
Table 5.1  Exit questionnaire summary statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bid1 (Hybrid variety)</td>
<td>14656.42</td>
<td>13742.27</td>
<td>0</td>
<td>36000</td>
</tr>
<tr>
<td>Bid2 (OPV variety)</td>
<td>12346.42</td>
<td>13157.01</td>
<td>0</td>
<td>38000</td>
</tr>
<tr>
<td>Bid3 (local variety)</td>
<td>17092.37</td>
<td>14399.23</td>
<td>0</td>
<td>40000</td>
</tr>
<tr>
<td>Hybrids yields more per acre</td>
<td>0.97368421</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>OPV yields more per acre</td>
<td>0.02631579</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Local yields more per acre</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Do you prefer hybrid</td>
<td>0.7894737</td>
<td>0.413155</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Do you prefer OPV</td>
<td>0.1052632</td>
<td>0.3110117</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Do you prefer local</td>
<td>0.2894737</td>
<td>0.4596059</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Do you feel close to well off farmers</td>
<td>0.3421053</td>
<td>0.4807829</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Experience in farming</td>
<td>24.7368421</td>
<td>16.6387438</td>
<td>3</td>
<td>64</td>
</tr>
<tr>
<td>Do you know differences of the varieties</td>
<td>0.9736842</td>
<td>0.1622214</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Ever grown hybrid</td>
<td>0.8684211</td>
<td>0.34257</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Ever grown OPV</td>
<td>0.3684211</td>
<td>0.4888515</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Ever grown local</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Grew hybrid last yr</td>
<td>0.7368421</td>
<td>0.4462583</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Grew OPV last yr</td>
<td>0.0789474</td>
<td>0.2732763</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Grew local last yr</td>
<td>0.5263158</td>
<td>0.5060094</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Do you continue growing hybrid</td>
<td>0.8947368</td>
<td>0.3110117</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Do you continue growing OPV</td>
<td>0.1052632</td>
<td>0.3110117</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Do you continue growing local</td>
<td>0.2105263</td>
<td>0.413155</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Acres used in farming over the years</td>
<td>1.842105</td>
<td>0.8861186</td>
<td>0.5</td>
<td>4</td>
</tr>
<tr>
<td>Applied fert. On hybrid</td>
<td>0.5789474</td>
<td>0.5003555</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Applied fert. On OPV</td>
<td>0.0789474</td>
<td>0.2732763</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Applied fert. On local</td>
<td>0.4210526</td>
<td>0.5003555</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Quantity basal dressing fert</td>
<td>19.26316</td>
<td>21.0523</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Quantity top dressing fert</td>
<td>20.71053</td>
<td>21.29257</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Age</td>
<td>46.9736842</td>
<td>17.6872023</td>
<td>18</td>
<td>85</td>
</tr>
<tr>
<td>Gender</td>
<td>0.3947368</td>
<td>0.4953554</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Household size</td>
<td>5.3421053</td>
<td>1.7128499</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

The results revealed that 97 percent of the participants knew the differences between all the maize varieties with 86 percent of them having grown hybrids at some time in their farming career and only 36 percent having grown OPVs. All participants reported to have grown local variety in their farming career. Looking at what farmers
grew the previous growing season, 73 percent of participants reported to have grown hybrid varieties, 7 percent to have grown OPVs and 52 to have grown local varieties as well. The percentages do not add up to 100 percent because, as pointed out above, some farmers grew both hybrid varieties and local varieties while others used only one variety.

The study also revealed that 89 percent of those who once grew hybrids still continue growing hybrids, while for those who once grew OPVs only 10 percent continue to grow it while for those who grew local variety 21 percent reported that they still continue to grow it. The other farm characteristics of the participants it was noted that the average plot size of the farms was 1.8 acres. On fertilizer application it was noted that 57 percent apply fertilizer to hybrids, 7 percent apply to OPVs and 42 percent apply to local maize variety. The average quantities of fertilizers applied to the plots were noted to be 19 kgs for basal dressing fertilizer and 20 kgs for the top dressing fertilizer. Looking at the demographic characteristics, it was noted that the average age of the participants was 46 years with the minimum age being 18 and maximum age being 85. It was also noted that 60 percent of the households were male headed households and the average number of family members in each household was 5 with a minimum being 2 and a maximum 10.

A further discussion with the farmers it was revealed that among the reasons farmers mentioned for variety choice in a particular year included the following:

1. Convenience: It was reported that during the peak period when the coupons have been distributed farmers demand for preferred varieties is high and most shops run out of stock. As a result farmers just buy the available variety on the market so they can plant on schedule.

2. External factors: when they receive seeds as a gift either from charitable organizations or relatives they do not have control over the variety type.
Despite these issues, when pressed about what they take into consideration when selecting the varieties they prefer, participants indicated that they look at yield potential; drought resistance; poundability (the ability to remove the grain husks without breaking the grain); resistance to weevil attack as well as fertilizer response rate. Generally local varieties are believed to withstand weevil attack better than any other variety if pesticides have not been applied. Hybrids are well known for their yield potential which surpasses any other seed type under good management practices. The study revealed that fewer farmers are using OPVs despite their being cheaper than hybrids and having a better yield potential than the local varieties. The explanation farmers gave for this is that when droughts occur OPVs perform worse than other seed types. Also, OPVs are more susceptible to weevils.

