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Input subsidies and improved maize varieties in Malawi: -What can we learn from the impacts in a drought year?[1]

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Abstract

After six years with a large scale Farm Input Subsidy Program that enhanced national and household food security high costs resulted in a cut-back of the program in 2011/12 at the same time as the country was hit by a more serious drought in form of a dry spell in the rainy season. This study used household and farm plot level data combined with choice experiments to assess the impacts of the cut-back of the program and the drought on maize production and the performance of different maize varieties. The demand for improved maize seeds and adoption constraints were investigated and so was the knowledge and use of conservation technologies that in recent years have been introduced by a national level extension program. One of the effects of the cut-back is that the standard package is split and shared by two or more households. The drought resulted in a reduction in maize yields of 400 kg/ha. Many of the most commonly used hybrid maize varieties performed significantly better than local maize with yields about 600 kg/ha higher than local maize. About 4.3% of the maize plots were planted with the new ZM523 drought tolerant maize variety but it did not perform better than the hybrid maize varieties and has not yet become one of the popular varieties that are in high demand. About 35% of the households stated that they failed to obtain the most preferred maize variety and these were among the most commonly grown varieties, showing that there is scope for increased adoption of such varieties. Cash constraints and high prices for improved maize and fertilizer are limiting adoption, however, and continue to be a challenge for sustainable intensification of the maize-based production system. Newly introduced conservation technologies appear promising as one way to reduce the vulnerability to drought and enhance the fertilizer use efficiency.

Key words: Improved maize varieties, drought, drought tolerance, input subsidies, leakage of input subsidies, targeting of subsidies, maize yields, conservation technologies, demand for maize seeds.

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JEL codes: Q12, Q18.

1. Introduction

Malawi implemented an ambitious Farm Input Subsidy Program (FISP[2]) from 2005/2006 after a period with drought shocks and food shortages (Dorward et al. 2008; Holden and Lunduka 2012). The national food deficit was eliminated and even changed to a surplus in some of the following years and the program was widely perceived as a success story that created a new interest in using farm input subsidies to promote development in Africa through a Green Revolution (Denning et al. 2009).

A number of studies have investigated various types of impacts of the Malawian input subsidy program which was targeted towards resource-poor smallholder households. Ricker-Gilbert and Jayne (2011) have investigated the extent to which input subsidies crowd out commercial demand for fertilizer. Holden and Lunduka (2012) have investigated whether input subsidies crowd out use of organic manure. Holden and Lunduka (2010a) and Holden (2012) have assessed the impacts on the cropping pattern including intensity of production and intercropping of maize. Several studies have assessed the maize production impacts of the subsidy program (Dorward et al. 2008; Dorward and Chirwa 2011; Holden and Lunduka 2010a, b). Holden and Lunduka (2013) have assessed the targeting efficiency of the subsidy program, including assessing the extent of leakages and distribution of subsidized inputs reaching households through the informal market. Attempts to measure the welfare effects have been constrained by the economy-wide nature of the program which contributes to substantial spill-over effects that cannot easily be handled through standard econometric analyses of household panel data. Various modeling approaches may therefore be more appropriate for estimating such effects than through reduced form econometric approaches. However, a combination of such reduced form and structural approaches may provide additional insights.

Another gap in the literature relates to how the subsidy program performs when droughts occur. The first serious dry spells or droughts since the subsidy program started in Malawi occurred in the 2011/12 season. Maize is a crop that is vulnerable to droughts and droughts played an important role when the credit program that supported the maize production in Malawi till the early 1990s collapsed (Zeller et al. 1997). CIMMYT has developed and introduced new and more drought tolerant maize varieties and such varieties, may make the subsidy program more robust to climate risks. However, it is not known how much better improved varieties perform in drought years compared to local varieties. Our survey in 2012, which is a resurvey of 350 households that had been surveyed three times before in the period 2007-2010, gave us an opportunity to investigate the performance of the different types of maize in 2011/12 with dry spells that affected large parts of central and southern Malawi.

Another threat to the Malawian input subsidy program is the high costs of fertilizer and fuel that led to shortage of foreign exchange, fuel, and drugs in the country (Dorward and Chirwa 2011; Holden and Lunduka 2013). Financial constraints forced the Malawian government to cut back on the subsidy program in 2011/12 from 1.7 million 50 kg bags of fertilizer to 1.2 million bags. Our survey thus allowed us to assess the consequences of this cut-back on the distribution of the targeted fertilizer subsidies. The objective of the program has been to provide two 50 kg bags of fertilizer and a packet of seeds to each household and if this objective is followed the cut-back of the program would imply a substantial

[2] The program was initially named the Malawi Agricultural Input Subsidy Program (AISP) but was later renamed the Farm Input Subsidy Program (FISP). We use only the latter name in this paper.

reduction in the number of households receiving the input package. There has, however, been a trend towards splitting the packages as a way to reach more households. The leakages that were detected by Holden and Lunduka (2010b; 2013) may also have contributed to the splitting of packages to reduce the dissatisfaction with poor targeting where poor and vulnerable households that should have been targeted in reality often were left out (Dorward and Chirwa 2011; Holden and Lunduka 2010b; 2013). Our study of the same sample of households that were surveyed by Holden and Lunduka (2010a; 2010b; 2013) allow us also to assess the changes in the targeting efficiency and extent of leakages from the program since 2009/2010 as compared to the early stages of the subsidy program. Ministry of Agriculture and Food Security (MOAFS) has implemented several measures to reduce the leakages and improve the targeting since these problems were revealed in 2008/09. Our study allows us to assess the extent of success of these measures in our study areas.

Overall we aim to answer the following research questions:

1. How has the distribution of subsidized fertilizer and seeds been affected by the cut-back of the subsidy program in the 2011/12 season as compared to earlier years?
2. What types and varieties of maize seeds are grown and to what extent are there supply constraints hindering adoption of the most preferred varieties?
3. To what extent has the leakages from the program been reduced through the tighter control of distribution of coupons by the Ministry of Agriculture and Food Security (MoAFS)? And to what extent has the targeting of subsidies been improved by the tighter control by MoAFS?
4. How widespread were the dry spells (droughts) and what were their impacts in the 2011/12 season on the yields of improved maize and local maize varieties? And how did households respond to these droughts?
5. How large a share of the maize area is planted with improved maize varieties and how large a share of this area is planted with drought-tolerant maize and how much better do these varieties do than other improved and local varieties?
6. What is the potential effect of scaling up the distribution of the best-performing drought tolerant varieties; in drought years and in normal years? How high is the demand for the input package and small quantities of fertilizer and improved maize seeds?

2. Recent and current policy changes and performance

Maize is the dominant food crop in Malawi and other SADC countries as it accounts for about 70 percent of the total caloric intake of rural people. In urban communities of Malawi, maize is also considered the main staple food. The crop is grown throughout Malawi on variable ecological zones, which are predominantly of low soil fertility. The maize growing areas are also characterized by droughts, extensive use of unimproved varieties and limited application of inorganic and organic fertilizers (Setimela et al., 2007).

Such environments have low agricultural and maize productivity which lead to high incidence of poverty and household/individual food insecurity. This becomes a greater problem in areas

where ultra poor rural people work on extremely small pieces of land that are largely put to maize (Dorward and Chirwa, 2011). Thus, agricultural transformation in Malawi is constrained by a number of factors. First, continuous cultivation of maize on the same piece of land with little or no application of organic and inorganic fertilizers translate into diminished yields and farm incomes that are so low that the farmers cannot afford to purchase farm inputs such as fertilizer and improved maize seed. The credit market in Malawi is largely underdeveloped, a scenario that makes it difficult for the majority of the smallholder farmers to purchase required farm inputs on credit. Furthermore, recommended amounts of inorganic fertilizers are not widely used on maize due to problems of affordability and profitability (Dorward and Chirwa, 2011). Thus, while fertilizer use may be profitable many households are cash constrained and may fail to buy the inputs at commercial prices (Holden and Lunduka, in press). There is also need to increase efficiency in the input supply chain and increase fertilizer use efficiency. Nearly 60% of the maize producers in Malawi are net maize buyers. This means that raising maize prices to make maize production profitable would reduce affordability of the staple food to the net buyers thereby destroying their livelihoods and those of poor urban dwellers (SOAS et al., 2008). To resolve the input affordability problem Malawi needs both affordable and accessible financial services and/or huge reduction in farm input prices (Dorward and Chirwa, 2011).