On input sources which participants use in their farming, some indicated that mostly it comes from the subsidy program with other sources being gifts from friends, relatives and charitable organizations. However very few farmers indicated that they buy small quantities of fertilizer and seeds on their own. Cash constraints which limit most of the participant’s ability to buy hybrids, made some farmers to simply resort to local variety use.
5.2 Assessing factors affecting decision making in adopting maize varieties

Table 5.2  Hedonic bidding function explanatory variables and descriptions

<table>
<thead>
<tr>
<th>Variable Group</th>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preference</td>
<td>Hybrid yield dummy variable (1 = Yes, 0 = no)</td>
<td>Hybrid yields more per acre</td>
</tr>
<tr>
<td></td>
<td>OPV yield dummy variable (1 = Yes, 0 = no)</td>
<td>OPV yields more per acre</td>
</tr>
<tr>
<td></td>
<td>Local yield dummy variable (1 = Yes, 0 = no)</td>
<td>Local yields more per acre</td>
</tr>
<tr>
<td></td>
<td>Hybrid preference dummy variable (1 = Yes, 0 = no)</td>
<td>Do you prefer hybrid</td>
</tr>
<tr>
<td></td>
<td>OPV preference dummy variable (1 = Yes, 0 = no)</td>
<td>Do you prefer OPV</td>
</tr>
<tr>
<td></td>
<td>Local preference dummy variable (1 = Yes, 0 = no)</td>
<td>Do you prefer local</td>
</tr>
<tr>
<td></td>
<td>Helps make you close to well off farmers</td>
<td>Do you feel close to well off farmers</td>
</tr>
<tr>
<td>Experience</td>
<td>Number of years a farmer has been in farming</td>
<td>Experience in farming</td>
</tr>
<tr>
<td></td>
<td>Variety difference dummy variable (1 = Yes, 0 = no)</td>
<td>Do you know differences of the varieties</td>
</tr>
<tr>
<td></td>
<td>Used hybrid before dummy variable (1 = Yes, 0 = no)</td>
<td>Ever grown hybrid</td>
</tr>
<tr>
<td></td>
<td>Used OPV before dummy variable (1 = Yes, 0 = no)</td>
<td>Ever grown OPV</td>
</tr>
<tr>
<td></td>
<td>Used Local before dummy variable (1 = Yes, 0 = no)</td>
<td>Ever grown local</td>
</tr>
<tr>
<td></td>
<td>Grew hybrid last yr dummy variable (1 = Yes, 0 = No)</td>
<td>Grew hybrid last yr</td>
</tr>
<tr>
<td></td>
<td>Grew OPV last yr dummy variable (1 = Yes, 0 = No)</td>
<td>Grew OPV last yr</td>
</tr>
<tr>
<td></td>
<td>Grew local last yr dummy variable (1 = Yes, 0 = No)</td>
<td>Grew local last yr</td>
</tr>
<tr>
<td>Farm Characteristics</td>
<td>Continue using hybrid dummy variable (1 = Yes, 0 = No).</td>
<td>Do you continue growing hybrid</td>
</tr>
<tr>
<td></td>
<td>Continue using OPV dummy variable (1 = Yes, 0 = No).</td>
<td>Do you continue growing OPV</td>
</tr>
<tr>
<td></td>
<td>Continue using local dummy variable (1 = Yes, 0 = No).</td>
<td>Do you continue growing local</td>
</tr>
<tr>
<td></td>
<td>Number of acres used in farming over the years</td>
<td>Acres used in farming over the years</td>
</tr>
<tr>
<td></td>
<td>Applied fert. On hybrid</td>
<td>Applied fert. On hybrid</td>
</tr>
<tr>
<td></td>
<td>Applied fert. On OPV</td>
<td>Applied fert. On OPV</td>
</tr>
<tr>
<td></td>
<td>Applied fert. On local</td>
<td>Applied fert. On local</td>
</tr>
<tr>
<td></td>
<td>Amount of basal dressing fert applied in kgs</td>
<td>Quantity basal dressing fert</td>
</tr>
<tr>
<td></td>
<td>Amount of top dressing fert applied in kgs</td>
<td>Quantity top dressing fert</td>
</tr>
<tr>
<td>Demographics</td>
<td>Gender dummy variable (1 = Male, 0 = Female)</td>
<td>Age</td>
</tr>
<tr>
<td></td>
<td>Number of people in the household</td>
<td>Gender</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hhsize</td>
</tr>
</tbody>
</table>
The variables in equation (1) were categorized into four variable groups, Preference, Experience, Farm characteristics and Demographics category as seen in table 2 above.

<table>
<thead>
<tr>
<th>Variable</th>
<th>DF</th>
<th>Hybrid maize variety package</th>
<th>OPV maize variety package</th>
<th>Local maize variety package</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1</td>
<td>-2053.89*** (74.08)</td>
<td>1199.35*** (87.89)</td>
<td>5268.17*** (58.51)</td>
</tr>
<tr>
<td>Close well off</td>
<td></td>
<td>-8844.77*** (60.86)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever grown</td>
<td></td>
<td></td>
<td>11799*** (107.66)</td>
<td>-9249*** (60.76)</td>
</tr>
<tr>
<td>Grown last year</td>
<td>1</td>
<td>1789.18*** (61.99)</td>
<td>-2147*** (74.56)</td>
<td>4847.38*** (42.70)</td>
</tr>
<tr>
<td>Contgrowhn</td>
<td>1</td>
<td>8202*** (77.66)</td>
<td>1989.05*** (97.55)</td>
<td>13871*** (35.76)</td>
</tr>
<tr>
<td>Acres</td>
<td></td>
<td>996.85*** (410.97)</td>
<td>2579.77*** (532.79)</td>
<td>2549.02*** (248.30)</td>
</tr>
<tr>
<td>Do you apply fert.</td>
<td></td>
<td></td>
<td>-11602*** (44.55)</td>
<td>-10574*** (31.34)</td>
</tr>
<tr>
<td>Gender</td>
<td>1</td>
<td>-1556.01*** (31.47)</td>
<td>2843.84*** (3912)</td>
<td>-842.38*** (25.71)</td>
</tr>
<tr>
<td>Hhsize</td>
<td>1</td>
<td>3928.09*** (314.46)</td>
<td>2416.8*** (346.45)</td>
<td>3140.53*** (296.43)</td>
</tr>
<tr>
<td>Income source</td>
<td>1</td>
<td>-3795.28*** (31.91)</td>
<td>3158.15*** (34.17)</td>
<td>-5769.38*** (27.15)</td>
</tr>
<tr>
<td>Sigma</td>
<td></td>
<td>10920*** (544.91)</td>
<td>10783*** (636.32)</td>
<td>11468*** (240.69)</td>
</tr>
<tr>
<td>Rho.Bid1.Bid2</td>
<td>1</td>
<td>0.675746*** (0.07)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rho.Bid1.Bid3</td>
<td>1</td>
<td>0.178147 (0.13)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rho.Bid2.Bid3</td>
<td>1</td>
<td>0.505051*** (0.10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log Likelihood</td>
<td></td>
<td>-1132</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC</td>
<td></td>
<td>2337</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schwarz Criterion</td>
<td></td>
<td>2398</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: *** denotes significance at $\alpha = 0.01$, ** denotes significance at $\alpha = 0.05$, and * denotes significance at $\alpha = 0.10$. Sigma is the standard error of the regression residuals. Rho is a degree of association between the bids.
As discussed in the previous chapter, the BDM mechanism was selected for this experiment so as to elicit farmer’s true value on the different maize variety packages. Subject’s WTP for each package were important in determining their preferences on the different varieties. Table 3 describes the Tobit model results on the factors that affect the bids for each of the three packages (Hybrids, OPV and Local variety). The results indicate that poor farmers who were not close to well off farmers were less willing to pay for hybrids by MK8844.77 relative to those who were close to well off farmers. It was noted that those farmers who once grew OPVs had an increased willingness to pay for OPV package by MK11799 while those who once grew local were less willing to pay for the local package by MK9249.

The results also indicated that farmers who grew hybrids the previous season were more willing to pay for hybrid package by MK1789 and for those who grew local were more willing to pay for local package by MK4847 while those who grew OPVs were less willing to pay for OPV packages by MK2147. Farmers who once grew a particular variety and continue to grow it had an increased willingness to pay for those varieties. For hybrids farmers’ WTP increased by MK8202, for OPVs their WTP increased by MK1989 while for local varieties their WTP increased by MK13871.

The results revealed that an increase in landholding size by 1 acre increased people’s willingness to pay for hybrids by MK996.85, for OPVs by MK2575.77 and for local variety by MK2549. For those farmers who apply fertilizer on particular varieties, it was noted that they were less willing to pay for OPVs by MK11602 and in local variety they were less willing to pay by MK10574. It was also noted that males were less willing to pay for hybrid and local varieties by MK1556 and MK842 respectively however they
were more willing to pay for OPVs by MK2843 relative to their female counterparts. The study also revealed that an increase in family size by 1 member increased people’s willingness to pay by MK3928 in hybrids, MK2416 in OPVs and MK3140 in local variety. Surprisingly those farmers who reported to have an off-farm income source were less willing to pay for hybrids and local variety by MK3795 and MK5769 respectively while for OPVs the willingness to pay increased by MK3158.

Looking at the results of table 3, all regression coefficients are significant at a level of significance of one percent. Table 3 also reports the estimated cross-equation correlations. The correlations between the error terms for hybrid variety bids and OPV varieties bids and error terms for OPV varieties bids and local varieties bids are 0.68 and 0.51 respectively and significant at a level of one percent. The correlation between error terms for hybrid variety bids and local variety bids is not statistically different from zero. The OLS regression results for the aggregate quantity demands for each of the maize variety package are presented in table 5.4 below.