Although inputs and financial services can be made accessible and affordable, averse attitude toward risk and vagaries of nature such as droughts can still lower maize production, thereby rendering the staple commodity both unprofitable and unaffordable.

Food security in Malawi has fluctuated over the past decades due to a variety of factors including population growth, production shocks such as droughts and unpredictable agricultural policies (Mandala, 2005; Smale and Rusike, 1998). Malawi has not seen complete famines for many decades but most households run out of maize stocks at least three months before the next harvest in a normal year and this can be worse in a year characterized by droughts or dry spells. The adoption of improved, high yielding and drought tolerant maize varieties is seen as a solution. Drought tolerant maize varieties such as ZM309 (Msunga banja) and ZM 523 (Mwayi or fortune) introduced by CIMMYT in 2009 would free land for other crops, thereby promoting crop diversification, reduce the impact of drought and increase farmer market participation. However, the adoption of such varieties is still low in Malawi (Denning et al., 2009; Katengeza, et al., 2012).

The low adoption of improved varieties has been observed in Malawi for many decades despite government support in the form of subsidies and extension advice. From the 1970s to the 1990s, the Malawian government implemented farm input and credit subsidy programs. These programs were discontinued in the 1990s following structural adjustment programs of the IMF and the World Bank (Chibwana et al., 2010). The withdrawal of subsidies brought untold household and national food insecurity problems throughout much of the 1990s. This state of affairs forced government to revisit subsidy programs focusing on fertilizer and seeds.

There were three sets of the subsidy programs from 1998 to date. The first program was the Starter Pack Initiative Scheme (SPIS or MFIP). The aim of the program was to increase household food security in rural areas and was introduced in the 1998/99 season. Government distributed free fertilizer and improved seeds to all smallholder farmers in Malawi and the program was seen as the mainstream of the Malawi Poverty Reduction Strategy intended to reverse some of the negative effects of the liberalization programs and the abolition of subsidies. Each household received a pack containing 5kg of basal fertilizer, 5 kg of top dressing fertilizer, 2kg of maize seed and 1kg of legume seed for summer program. In the period 1998 to 2000, the program covered all smallholder households providing a total of 2.86 million packs. The major problems with the program were high operation costs, poor targeting of poor households and leakages.

The second program was the Targeted Input Program (TIP). The SPIS was scaled down and renamed TIP in 2000/2001. TIP distributed free agricultural inputs to 1.5 million targeted households in 2001. To minimize administrative and operational costs, TIP was further scaled down to target about 1 million households in 2001/02 season. The targeted households were those that looked at the elderly, disabled, widows, widowers and other vulnerable members of society. The visible benefits of the program included production surpluses and yield increases. TIP dismal performance was due to bad weather that prevailed during the period further underlining the importance of drought tolerant or drought escaping varieties. Evaluations of TIP revealed inadequate use of fertilizer, hybrids and composite maize seeds. An extended TIP (ETIP) in 2002/2003 was implemented for summer season to reduce impact of food insecurity following poor harvest in the year. Evaluation of MFIP showed highest contribution of about 13% of total maize production in 1999/2000 and 10% in 2002/03. The program's lowest contribution was at 6%. These contributions helped Malawi save foreign exchange on imports while surpluses in 1998/99 and 1999/00 contributed to foreign exchange generation.

The Farm Input Subsidy Program (FISP) was introduced in the 2005/06 season in response to severe food shortage in the 2004/05 season. The aim was to increase smallholder productivity and therefore achieve food security at both household and national levels. The program targets resource poor smallholder farmers to access fertilizer and quality maize and legume seeds. In the long run, the program was expected to promote adoption of the improved technologies.

The FISP has made some important contributions. First, it has raised smallholder productivity and contributed to the growth averaging 7% per year in the past 5 years after 25 years of stagnation. It is believed that the program has also contributed to reduced food prices and rise in rural casual wage rates. Household resilience was improved and increasing use of drought tolerant early maturing varieties may have had an impact on crop productivity and on enhancing climate change responses although these effects have not yet been measured with high accuracy. The main problems with FISP relate to lack of an exit strategy, problems of targeting, leakage of fertilizer to unintended users, crowding out of the private sector, the high burden on government budgets and the drainage of foreign exchange.

The targeted input subsidy program registered some success but the food systems continued to be fragile. For instance, the drought of 2004/05 led to massive household and national food insecurity. Government then introduced the Farm Input Subsidy Program on seed and fertilizer. The program led to continuous food surpluses (Buffie and Atolia, 2009; Simtowe et al., 2009; Chirwa, 2010 and Holden and Lunduka, 2010). However, such success was also associated with favorable weather considering that there was still low use of improved maize varieties. About 58% of all households in Malawi grew hybrids in 2006 (World Bank 2006). This figure was much lower in the Southern Region of Malawi where only 40% of the households grew hybrids (Chirwa, 2005).

Smallholder farmers in Malawi prefer local maize varieties because of the quality of the flour when produced using traditional pounding methods. The local varieties may also require lower fertilizer dosages than hybrids and OPVs and are more storable (Denning et al., 2009; Smale and Rusike, 1998). In addition, yield stability and resilience or ability to escape or withstand drought has now been seen as quite fundamental to adoption among smallholder farmers considering that they are continuously operating under risky environments (Kassie et al., 2010; Peters 1995). Farmers have often failed to adopt new improved varieties for a number of reasons including failure to meet farmers' requirements, farmers' insufficient knowledge about the new varieties on offer, and varietal seeds sold at prices beyond the economics reach of the farmers (Aloyce et al., 2000; Langyintuo, 2005; Takane, 2008). As such even for the farmers that grow hybrids, nearly all of them continue growing the local maize variety for home consumption (Takane, 2008).

Southern Africa including Malawi is susceptible to climate change shocks. This is a threat to maize production, necessitating breeding programs to come up with new varieties that are drought tolerant. CIMMYT in 2009 produced two varieties, ZM309 and ZM523, which are drought tolerant and were supplied to the Farm Input Subsidy Program. Since the introduction of the two varieties in FISP no quantitative study has been conducted to assess the performance of the CIMMYT varieties vis a vis other varieties (hybrids and unimproved varieties under smallholder conditions.

3. Data and descriptive statistics

Our survey was based on an original sample of 450 households located in two districts in Central Malawi (Kasungu and Lilongwe) and four districts in Southern Malawi (Chiradzulu, Machinga, Thyolo and Zomba) that were surveyed in 2006, 2007 and 2009. We managed to find and survey 350 of these households in our 2012 survey. Households had been randomly sampled within each Enumeration Area following the integrated household survey of 2004 by the National Statistical Office, Malawi. Two (in Thyolo, Chiradzulu and Machinga districts) or three (Zomba, Kasungu and Lilongwe districts) Enumeration Areas (EAs) were randomly sampled and at least 30 households were randomly sampled from each of the EAs (Lunduka 2009). Like in the earlier years the survey included collection of detailed farm plot level data with GPS-measurement of

plot sizes. A plot was defined as a uniform crop stand that received homogenous "input treatment" (Holden and Lunduka 2012).

In this report we only analyze the 2012 data but these data can be merged with the data from earlier survey rounds. The 2012 data also includes a substantial amount of recall information from the 2010/11 and the 2009/10 seasons as well for variables that we thought would be quite easy for the households to remember. We cannot rule out some larger recall bias in these data than for the recall information for the 2011/12 season, however.

We have retained much of the same structure of the questionnaires in the 2012 survey round as in earlier survey rounds to ensure comparability of the data across years. A special module of the questionnaire investigated the role of the input subsidy program, including access to subsidies and participation in the informal and formal input markets over the last three years based on households' ability to recall. A similar questionnaire was used in the 2008/09 survey round for the 2008/09 and 2007/08 production years and can serve as a base for comparison. Our impression is that the subsidy program and input use are so important to households that they are able to recall these data in a reliable way. Our impression is also that they trusted us and revealed the truth based on their experiences with repeated surveys and not facing any repercussions based on revealing politically sensitive information. Our impression based on the data from earlier survey rounds and a comparison with finding in the larger national surveys that our sample is fairly representative of the situation in the Central and Southern regions of Malawi. Two important quality aspects of our survey as compared to the larger surveys are that 1) we collected data from all plots of all the households while the larger surveys typically collected data from only one plot per households; 2) we measured all plots with GPS while most of the larger surveys relied on farmers' own estimates of plot sizes. Our data should therefore suffer less from measurement error than the larger surveys. Our "complete farm" data also give a much better basis for assessing the farming system as a whole, see Holden (2013) for an example of analyses that can be done with these data.

4. Descriptive statistics

4.1. Basic household characteristics by district

Table 1 presents basic statistics for some key variables by district to highlight some of the variations across districts in Central and Southern Malawi.

Table 4.1.1. Household land, gross production income, shock exposure, cash saving for fertilizer purchase, having formal employment and non-agricultural business.

District	Stats	Farm size, ha	Farm value, MK	Sales revenue 2011/12 MK	Shock exposure dummy 2011/12	Have cash savings for fertilizer, dummy	Formal employ-ment, dummy	Non-agricultural business, dummy
Thyolo	Mean	0.62	282378	31056	0.71	0.15	0.23	0.45
	St. Err.	0.06	42045	5751	0.07	0.05	0.06	0.07
	N	45	45	50	48	48	47	47
Zomba	Mean	0.89	349071	19987	0.73	0.38	0.07	0.45
	St. Err.	0.06	106443	7631	0.05	0.06	0.03	0.06
	N	73	73	83	74	74	73	73
Chiradzulu	Mean	0.75	218162	15678	0.70	0.35	0.27	0.42
	St. Err.	0.07	75031	3941	0.08	0.08	0.07	0.08
	N	37	37	42	37	37	37	36
Machinga	Mean	1.31	188486	23573	0.65	0.41	0.07	0.54
	St. Err.	0.12	48917	5690	0.07	0.07	0.04	0.07
	N	47	47	49	46	46	46	46
Kasungu	Mean	2.05	259124	78103	0.59	0.54	0.16	0.36
	St. Err.	0.27	41591	16564	0.05	0.06	0.04	0.05
	N	78	78	88	82	82	81	81
Lilongwe	Mean	1.19	774958	20721	0.76	0.25	0.18	0.51
	St. Err.	0.17	159184	7393	0.05	0.06	0.05	0.06
	N	60	60	71	63	63	61	61
Total	Mean	1.22	358321	34907	0.69	0.36	0.15	0.45
	St. Err.	0.08	40531	4656	0.02	0.03	0.02	0.03
	N	340	340	383	350	350	345	344

Source: Own survey data.

Farm sizes tend to be smaller in the more densely populated districts in Southern Malawi. Exposure to the dry spell or droughts in 2011/12 was high in all districts. The table also reveals information on the extent of access to formal employment and non-agricultural business activities. Sales revenues were highest in Kasungu district than in any other district because of the role tobacco play in the agricultural portfolio of the district. Table 4.1.2 provides additional information on access to credit, informal employment and access to subsidized fertilizer during the last three growing seasons based on household recall.

About 29% of the households had applied for loans and out of these 84% had received loans. Informal (*ganyu*) employment was also common as a supplementary source of income (note incomplete data for Lilongwe district). The share of households that had accessed subsidized fertilizer was 73% in 2011/12, not much lower than in the two previous years. These shares are close to the shares found by Holden and Lunduka (2013) for the same sample of households in 2007/08 and 2008/09. This is quite surprising considering the cut-back of the program that took place in 2011/12. It may be because of increasing splitting of the packages. We get back to that below.

Table 4.1.2. Share of households applying for loan (and whether loan was given), having formal or informal employment and non-agricultural business, by district.

District		Apply loan	Loan given	Ganyu, informal employment	Received subsidized fertilizer 2011/2012	Received subsidized fertilizer 2010/2011	Received subsidized fertilizer 2009/2010
Thyolo	Mean	0.35	1.00	0.43	0.98	0.96	0.91
	St. Err.	0.07	0.00	0.07	0.02	0.03	0.04
	N	46	16	47	47	47	47
Zomba	Mean	0.22	0.63	0.53	0.86	0.86	0.84
	St. Err.	0.05	0.13	0.06	0.04	0.04	0.04
	N	73	16	70	73	73	73
Chiradzulu	Mean	0.19	0.86	0.59	0.73	0.78	0.73
	St. Err.	0.07	0.14	0.08	0.07	0.07	0.07
	N	37	7	37	37	37	37
Machinga	Mean	0.30	0.86	0.64	0.70	0.65	0.59
	St. Err.	0.07	0.10	0.07	0.07	0.07	0.07
	N	46	14	45	46	46	46
Kasungu	Mean	0.30	0.90	0.51	0.65	0.76	0.75
	St. Err.	0.05	0.07	0.06	0.05	0.05	0.05
	N	81	21	81	79	78	79
Lilongwe	Mean	0.39	0.78	1.00	0.52	0.52	0.61
	St. Err.	0.06	0.09	0.00	0.06	0.06	0.06
	N	61	23	6	62	62	62
Total	Mean	0.29	0.84	0.54	0.73	0.75	0.74
	St. Err.	0.02	0.04	0.03	0.02	0.02	0.02
	N	344	97	286	344	343	344

Source: Own survey data.

Cash availability of households may be important for their ability to buy inputs and ability to tackle shocks. Table 4.1.3 provides information on household cash availability and ability to mobilize cash for urgent needs.

Table 4.1.3 shows that cash availability is higher in Kasungu district where farm sizes are larger and where more cash crops are produced (tobacco). The majority of households do not have any cash savings specifically for purchase of fertilizers in the middle of the dry season the survey was carried out but most households stated that they were able to mobilize cash for purchase of fertilizer (Median= 5750MK which is equivalent to about 30 kg fertilizer at commercial price). This was after a year with wide-spread dry spells during the rainy season. It appears that households are able to mobilize more funds for investment than for urgent consumption needs.

Table 4.1.3. Ability of households to mobilize cash for different purposes, by district

District	Stats	Max. cash amount that can be mobilized in a day for urgent household expenditure (MK)	Max. cash that can be mobilized in a day for urgent investment opportunity (MK)	Total cash the household can mobilize for fertilizer purchase (MK)	Cash savings of household for fertilizer purchase (MK)
Thyolo	Mean	1854	4029	7994	1820
	Median	1000	2500	6250	0
	St.err.	507	631	960	467
	N	40	41	48	48
Zomba	Mean	1649	5780	10045	3277
	Median	1000	3000	3800	0
	St.err.	230	937	2260	932
	N	65	55	74	74
Chiradzulu	Mean	1756	5383	9236	2563
	Median	1100	2000	3000	0
	St.err.	294	1604	2091	998
	N	27	30	37	37
Machinga	Mean	2593	6495	11311	2446
	Median	1500	3000	2750	0
	St.err.	535	1428	3134	694
	N	43	39	46	46
Kasungu	Mean	3330	13900	28529	2256
	Median	2000	5000	12500	0
	St.err.	505	2688	6140	821
	N	71	64	82	82
Lilongwe	Mean	2809	5214	15960	1939
	Median	1500	1250	6000	0
	St.err.	601	1430	4797	478
	N	54	50	63	63
Total	Mean	2428	7341	15240	2412
	Median	1050	3000	5750	0
	St.err.	201	773	1848	326
	N	300	279	350	350

Source: Own survey data.

4.2. Access to subsidized inputs

We will now look at access to subsidized fertilizer over the last three production years based on household recall. The distribution of coupons in terms of bags of fertilizer per household for the three years are presented in Figures 1-3 with the most recent year first.

Figure 4.2.1 shows that a larger share of the households received at least some subsidized fertilizer in 2011/12 in the Southern region than in the Central region as less than 20% received nothing in the South against about 45% receiving no subsidized fertilizer in the Central region. The share receiving a full package of two bags of fertilizer was small in both regions, about 15% and 12%. About 55% received the one coupon/bag of fertilizer in the South and close to 35% received one coupon/bag in the Central region sample. There were very few who received more than two bags of fertilizer.