Table 1.2 Results of the Ordinary Least Squares models of independent aggregate maize package demand equation (robust standard errors in parenthesis).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hybrid Maize Variety Package</th>
<th>OPV Maize Variety Package</th>
<th>Local Maize Variety Package</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parameter Estimate (std error)</td>
<td>Parameter Estimate (std error)</td>
<td>Parameter Estimate (std error)</td>
</tr>
<tr>
<td>Intercept</td>
<td>28.74325*** (0.19958)</td>
<td>27.36473*** (0.36094)</td>
<td>33.17473*** (0.41431)</td>
</tr>
<tr>
<td>p1</td>
<td>&quot;(-0.07094)*** (8.5x10^-5)</td>
<td>&quot;(-0.10203)*** (0.00377)</td>
<td>-0.06433*** (0.01306)</td>
</tr>
<tr>
<td>p2</td>
<td>9.5x10^-5*** (8.3x10^-6)</td>
<td>4.0x10^-5*** (4.4x10^-7)</td>
<td>-5.99x10^-5*** (5.3x10^-10)</td>
</tr>
<tr>
<td>p3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.96</td>
<td>0.96</td>
<td>0.98</td>
</tr>
</tbody>
</table>
To derive the results in table 4 above, we started with a $4^{th}$ order polynomial for each demand model and then based on the statistical significance of the highest order term, each model was reduced to the form as presented in the table. Looking at the R-square values of the three models it shows that the models are a good fit as they explain about 96 percent of the variations in aggregate demand in the models for hybrid maize and OPV varieties and 98 percent of the variations in the model for local varieties. Robust standard errors were used in the model selection.

Figure 5.1  Observed Subject Independent Aggregate Demand for the maize packages

In figure 5 above, the observed individual unit demands were aggregated to develop the aggregate demand functions for the three maize packages as described in Data and Methods (section 4.3.2) above. This indicates the effect of changing prices on
quantity demanded for the three different types of maize variety packages. In this analysis, the quantity demanded which is the dependent variable was sorted by the maximum price individuals were willing to pay. These prices were in MK100 increments ranging from MK0.00 to MK40,000.

5.3 **Assess the effectiveness of subsidies for the long run adoption of the improved maize varieties.**

Demand elasticity for inputs tells us percentage increase (decrease) of quantity demanded as a result of a one percent decrease (increase) in price of the inputs. To that effect we estimated the demand elasticity so as to gauge what will be the change in quantity of the inputs demanded by farmers. We calculated the demand elasticity at different price levels. The results are shown in table 5.5 below

<table>
<thead>
<tr>
<th>Price</th>
<th>Observed quantities</th>
<th>Percentage</th>
<th>Elasticity</th>
<th>Observed quantities</th>
<th>Percentage</th>
<th>Elasticity</th>
<th>Observed quantities</th>
<th>Percentage</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>35000</td>
<td>5</td>
<td>13.15</td>
<td>-4.9658</td>
<td>3</td>
<td>7.89</td>
<td>-4.180283333</td>
<td>8</td>
<td>21.05</td>
<td>-4.500151</td>
</tr>
<tr>
<td>30000</td>
<td>10</td>
<td>26.31</td>
<td>-2.1282</td>
<td>8</td>
<td>21.05</td>
<td>-1.6983</td>
<td>13</td>
<td>34.21</td>
<td>-0.97814</td>
</tr>
<tr>
<td>20000</td>
<td>15</td>
<td>39.47</td>
<td>-0.94587</td>
<td>10</td>
<td>26.31</td>
<td>-1.28404</td>
<td>16</td>
<td>42.1</td>
<td>-0.603629</td>
</tr>
<tr>
<td>10000</td>
<td>23</td>
<td>60.52</td>
<td>-0.30843</td>
<td>19</td>
<td>50</td>
<td>-0.437452632</td>
<td>25</td>
<td>65.78</td>
<td>-0.414108</td>
</tr>
</tbody>
</table>

From the elasticity calculations it can be seen that at a price of MK35000 input demand elasticity for hybrid maize, OPV and local maize is respectively, -4.97, -4.18, and -4.50. This means that near the price level of MK 35000, an increase in price of one
percent would lead to a decrease in the quantity demanded of five percent. This is a highly elastic response. At the price level of MK10000 the input demand elasticities for hybrid maize, OPV and local maize is -0.31, -0.43 and -0.41 respectively. Similarly at this price (MK10000), an increase in price of one percent would lead to a decrease in quantity demanded of 0.3 percent. This implies that the input demand is inelastic. This shows that at low rates of subsidies where prices farmers pay for the hybrid maize packages are high demand is very elastic while for high rates of subsidies where the cost farmers pay for the inputs is low demand is inelastic.