Figure 4.2.1. Distribution of free fertilizer coupons in Southern and Central Malawi, 2011/12

Figure 4.2.2. Distribution of free fertilizer coupons in Southern and Central Malawi, 2010/11

Figure 4.2.3. Distribution of free fertilizer coupons in Southern and Central Malawi, 2009/10

Figures 4.2.2 and 4.2.3 for the 2010/11 and 2009/10 years show that the splitting of packages was not something new that came in 2011/12 but there has been a decline in the share of households receiving the full package, especially in the Central region. The share of households receiving no subsidized inputs was higher in the Central region in all three years. One may argue that this is in line with a poverty targeting objective of the program as farm sizes are smaller and poverty levels higher in the Southern region.

Figure 4.2.4 gives a more disaggregated picture by district for the 2011/12 season only. We see that the most complete coverage was in Thyolo district where very few of the sample households received no subsidized fertilizer. The highest shares receiving the full package (two bags) was in Machinga and Kasungu while none received the full package and a very high share received no subsidized fertilizer in the Lilongwe district sample. It is evident that implementation policies related to the distribution of the input subsidies vary substantially across districts.

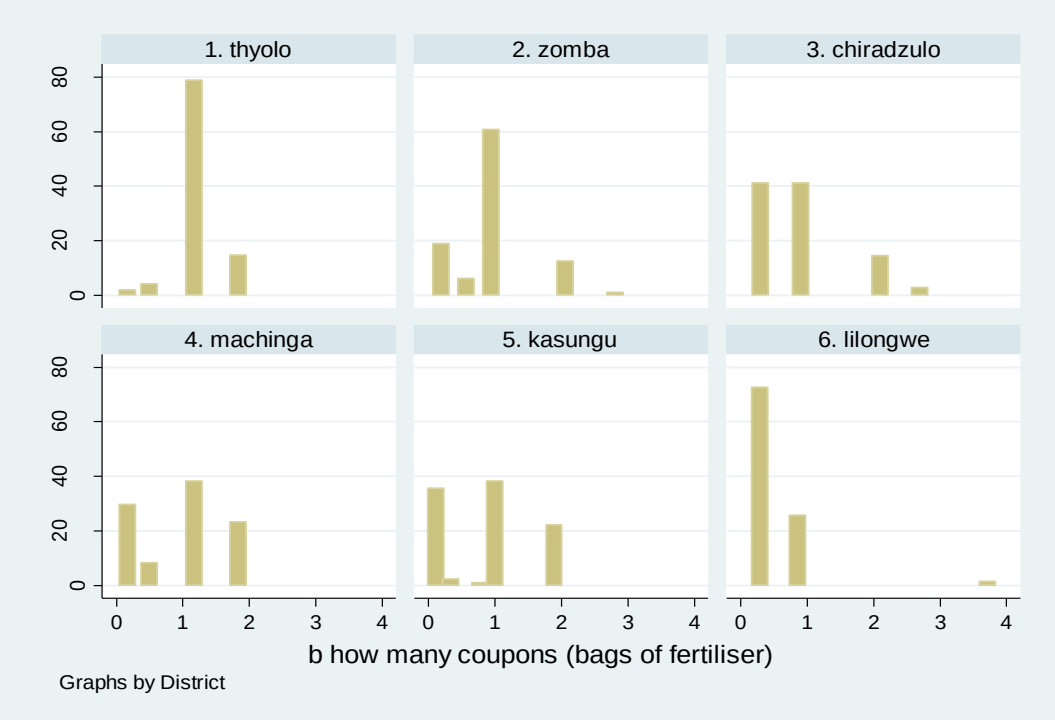

Figure 4.2.4. Distribution of free fertilizer coupons in 2011/12, by district

We will now look at the distribution of free seeds under the subsidy program. The program includes distribution of free improved maize seeds as well as various types of legumes seeds as part of the packages. Figure 4.2.5 shows the distribution of free seeds during the 2011/12 season by number of kg seeds received per household of any type of free seed.

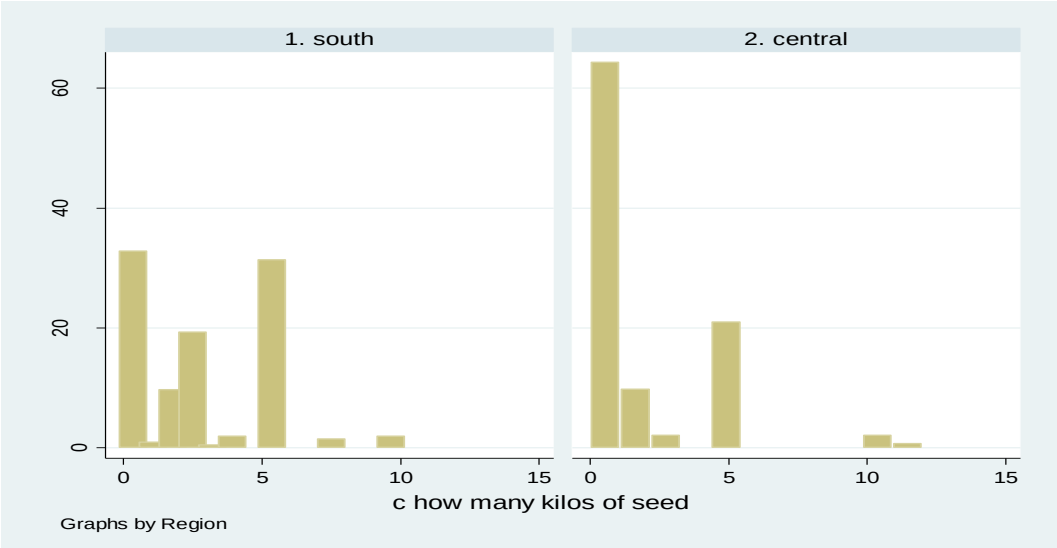

Figure 4.2.5. Distribution of free seeds under the subsidy program, 2011/12

Figure 4.2.5 shows that about 65% received no free seeds in the Central region sample while about 33% received no free seeds in the Southern region sample. The most common quantities received were 5 kg while some received 2.5 kg, 2 kg and 10 kg. Figure 6 shows the distribution of seeds by type of seed for the first seed package received and Figure 7 shows the distribution by seed type for those receiving a second package of seeds.

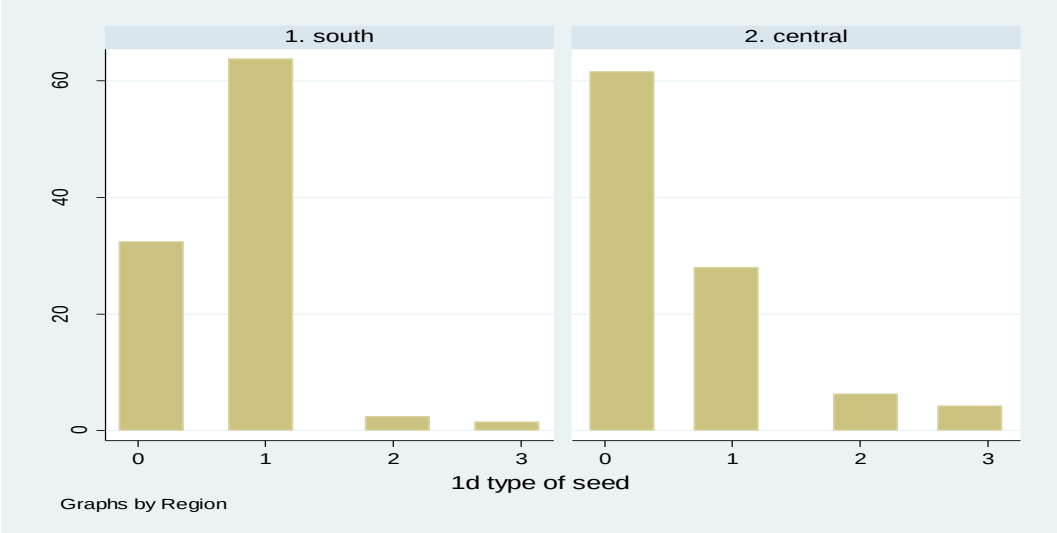

Figure 4.2.6. Type of seeds distributed in 2011/12: 0: No seed, 1:HYV, 2:OPV, 3:Legume seeds

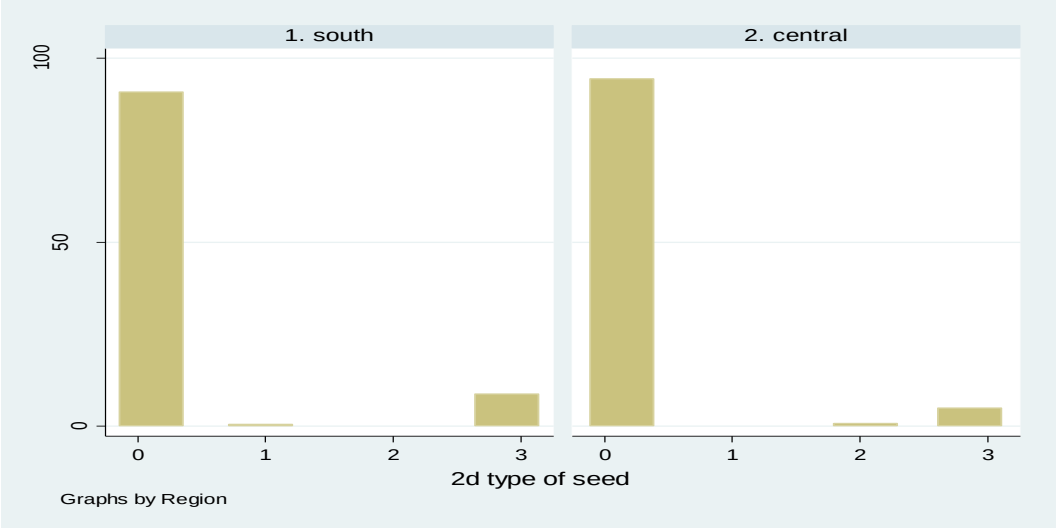

Figure 4.2.7. Households receiving a second seed package in 2011/12, by seed type: 0: No seed, 1:HYV, 2:OPV, 3:Legume seeds

Hybrid maize dominated as the first package received, especially in Southern region while a larger share of households received OPV or legume seeds in the Central region sample. Figure 4.2.7 shows that a very small share of households received a second seed package which typically was a package of legume seeds while the first package in most cases was an improved

maize package. Overall, the coverage for seeds was again better in the South than in the Central region and the coverage with legume seed was fairly modest.

4.3. Maize variety use and preferences

In the 2011/12 season 173 out of 351 households in our sample received hybrid maize seeds through the input subsidy program, 15 households received OPV seeds and 34 households received legume seeds. Of those receiving improved seeds, 34.4% received SC403 (Kanyani), 25% received SC627 (Mkango), 13.9% received DK8053, 7.2% received DK8033, according to their own memory. Table 4.3.1 provides an overview of the most common maize varieties that the households stated to have received through the subsidy program during the last three production years.

Table 4.3.1. Maize varieties received as % of those receiving in the 2011/12, 2010/11 and 2009/10 seasons

Maize variety	2011/12, %	2010/11, %	2009/10, %
Receiving improved maize seeds	50.7	54.1	51.9
SC403 - Kanyani	34.4	39.0	42.3
SC627 – Mkango	25.0	23.7	24.7
DK8053	13.9	5.3	3.3
DK8033	7.2	9.5	8.8
ZM523 – Demeta (OPV)	**6.7**	**5.3**	**7.7**
Pannar 43	2.8	0.5	4.4
SC719 – Njobvu	2.2	0.5	2.2
MH18	2.2	4.2	0.6
MH19	0.6	3.2	0.6
Decap	0.6	1.1	0
ZM63	0.6	1.6	5.0
SC407	0.6	4.7	0.6
MH41	0.6	0.5	0
DK9089	0.6	0	0
DK8071	0.6	0	0
DK8067	0.6	0	0

Source: Own survey data.

It is not possible to state that this distribution is representing the demand for maize varieties as supply side factors related to what was available in the depots for distribution with the inputs subsidy coupons may be more important for what households received than their own preferences.

Table 4.3.2 gives an overview of preferred maize varieties that the households stated that they would have used if they had good access to fertilizers and if they did not have access to fertilizer. They were first asked about the preference of type of maize variety (Local, HYV, OPV) and then asked to name a variety.

Table 4.3.2. Preferred types of maize and varieties with good access and no access to fertilizer

Variety type	With good access to fertilizer, %	Without fertilizer access, %
Hybrid	78.5	46.8
OPV	4.6	3.5
Local	16.7	47.1
Name of variety		Name of improved variety, % of those who want improved var.
SC403 - Kanyani	35.9	34.1
SC627 – Mkango	22.1	20,8
DK8053	7.6	5.2
DK8033	9.1	9.8
ZM535	1.1	1.7
Pannar 43	2.2	1.2
SC719 – Njobvu	15	5.8
MH18	8.3	13.3
MH19	0.4	
Pioneer	1.5	
ZM63		
SC407	0.4	
MH41	1.1	
DK9089	0.4	
DK8071	0.7	0.6
DK8052	0.7	

Source: Own survey data.

The households were also asked about their reasons for their variety preferences. They are summarized in Table 4.3.3.

Table 4.3.3. Reasons for maize variety preferences with good access and no access to fertilizer

Stated reasons for maize variety preferences	Good access to fertilizer, % of 324 respondents	Without fertilizer access, % of 322 respondents
High yield	59.3	17.7
Early maturing	16.1	13.0
Not prone to pests	9.3	4.0
High fertilizer response	5.3	0
Flour lasts long	3.4	2.8
Poundability	3.1	1.9
Drought tolerant	2.5	2.8
Good taste	0.9	1.2
Seeds readily available	0.3	1.2
Still produce yields without fertilizer		55.3

Source: Own survey data.

Perceived advantages and disadvantages of different types of maize varieties are presented in Table 4.3.4. The lower number of responses for OPV indicates the poorer knowledge of this type of varieties and this is also to some extent reflected in the responses.

Table 4.3.4. Perceived advantages and disadvantages of different maize varieties

Perceived advantages of local maize	% of 341	Perceived disadvantages of local maize	% of 317
Pest resistance	40.8	Low yield	55.5
Flour lasts longer	25.5	Late maturity	20.8
Poundability	22.9	Demand high rainfall	13.3
Taste	2.6	Require more fertilizer	9.5
More weight than HYV	0.9		
Perceived advantages of OPV maize	% of 133	Perceived disadvantages of OPV maize	% of 107
High yield	51.1	Easily attacked by storage pests	46.7
Early maturity	16.5	Late maturity	21.5
Good poundability	13.5	Require fertilizer to produce well	18.7
Can be reused the next season	7.5	Require more rain	6.5
Large grains(!)	6.0	Small grains(!)	2.8
Flour lasts long	5.3	Light weight (marketing)	1.9
		Not taste	1.9
Advantages of hybrid maize	% of 344	Disadvantages of hybrid maize	% of 327
Early maturity	43.2	Susceptible to pests	66.7
High yield	36.4	Needs more fertilizer	14.7
Drought tolerant	13.6	Flour does not last long	9.8
Fertilizer responsive	6.8	Poor poundability	5.5
		Require good rainfall	2.1

Source: Own survey data.

In order to investigate further whether households obtained the preferred varieties in the last three years we asked for each year "*Regarding the maize seed demanded in 2011/2012, did the household try to obtain different type of seed than it used?"* If they answered yes, we asked the following follow-up question: "*If yes, what type of seed did the household try to obtain but failed to obtain?"* Table 4.3.5 provides information about the share of households that did not obtain the maize varieties they demanded and what type of variety they demanded in the three years.

Table 4.3.5. Unmet demands for improved maize varieties by production year

	2011/12	2010/11	2009/10
% of households not obtaining their preferred variety	35.1	26.3	20.6
Maize varieties demanded but not obtained	% of 108	% of 79	% of 72
SC403 - Kanyani	29.6	40.5	35.6
SC627 – Mkango	25.0	24.1	30.5
DK8053	7.4	6.3	5.1
DK8033	9.3	10.1	10.2
ZM535		1.3	
SC719 – Njobvu	12.0	7.6	5.1
MH18	4.6	3.8	8.5
Pioneer	5.6	1.3	1.7
MH31	1.9	1.3	1.7
MH41	1.9	1.3	1.7

Source: Own survey data.

The responses indicate that it is the most commonly used varieties that are also the ones that most often people have failed to obtain. Supply constraints therefore appear to constrain the adoption of the most popular varieties.