Table 5 also reports the observed quantities purchased and the respective percentage (as a share of the total number of participants) for the different price levels for each of the three packages. These results can be used to determine the effect of reducing the level of the subsidy on the demand for the three input packages. From the results of table 5 it can be seen that:

- If the subsidy was only MK5000 reducing the price from MK40000 to MK35000 about 13 percent of the participants would buy hybrid maize package, 8 percent would buy OPVs, and 21 percent would buy local maize;

- If the subsidy was MK10000 reducing the price from MK40000 to MK30000 about 26 percent of the participants would buy hybrid maize package, 21 percent would buy OPVs, and 34 percent would buy local maize.

- If the subsidy was MK20000 reducing the price from MK40000 to MK20000 about 40 percent of the participants would buy hybrid maize package, and 26% would buy OPVs and 42 percent would buy local maize.

- If the subsidy was MK30000 reducing the price from MK40000 to MK10000 about 61 percent of the participants would buy hybrid maize package, and 50% would buy OPVs and 65 percent would buy local maize.
CHAPTER VI
CONCLUSIONS AND IMPLICATIONS

6.1 Summary of findings

Overall, the study has revealed that the subsidy programs implemented in Malawi over the years have exposed many farmers to the advantages of using improved farm inputs. Almost 86 percent of the participants had a chance to grow hybrids in their farming career and out of that number 89 percent continues to grow on yearly basis and 76 percent indicated that hybrids have turned out to be their preferred variety.

Based on available literature, it is reported that the current adoption level for improved farm inputs in Malawi is at 45 percent. The study however, has established that adoption of improved farm inputs among poor farmers (who are beneficiaries of government subsidies) is at 60 percent. This was revealed by observing the farmers’ bidding behavior during the study experiment. On factors affecting people’s willingness to pay for maize variety packages, the study revealed that WTP increase with land holding size, household size female headed households and experience in farming which agrees with the findings of Chirwa (2005). The results indicate that poor farmers who were not close to well off farmers were less willing to pay for hybrids relative to those who were close to well off farmers. It was noted that farmers who once grew OPVs and local maize varieties were more willing to pay for the OPV and local maize variety packages.
The study also indicated that farmers who grew hybrids the previous season were more willing to pay for hybrid package and for local maize variety while those who grew OPVs were less willing to pay for OPV packages. For the farmers who once grew a particular variety and continue to grow it, had and increased willingness to pay for those varieties.

The study also revealed that farmers who apply fertilizer on particular varieties, it was noted that they were less willing to pay for all varieties. This may be an indirect measure of the effect the cost of fertilizers has on the adoption of the different varieties. Surprisingly those farmers who reported to have an off-farm income source were less willing to pay for hybrids and local variety while they were more willing to pay for OPVs.

On the effectiveness of subsidies for the long run adoption of improved farm inputs the study has revealed that farmers’ exposure to improved farm inputs over the years has developed their desire to use them however a lack of purchasing power hinders most farmers from using the inputs. This has helped create a significant latent demand which can be turned into effective demand with proper government programs in place.

This agrees with the findings of Holden and Lunduka (2009) who reported that rural Malawian households value use of improved farm inputs like fertilizers and seeds where more than 50% of the households preferred small amounts of fertilizer to cash payments which were 50% higher than the prevailing market price of the farm input. This shows that the limited demand is not necessarily an indication that poor households are irrational but rather have less freedom in absence of purchasing power.
6.2  Policy implications

The study has established that farmers’ exposure to use of improved farm inputs increases their willingness to pay for the inputs. Since government subsidy reaches only about fifty percent of eligible beneficiaries there is need to properly alternate beneficiaries so that all eligible farmers can get the exposure and appreciate the benefits of using the improved inputs and consequently improve on their willingness to pay for the inputs.

It has also revealed that complete removal of subsidy will result in the demand for inputs from subsidy eligible farmers to be removed from the market. This is based on the fact that only 5 percent of the participants were willing to pay for the improved input packages at market prevailing price. To that effect it is recommended that subsidy removal should be a gradual process.

After exposing farmers to the advantages of hybrids over local varieties over the years, farmers are able to appreciate that hybrids are better performers as compared to other varieties. However, cash constraints still remain a barrier in turning the latent demand on hybrids into effective demand (demand supported by purchasing power). This agrees with the findings of Chirwa (2005) who reported that farmers’ adoption of improved varieties increases with an increase in farmers’ income levels as well as experience. As such there is need for government and other development partners to come up with alternative approaches if subsidies are to be dropped without affecting much the quantity demanded of the inputs because subsidies in Malawi target mostly farmers who otherwise would not have accessed the farm inputs. Therefore subsidy removal would only reduce effective demand.
REFERENCES


APPENDIX A

THE AUCTION MECHANISM INSTRUCTIONS
Farm input packages Auction Instructions

Please follow along as I read the following instructions. There is to be no talking between participants during the session. If you have any questions, please notify the Moderator at any time.

Thank you for agreeing to participate in today’s auction session. Before we begin, we want to remind you that your participation in the auction session is completely voluntary, and the results from which will remain confidential.

Auction procedure

In today’s auction session, we are primarily interested in your value preferences for the 3 input packages which you see in front of you, consisting of maize varieties and fertilizers types. Package number 1 includes 5 kg of Hybrid maize varieties and 100 kg Basal dressing and Top dressing fertilizers. Package number 2 includes 10 kg of Open Pollination maize varieties (OPV) and 100 kg Basal dressing and Top dressing fertilizers. Package number 3 includes 10 kg of Local maize varieties and 100 kg Basal dressing and Top dressing fertilizers.

Each of you will be given an allowance in the amount of MK40,000.00. You can use this allowance as you attempt to purchase one of the three packages (your favorite maize variety and fertilizer). You are being asked to submit a single Bid for each of the three packages. Though you will be submitting 3 Bids, you can only win up to 1 Package. After you have submitted your Bids, the moderator will randomly draw a Price for each of the three packages. Possible Prices per package are in MK400.00. Increments, ranging from MK0.00 to MK40,000.00. Please note that any given Price within this range has an equal chance of being drawn.

If the Bid you submit is greater than or equal to the randomly drawn Price, you are then eligible to win that particular package at that Price. Again, though you will submit 3 Bids, you can only win at most 1 package. If you are eligible to win more than one package, the Moderator will randomly determine which package you will win. For the package you win, the randomly drawn Price for that package will be paid from the
allowance you are given. If all of your Bids are less than any package’s randomly drawn Price, you will not win a package and keep the amount you are given.

Please turn to the next page for bidding examples and how the package you may ultimately purchase and remaining allowance will be determined.

**Example 1:** If you submit a series of Bids and the series of randomly drawn Prices are:

<table>
<thead>
<tr>
<th>Package</th>
<th>Bid</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>MK24,000.00</td>
<td>MK26,000.00</td>
</tr>
<tr>
<td>#2</td>
<td>MK35,000.00</td>
<td>MK30,000.00</td>
</tr>
<tr>
<td>#3</td>
<td>MK17,000.00</td>
<td>MK31,000.00</td>
</tr>
</tbody>
</table>

Because your Bid is greater than the randomly drawn Price for package #2, you will win package #2 and pay MK30,000.00 from the allowance money you are given, not the MK35,000.00 you Bid. Therefore, you will receive the package #2 and a MK10,000.00 amount (MK40,000.00 – MK30,000.00).

NOTE: You will not pay your MK35,000.00, Bid, but rather the MK30,000.00 randomly drawn Price.

NOTE: The sum of your Bids can be as much as 3 times your MK40,000.00 allowance as you will only be subject to winning and paying for one package.

NOTE: Because Price is randomly determined, you are not competing against other bidders to win one of the packages.

**Example 2:** If you submit a series of Bids and the series of random Prices are:

<table>
<thead>
<tr>
<th>Package</th>
<th>Bid</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>MK32,000.00</td>
<td>MK25,000.00</td>
</tr>
<tr>
<td>#2</td>
<td>MK26,000.00</td>
<td>MK20,000.00</td>
</tr>
<tr>
<td>#3</td>
<td>MK38,000.00</td>
<td>MK30,000.00</td>
</tr>
</tbody>
</table>

As you can see, you are eligible to win all 3 packages given your Bid is greater than all 3 randomly drawn Prices.
NOTE: Though you are *eligible* to win all 3 variety packages, you will actually win only 1 of the varieties by a random draw and pay the corresponding randomly drawn Price.

******************************************************************
*****

After completion of the experiment today, the moderator will randomly draw a Price for each of the packages, determine which, if any, package you may win, and then calculate the balance on your allowance money. Therefore, you will not know if you have won a package or the remaining balance on your allowance money until you pick up your winnings. You will be able to pick up the packages here.

If you have no further questions, please turn to the next page where you will submit your bids.

******************************************************************
*****
Bidding Sheet

You should have your package (maize variety and fertilizer) options with your assigned participant number. Please enter your participant number below.

Participant #________________

Please take your time considering your Bids, and feel free to refer to your variety options as you make your bidding decisions. Please do not talk with other participants while considering your Bids or let them see your Bidding Sheet.

REMINDER: Possible Prices per package are in 1 Malawi Kwacha increments, ranging from MK0.00 to MK40,000.00. Please note that any Price within this range has an equal chance of being drawn.

NOTE: Allowable Bids for each serving are any value in 1 Malawi Kwacha increments between MK0.00 and MK40,000.00.

Please enter the package number in the order you saw the maize varieties and submit each of your Bids:

Package number #_________   Bid = MK_________
Package number #_________   Bid = MK_________
Package number #_________   Bid = MK_________
Package number #_________   Bid = MK_________

After you have entered your bids, please notify the Moderator, and you will be asked to complete a brief Questionnaire.
APPENDIX B

THE APPROVED CONSENT FORM
Mississippi State University

Informed Consent Form for Participation in Research

Title of Research Study: Adoption of Agricultural Technologies in Malawi in Absence of Subsidies: A case of Hybrid Maize Technology

Study Site: Machinga District, Southern region of Malawi - Africa

Researchers: Yohane Chimbalanga, Dr. Ardian Harri, Dr. Kalyn Coatney, Dr. Barry J. Barnett and Dr. Jesse Tack, Mississippi State University, Department of Agricultural Economics.