We also asked people about their sources of maize seeds. People had more than one source of such seeds. Table 4.3.6 gives an overview of how large % of the respondents used each of the following sources to obtain their maize seeds.

Table 4.3.6. Sources of maize seeds used by households

Source of maize seed	% of households obtaining maize seeds from this source
ADMARC depot	68.3
Private trader	24.0
Shop	21.7
Own seeds	49.0
Neighbor	26.1

Source: Own survey data.

The variation in distance to the nearest place to purchase maize seeds, measured in minutes walking time, is presented in Table 4.3.7. The average time for all households is 80 minutes while the longest is 720 minutes.

Table 4.3.7. Distance to nearest place to buy maize seeds by district

District	Mean	St. Error	Minimum	Maximum	N
Thyolo	85	8	15	240	47
Zomba	105	8	3	300	76
Chiradzulu	114	10	10	240	36
Machinga	74	18	2	720	44
Kasungu	71	8	0	300	81
Lilongwe	43	6	0.5	180	60
Total	80	4	0	720	344

Note: Distances are measured in minutes walking time one way.

We asked whether there had been a change in the varieties of maize seeds available over the last three years? 45.7 % of the respondents confirmed that there has been a change. The distribution of their responses about what changes have taken place is summarized in Table 4.3.8. We see that 80% of those who perceived that there had been a change experienced an improvement in the availability of improved maize seeds.

Table 4.3.8. Changes in maize seed availability over the last three years

Changes	Freq.	Percent	Cum.
The variety of seeds available has improved	123	80.92	80.92
The variety of seeds available has become worse	4	2.63	83.55
Seed access varies from year to year and is highly unreliable	18	11.84	95.39
The best varieties are out of stock, we have to take what we can find	2	1.32	96.71
I don't know, I only use local maize seeds	5	3.29	100
Total	152	100	

Source: Own survey data.

Finally, we asked those who did not use improved maize seeds in 2011/12 about their reasons for not using such seeds. The responses are presented in Table 4.3.9. The most important reason is the high price of seeds which also relates to the lack of money while the second important reason is the preference for local maize varieties. Limited availability of seeds and preferred varieties was the third most important reason.

Table 4.3.9. Reasons for not using improved maize seeds in 2011/12

Reasons	Freq.	Percent	Cum.
Unavailability of seeds	8	8.3	8.3
Unavailability of preferred variety	3	3.1	11.5
Too high price for the seed	52	54.2	65.6
Prefer own seed	15	15.6	81.3
Prefer local seeds	11	11.5	92.7
No difference between local and improved seed	3	3.1	95.8
Lack of money	2	2.1	97.9
Limited fertilizer access	1	1.0	99.0
Disease resistant	1	1.0	100
Total	96	100	

Source: Own survey data.

4.4. Leakages from the subsidy program

We will now assess the extent of leakages of subsidized fertilizers and access to such leaked fertilizers for the sample households through the informal market, including the prices paid from such informal sources of inputs relative to the full subsidy and commercial prices for fertilizers. Holden and Lunduka (2010a, 2013) were the first to uncover this problem by including specific questions in their survey instruments on the different sources of inputs, something that had not been included in the larger national surveys. Holden and Lunduka estimated, based on the assumption that their sample was representative of the situation in Malawi that as much as 30% of the fertilizer may have leaked into the informal market in the 2007/08 and 2008/09 seasons at prices that were 20-50% of the commercial price.

Table 4.4.1 presents information about the informal market for fertilizer coupons which is part of the informal market for subsidized inputs. It presents data on whether the households have been offered any cheap coupons over the last three production years by region. Table 4.4.2 presents the same information in a more disaggregated form, by district. Since we use the sample as that of Holden and Lunduka (2010a; 2013) we may assess the trend from 2007/08 and 2008/09 that they studied. At that time they found that 25-26% of the households were offered to buy coupons. Table 4 shows that this has gone down to 11% in 2009/10, probably due to the efforts by MoAFS to reduce such leakages. However, we see an increase again in the two following years to 15 and 17%, possibly indicating that the problem is on the increase. We also see that the informal market is more active in the Central region than in the South. This may also be related to the lower share of households receiving subsidized fertilizer in the Central region, something that also could be due to a higher level of leakages in this region. A further disaggregation in Table 4.4.2 shows that the informal market for coupons is most developed in Kasungu, followed by Lilongwe and Thyolo.

Table 4.4.1. Exposure to offering of cheap fertilizer coupons in the informal market by region and year

Region	Stats	Offered cheap coupons in 2011/12	Offered cheap coupons in 2010/11	Offered cheap coupons in 2009/10
South	Mean	0.09	0.08	0.06
	N	207	207	207
Central	Mean	0.29	0.24	0.19
	N	143	142	142
Total	Mean	0.17	0.15	0.11
	N	350	349	349

Note: These are coupons that are sold (illegally) in the informal market.

Table 4.4.2. Share of households offered cheap fertilizer coupons in the informal market by district and year

District	Stats	Offered cheap coupons in 2011/12	Offered cheap coupons in 2010/11	Offered cheap coupons in 2009/10
Thyolo	Mean	0.13	0.11	0.06
	N	47.00	47.00	47.00
Zomba	Mean	0.11	0.10	0.06
	N	79	79	79
Chiradzulu	Mean	0.03	0.03	0.03
	N	34.00	34.00	34.00
Machinga	Mean	0.06	0.06	0.06
	N	47	47	47
Kasungu	Mean	0.32	0.26	0.21
	N	81	81	81
Lilongwe	Mean	0.24	0.21	0.16
	N	62	61	61
Total	Mean	0.17	0.15	0.11
	N	350	349	349

Source: Own survey data.

The prices offered for coupons in the informal market by district and year are presented in Table 4.4.3. These prices may also be compared with the prices found by Holden and Lunduka (2010a; 2012) in the 2007/08 and 2008/09 years. They found the median price to be 1500 MK and 2500 MK in those two years. The fertilizer prices fell in the following year and that may explain why we find no price increase from 2008/2009 to 2009/10 (Table 4.4.3). However, we see a further increase in the informal prices over the last three years with higher prices in the Central region where the market is more active and fewer households received free coupons.

Table 4.4.3. Prices offered for fertilizer coupons in the informal market, by region and year

Region	Stats	Price offered for coupons 2011/12	Price offered for coupons 2010/11	Price offered for coupons 2009/10
South	Mean	2833	2469	1695
	St. Err.	259	283	320
	N	18	16	10
Central	Mean	3639	3221	2679
	St. Err.	260	173	233
	N	41	34	28
Total	Mean	3393	2980	2420
	St. Err.	202	155	202
	N	59	50	38

Source: Own survey data.

Another indicator of the extent of the informal market is through assessing to what extent households have been offered to sell their fertilizer coupons and the extent to which they did so. Again we can compare with Holden and Lunduka (2010a; 2012) who found that about 7-7.5% of the households stated to have received such offers. In Table 4.4.4 we see sign of a similar contraction in the market in 2009/10 to about 3% of the households, followed by an expansion to about 7% again in 2011/12. Table 4.4.5 provides information on actual sale of coupons which was minimal, the same as was found by Holden and Lunduka (2010a; 2013), making them conclude that the source of the leaked coupons is not the households that have received the free coupons but must be higher up in the distribution system. This is also consistent with the findings of Holden and Lunduka (2012) that most households have very high shadow prices for fertilizer and very few are therefore likely to be willing to sell coupons at the low prices found in the informal market.

Table 4.4.4. Offered to sell fertilizer coupons, by region and year

Region	Stats	Offered to sell coupons in 2011/12	Offered to sell coupons in 2010/11	Offered to sell coupons in 2009/11
South	Mean	0.07	0.03	0.02
	N	205	207	207
Central	Mean	0.08	0.06	0.04
	N	143	143	142
Total	Mean	0.07	0.04	0.03
	N	348	350	349

Source: Own survey data.

Table 4.4.5. Sold coupons, by region and year.

Region	Stats	Sold coupons in 2011/12	Sold coupons in 2010/11	Sold coupons in 2009/10
South	Mean	0.01	0.00	0.00
	N	207	207	207
Central	Mean	0.01	0.01	0.00
	N	143	143	143
Total	Mean	0.01	0.00	0.00
	N	350	350	350

Source: Own survey data.