Purpose: The purpose of this research is objective of the study is to measure the demand/ adoption of hybrids in absence of the subsidies in Malawi.

Procedures

In today’s auction session, we are primarily interested in your value preferences for the 3 input packages which you see before you. Each of the three packages consists of maize seed and fertilizer. The amount of money you are given is your allowance from which you can attempt to purchase your package (favorite maize variety and fertilizer). You see before you an example of all the maize varieties and fertilizers types which are loaded in the truck outside. The maize varieties include (Hybrids, OPVs and Local) while the fertilizers include (Basal dressing and Top dressing fertilizers). Each of the packages you will be attempting to purchase includes a combination of maize variety and the two fertilizers (i.e. Hybrid + Basal & Top dressing fertilizer; OPV + Basal & Top dressing fertilizer; and Local + Basal & Top dressing fertilizer). Therefore you are being asked to submit a single bid per package. After, submitting your bid you will be asked to fill out a brief questionnaire regarding your use of your favored maize varieties. At the end of the experimental session today, your total payoff will be determined and you will get your earnings.
Risks or Discomforts

The researchers expect that discomfort to you will be minimal to non-existent. You will be asked to sit in a chair and record your responses with the help of research assistants.

Benefits

Subjects participating in the experimental sessions benefit directly by earning Cash or farm inputs (maize seed and fertilizers) plus cash. Results from the study will be used to better inform government and development partners on demand elasticity of subsidized farm inputs and the effects of subsidy removal on adoption of improved farm inputs.

Incentive to participate

For participating in the experiment today, you are guaranteed to earn $100.00 or input package worth $100.00 plus some cash. Based on your earnings you will be paid in cash or inputs package plus some cash.

Confidentiality

All Consent forms, payment records, and data is kept confidential. Subjects are identified by number only in stored data. Please note that these records will be held by a state entity and therefore are subject to disclosure if required by law. Research information may be shared with the MSU Institutional Review Board (IRB) and the Office for Human Research Protections (OHRP).

Questions

If you have any questions about this research project, please feel free to contact Dr. Ardian Harri at 662-325-5179.

For questions regarding your rights as a research participant, or to discuss problems, express concerns or complaints, request information, or offer input, please feel free to contact the MSU Research Compliance Office by phone at 662-325-3994, by e-mail at irb@research.msstate.edu, or on the web at http://orc.msstate.edu/humansubjects/participant/.
Voluntary Participation

Please understand that your participation is voluntary. Your refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may discontinue your participation at any time without penalty or loss of benefits.

Options for Participation

Please initial your choice for the options below:

___ The researchers may contact me again to participate in future research activities.

___ The researchers may NOT contact me again regarding future research.

Please take all the time you need to read through this document and decide whether you would like to participate in this research study.

If you agree to participate in this research study, please sign below. You will be given a copy of this form for your records.

_________________________________________  ______________________
Participant Signature                      Date

_________________________________________  ______________________
Investigator Signature                    Date
APPENDIX C

THE EXIT QUESTIONNAIRE ON SURVEY OF MAIZE VARIETY ADOPTION IN MALAWI
IDENTIFICATION

Farmer name ________________________
Current age of household head ______
Current sex of household head ______ (male=1; female=2)
Current household size ________

Use of varieties and fertilizer ever since

1. For how long have you been farming
2. Do you know the differences in maize varieties (Local, OPVs and Hybrids)
   (1=yes, no=2)
3. If yes what are the differences
   (in terms of Yield potential, Duration of Maturity, drought resistance, Pests resistance)
   _____________________________________________________________
   _____________________________________________________________
   _____________________________________________________________

4. Which maize varieties have you ever grown
   a). Hybrid maize seed ------------------------ (1=yes, no=2)
   b). OPVs maize seed -------------------------- (1=yes, no=2)
   c). Local maize seed -------------------------- (1=yes, no=2)

5. What maize varieties did you grow last season?
   a). Hybrid------------------
   b). OPV ---------------------
   c). Local-------------------
6. Did you apply fertilizer to each variety?
   A). Hybrid------------- (1=yes, 2=no)
   b). OPV ------------- (1=yes, 2=no)
   c). Local---------- (1=yes, 2=no)

7. What was the quantity of seed that you planted last season, (ALL varieties)
   a). Hybrid-------------- (kgs)
   b). OPV -------------- (kgs)
   c). Local------------- (kgs)

8. What was the quantity of fertilizers that you applied last year
   A). Basal dressing fertilizer -------------- (kgs)
   b). Top dressings fertilizers ---------- (kgs)

9. What were the sources of the seed.(Tick all that apply)
   a) Own seed / Recycled ---------------
   b) Bought from Agro-dealers (seed shops) ---------------
   c) Coupon redemption ---------------
   d) Given by relatives/friends -----------
   e) Other specify ------------------------------------------------