Table 4.4.6 presents the prices offered if households were willing to sell their fertilizer coupons by year. As expected these prices were lower than the prices that were offered to households willing to buy coupons in the informal market.

Table 4.4.6. Prices offered for selling fertilizer coupons by region and year.

Region	Stats	Price received for sold coupons 2011/12	Price received for sold coupons 2010/11	Price received for sold coupons 2009/10
South	Mean	1832	1917	1833
	St. Err.	360	271	333
	N	14	6	3
Central	Mean	3545	2838	2500
	St. Err.	327	500	577
	N	11	8	7
Total	Mean	2586	2443	2300
	St. Err.	298	324	416
	N	25	14	10

Source: Own survey data.

Next we assess the extent of the informal market for fertilizers that must have leaked from the system distributing subsidized fertilizer as the prices it was sold for were much lower than the commercial prices. Table 4.4.7 presents the share of the households that have been offered such cheap fertilizers during the three last production years. Again we see an increase from 2009/10 while the extent of participation had been reduced from 2008/09 when 23% of the household stated that they had bought such cheap fertilizers.

Table 4.4.7. Offered to purchase cheap fertilizer in the informal market by region and year

Region	Stats	Offered to buy cheap fertilizer 2011/12	Offered to buy cheap fertilizer 2010/11	Offered to buy cheap fertilizer 2009/10
South	Mean	0.19	0.14	0.10
	N	207	207	207
Central	Mean	0.22	0.13	0.12
	N	143	143	143
Total	Mean	0.20	0.13	0.11
	N	350	350	350

Source: Own survey data.

Table 4.4.8 presents the prices paid for such cheap fertilizers in the informal market. The commercial price was about 10000 MK/50 kg bag in 2011/12. We see that the prices in the informal market are around 50% of the commercial price. Again prices are a bit lower in Southern region than in the Central region but this market was quite active in both regions.

Table 4.4.8. Prices offered for cheap fertilizer in the informal market

Region	Stats	Price per 50 kg bag in 2011/12	Price per 50 kg bag in 2010/11	Price per 50 kg bag in 2009/10
South	Mean	4632	4183	3474
	St. Err.	364	400	376
	N	40	27	19
Central	Mean	5197	4558	6265
	St. Err.	354	493	2762
	N	32	19	17
Total	Mean	4883	4338	4792
	St. Err.	257	309	1319
	N	72	46	36

Source: Own survey data.

Table 4.4.9 shows how much fertilizer households that participated in this market bought during the last three years. We see that they bought on average of one bag each.

Table 4.4.9. Number of bags of cheap fertilizer bought by households buying, by region and year

Region	Stats	Number of cheap fertilizer bags bought 2011/12	Number of cheap fertilizer bags bought 2010/11	Number of cheap fertilizer bags bought 2009/10
South	Mean	1.14	1.16	1.36
	St. Err.	0.15	0.19	0.19
	N	31	26	18
Central	Mean	0.93	0.87	1.14
	St. Err.	0.24	0.31	0.41
	N	25	17	14
Total	Mean	1.05	1.05	1.26
	St. Err.	0.14	0.17	0.21
	N	56	43	32

Source: Own survey data.

Table 4.4.10 provides information about how much fertilizer the households bought on average at full commercial price in each of the three last growing seasons by region. We see that on average they bought 0.44 bags in 2009/10 and this declined to 0.21 and 0.16 bags in the following years. The decline seems particularly strong in the Central region and this may be related to unfavorable tobacco prices in recent years.

Table 4.4.10. Average number of bags of commercial fertilizer bought by region and year

Region	Stats	Commercial fertilizer bags 2011/12	Commercial fertilizer bags 2010/11	Commercial fertilizer bags 2009/10
South	Mean	0.23	0.13	0.21
	St. Err.	0.06	0.04	0.06
	N	207	207	207
Central	Mean	0.05	0.33	0.76
	St. Err.	0.05	0.33	0.23
	N	143	143	143
Total	Mean	0.16	0.21	0.44
	St. Err.	0.04	0.14	0.10
	N	350	350	350

Source: Own survey data.

Table 4.4.11 summarizes total average fertilizer use by year and region including subsidized fertilizers, informal (cheap) fertilizer and commercial fertilizer obtained. We see that the average amount was 2.3 bags in 2009/10 and it increased to 2.36 and to 2.48 bags in the two following years. Total fertilizer use appears therefore not to have declined in this period. It seems therefore that improved informal access has compensated for the reduced formal access.

Table 4.4.11. Total average fertilizer use in 50 kg bags by region and year

Region	Stats	Total fertilizer use 2011/12	Total fertilizer use 2010/11	Total fertilizer use 2009/10
South	Mean	1.81	1.70	1.65
	St. Err.	0.11	0.09	0.09
	N	207	207	207
Central	Mean	3.47	3.30	3.25
	St. Err.	0.58	0.43	0.45
	N	143	143	143
Total	Mean	2.48	2.36	2.30
	St. Err.	0.25	0.19	0.20
	N	350	350	350

Source: Own survey data.

4.5. Exposure to dry spells

We will now assess the extent of exposure to dry spells during the last three seasons by households in each of the six districts. We were in advance informed that there were widespread dry spells in the 2011/12 season but we also asked about the situation in the previous two production years. Table 4.5.1 presents households' perception whether they had experienced dry spells during the last three years. There is obviously a subjective element in assessment of what is a dry spell. We did not force a special definition of this onto the respondents but asked them about their own perceptions.

Table 4.5.1. The frequency of drought the last three years by district.

District	Stats	Drought occurred at least once during last 3 years	Drought in 2011/12	Drought in 2010/11	Drought in 2009/10
Thyolo	Mean	1.00	0.98	0.24	0.11
	n	47	47	46	46
Zomba	Mean	0.97	0.95	0.13	0.04
	n	79	79	79	79
Chiradzulu	Mean	1.00	1.00	0.58	0.18
	n	33	33	33	33
Machinga	Mean	0.85	0.81	0.23	0.11
	n	47	47	47	46
Kasungu	Mean	0.40	0.26	0.10	0.06
	n	81	81	81	79
Lilongwe	Mean	0.81	0.73	0.07	0.12
	n	62	60	59	59
Total	Mean	0.80	0.74	0.18	0.09
	n	349	347	345	342

Note: The table shows frequencies and sample size by district.

Table 4.5.1 shows that 74% of the households were exposed to a dry spell in the 2011/12 season against 18% and 9% in the previous two years. The aggregate measure indicates that 80% have been exposed to a dry spell at least once during the last three years. The seriousness or extent of the dry spell appears to have been lower in Kasungu district than in the other districts as only 26% perceived that they had been exposed to a dry spell in the 2011/12 season and only 40% perceived that they had been exposed to such an event at least once the last three years. In the Appendix we have provided maps for rainfall during 10-day intervals during the early 2011/12 rainy season when the dry spells occurred.

Table 4.5.2 provides information about initial timing of planting of maize by district for sample households. The dry spell caused many households to replant maize due to crop failure. Table 4.5.3 gives the planting times for maize for households that replanted their maize after the dry spell.

Table. 4.5.2. Initial planting time for maize in the 2011/12 season by district

District	October	November	December	January	February
Thyolo	14	29	3	0	1
Zomba	25	30	12	0	0
Chiradzulu	14	14	5	0	0
Machinga	5	12	17	2	0
Kasungu	1	31	39	0	0
Lilongwe	1	21	16	2	0
Total	60	137	92	4	1

Note: The table gives the number of respondents.

Table 4.5.3. Timing of replanting of maize after the dry spell in the 2011/12 season by district

District	October	November	December	January	February
Thyolo	0	11	16	2	0
Zomba	2	13	28	4	1
Chiradzulu	0	3	6	2	0
Machinga	0	5	7	10	1
Kasungu	0	1	6	4	2
Lilongwe	0	4	9	12	0
Total	2	37	72	34	4

Note: The table gives the number of respondents.

We use this exposure to the dry spell to assess the impacts on maize yields of different types of maize using our farm plot level data in the following analysis at plot level. But before that we look at some of the household perception data on the functioning of the targeted input subsidy program.