10. If purchased, what were the prices in (MK)
    a). Hybrid price ---------------
    b). OPV Price ---------------
    c). Local price------------

11. Which maize varieties do you prefer
    A). Hybrid maize seed --------------(1=yes, no=2)
    b). OPVs maize seed ---------------- (1=yes, no=2)
    c). Local maize seed ------------------ (1=yes, no=2)
12. Which varieties will you continue to grow in future
   A). Hybrid maize seed ------------------------ (1=yes, no=2)
   b). OPVs maize seed -------------------------- (1=yes, no=2)
   c). Local maize seed -------------------------- (1=yes, no=2)

13. If no to any variety above give reasons

Acreage and Production

1. How many hectares on average have you been operating over the years ------------ (Ha)
2. How much of the land do you own -------------- (Ha)
3. How much of the land do you rent from others -------------- (Ha)
4. How much of the land do you rent to others -------------- (Ha)
5. What are the reasons you consider most as factors affecting farmers’ adoption of
   improved maize varieties. (Rank them in order of importance)
   a). Lack of purchasing power --------------
   b). Level of education --------------
   c). Plot size cultivated --------------
   d). Level of non-farm incomes --------------
   e). Lack of access to reliable markets --------------
   f). Information gap among farming communities --------------
   g). Profitability of improved technologies in the context of smallholder farmers --
---
6. What are the factors that you strongly believe are helping you keep farming (Rank them)
   a). Extension programs
   b). My participation in farmers’ groups
   c). Government subsidy programs
   d). The community supports its members in times of need

7. What are the social factors you believe are most effective in helping farmers
   a). Farmers clubs/ organizations
   b). Increased access to markets for inputs and outputs
   c). Increased availability of off farm jobs

8. Can you suggest other programs that government can implement, to improve adoption of improved farm inputs in absence of subsidies

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General information

1. Describe a well-off farm household (three of four aspects).
   a. __________________________________________________________
   b. __________________________________________________________
   c. __________________________________________________________
   d. __________________________________________________________

2. What is the difference between your household and the well-off household (for each? aspect in [1])?
   a. __________________________________________________________
   b. __________________________________________________________
   c. __________________________________________________________
   d. __________________________________________________________

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3. Do you continuously grow hybrid maize ever since you first planted it?  
---------- (1=yes, 2=no)

4. Are you closer to being like the well-off household today than before you started using hybrids?  
---------- (1=yes, 2=no)

5. This season, did you grow tobacco? _____ (yes=1 no=2)

6. This season, did you grow crops other than tobacco or maize? ___ (yes=1 no=2)
   If yes, specify __________________

7. Did you apply fertilizer to any of your crops other than maize? ___ (yes=1 no=2)
   Which ____________________________

8. of all crops including maize, which covers most of your land? ______

9. Do you have any regular source of cash? ___ (yes=1 no=2)

10. If yes what are they? (Tick those that apply)
    a) Business
    b) Employment
    c) Exchanging labour for cash
    d) Gifts from friends and relatives
    e) Other specify ____________________________

11. What is your current household size? ---------------

Feel free to ask any questions: If not thank you for your time.
APPENDIX D

IRB APPROVAL LETTER
Protocol Title: Adoption of Agricultural Technologies in Malawi in Absence of Subsidies: A case of Hybrid Maize Technology

Protocol Number: 14-262

Principal Investigator: Mr. Yohane Chimalanga

Date of Determination: 9/24/2014

Qualifying Exempt Category: 45 CFR 46.101(b)(2)

Attachments: 14-262 - Stamped IC (in follow-up e-mail)

Dear Mr. Chimalanga:

The Human Research Protection Program has determined the above referenced project exempt from IRB review.

Please note the following:

- Retain a copy of this correspondence for your records.

- An approval stamp is required on all informed consents. You must use the stamped consent form for obtaining consent from participants.

- Only the MSU staff and students named on the application are approved as MSU investigators and/or key personnel for this study.

- You do not need to submit an application for annual continuing review; however, a new application must be submitted if the study is ongoing after 5 years from the date of approval. (SOP 01-03 Administrative Review of Applications)

- Any modifications to the project must be reviewed and approved by the HRPP prior to implementation. Any failure to adhere to the approved protocol could result in suspension or termination of your project.
• Per university requirement, all research-related records (e.g. application materials, letters of support, signed consent forms, etc.) must be retained and available for audit for a period of at least 3 years after the research has ended.

• It is the responsibility of the investigator to promptly report events that may represent unanticipated problems involving risks to subjects or others.

This determination is issued under the Mississippi State University's OHRP Federalwide Assurance #FWA00000203. All forms and procedures can be found on the HRPP website: www.orc.msstate.edu.

Thank you for your cooperation and good luck to you in conducting this research project. If you have questions or concerns, please contact me at kmyhand@orc.msstate.edu or call 662-325-3294.

Finally, we would greatly appreciate your feedback on the HRPP approval process. Please take a few minutes to complete our survey at https://www.surveymonkey.com/s/YZC7QQD.

Sincerely,

Katie Myhand
Assistant Compliance Administrator