4.6. Perceptions on the performance of the input subsidy program

We have asked the households about their perceptions of who decide on the allocation of subsidized inputs in their community, their impression about the effects of the cutback of the subsidy program in 2011/12, the perceptions of the problems with the program and how it may be improved.

Table 4.6.1 gives their opinions on who decides on the allocation of subsidies in their community. We see that 58% perceive that it is the chief that decides while another 18% perceives that it is the chief jointly with a village committee. Only 9% perceive that it is agricultural officers in collaboration with a village committee, followed by 7% thinking that it is the chief in collaboration with agricultural officers. This illustrates that the main power in relation to the allocation still rests with the local chief.

Table 4.6.1. Who decides on the distribution of input subsidy coupons in the community

Who decides input coupon distribution	Freq.	Percent	Cum.
The chief	199	58	58
Village committee	15	4	62
Chief & agricultural officers	23	7	69
Agricultural officers	13	4	72
Agricultural officers & village committee	30	9	81
Chief & village committee	63	18	99
Other, chief & police unit	3	1	100
Total	346	100	

Source: Own survey data.

Table 4.6.2 assesses the effect of cutback in the subsidy program in 2011/12. 72% perceive that there was a cutback, 49% of those that responded that there was a cutback stated that it resulted in more households having to share coupons, while 48% responded that it resulted in fewer households receiving subsidies.

Table 4.6.2. Effects of cutback of the subsidy program in 2011/12 in your village

Reduction in input access in 2011/12?	Freq.	Percent	Cum.
No	96	27.75	27.75
Yes	250	72.25	100
Total	346	100	
How were input coupons distributed?			
Fewer hhs receive coupons	119	48.37	48.37
More hhs had to share coupons	121	49.19	97.56
Nobody in the village received	6	2.44	100
Total	246	100	
Outcome for poor & female headed hhs			
Given priority in allocation	81	33.75	33.75
Less likely to get coupons	109	45.42	79.17
Other considerations determine allocation	42	17.5	96.67
Those related to chief given coupons	1	0.42	97.08
Some got coupons	2	0.83	97.92
Shared like all beneficiaries	3	1.25	99.17
Rich people are accessing the inputs	2	0.83	100
Total	240	100	

Source: Own survey data.

On the question whether poor and female-headed households were likely to be given priority in the allocation after the cutback, 45% responded that these households were less likely to get while 34% stated that these households were given priority. These responses seem to indication

that there is substantial variation and may depend on the preferences and decisions of the chiefs in each locality.

Table 4.6.3 presents responses to perceived problems with the input subsidy program. Obviously, however, big the program is there is demand for more and 33% perceived the main problem was too few coupons for distribution. The second perceived problem was corrupt practices (26%) which also relate to the response that they create conflicts in the village (9%).

Table 4.6.3. Perceived problems with current input subsidy system

Stated problem with the current subsidy program	Freq.	Percent	Cum.
Create conflicts in village	30	9.2	9.2
Few coupons	109	33.44	42.64
Chiefs take more coupons	9	2.76	45.4
People sell coupons a lot	5	1.53	46.93
Expensive inputs	50	15.34	62.27
Corrupt practice	86	26.38	88.65
Long queues at the depots	17	5.21	93.87
No proper procedures for receiving coupons	3	0.92	94.79
Subsidy fertilizer arrives late	9	2.76	97.55
Long distance to the market	3	0.92	98.47
Fertilizer is not enough for large farms	5	1.53	100
Total	326	100	

Source: Own survey data.

Table 4.6.4 summarizes responses in terms of suggested solutions to the perceived problems with the input subsidy system. While the most common response was the program should be scale up which obviously is difficult given the financial constraints, 23% responded that more government intervention was needed to improve the program, 17% responded that the program should be replaced by a general subsidy and 7% stated that the chiefs should not have authority in coupon distribution.

Table 4.6.4. Suggested solutions to the current problems with the input subsidy program

Solutions to problems	Freq.	Percent	Cum.
Stop coupon system, introduce general subsidy	51	16.83	16.83
More coupons needed	98	32.34	49.17
Chiefs should not have authority in coupon distribution	21	6.93	56.11
Reduce price of fertilizer	11	3.63	59.74
Manure making	1	0.33	60.07
Extension workers be in charge in distribution	6	1.98	62.05
Government intervention	71	23.43	85.48
Allocated days to each particular village	17	5.61	91.09
Proper procedures for distributing coupons	6	1.98	93.07
Early delivery of fertilizer	11	3.63	96.7
Coupons should bear a name of beneficiaries	3	0.99	97.69
Fertilizer market should be near	5	1.65	99.34
Government to provide loans	1	0.33	99.67
Improve security	1	0.33	100
Total	303	100	

Source: Own survey data.

4.7. Familiarity with conservation technologies

To obtain more insights about knowledge of conservation technologies we added some extra questions in the 2012 survey instrument. A special program, the Agricultural Sector-Wide Approach – Support Program (ASWAp-SP) has been implemented since 2008-09 in Malawi and has aimed to disseminate improved technologies in form of improved maize varieties and various types of conservation technologies such as agroforestry trees, minimum tillage methods, pit planting, and manure making, The program was rolled out to all district in the country over a three year period and has identified lead farmers to keep demonstration trials and organize farmers' groups to promote the adoption of these technologies. By 2012 we should therefore expect that at least a part of our household sample has been exposed to this program and may have been influenced by it. We here summarize some of the findings in this regard below.

Table 4.7.1 summarizes household familiarity with a range of conservation technologies, the share of the respondents that have tried these technologies and the share of them that have learnt about these technologies from ASWAp-SP.

We see that compost making is the technology that most households (75%) are familiar with followed by agroforestry trees (54%), mulching (44%), pit planting (41%), minimum tillage with herbicides (40%), and drought tolerant maize varieties (33%). The most commonly and currently used technologies among these were compost making (43%), drought tolerant maize (20%) and agroforestry trees (18%) while few households were using minimum tillage with herbicides (1.4%) and pit planting (5%). The table also shows that many had learnt about these technologies from the ASWAp-SP program.

Table 4.7.1. Familiarity with conservation technologies

Technology	Know it	Total resp-onses	Percent	Tried it N(%)	Use it on farm now N(%)	Learnt it from ASWAP-SP N(%)
Minimum tillage with herbicides	139	349	39.8	10(2.9)	5(1.4)	42(12.0)
Mulching to conserve moisture	153	349	43.8	44(12.6)	26(7.5)	62(17.8)
Pit planting	142	349	40.7	25(7.2)	18(5.2)	56(18.9)
Agroforestry trees	189	349	54.2	80(22.9)	62(17.8)	90(25.9)
Compost making	261	348	75.0	192(55.0)	150(43.0)	126(36.2)
Drought tolerant maize varieties	113	348	32.5	77(22.1)	71(20.3)	64(18.4)
Spacing of maize	30	335	9.0			
Box ridges		315		53(15.7)	45(13.4)	33(10.5)
Using contour bunds to control erosion	51	321	18.5	20(6.2)	22(6.9)	
Avoid deforestation	2	322	0.6			
Early planting	1	319	0.3	1(0.3)	2(0.6)	
Crop rotation	10	281	3.8	4(1.4)	5(1.8)	9(3.4)
Planting vetiver grass	14	247	5.7	7(2.9)	6(2.4)	

Source: Own survey data.

24.4% stated that they were very familiar with the ASWAP-SP program promoting conservation agriculture technologies in Malawi since 2008. Another 20.6% stated that they were aware of it but they did not know it well. The remaining 55.1% stated that they did not know it.

We also asked more specific questions why the specific technologies that they have learnt about had not been adopted. The most important ranked responses are summarized in Table 4.7.2. Lack of familiarity was the most common and important constraint for most of the technologies for many households. High costs and lack of tools was stated as important additional constraints for the adoption of minimum tillage with herbicides. High labor requirement/intensity was another important constraint for agroforestry trees, pit planting, mulching and compost making.

Table 4.7.2. Reasons for not adopting specific technologies

Technology	Most important N(%)	Second most important N(%)	Third most important N(%)	Fourth most important N(%)
Minimum tillage with herbicides	Not familiar: 159(56.8)	Expensive: 73(26.1)	Lack of tools: 27(9.6)	Do not believe it 5(1.8)
Mulching to conserve moisture	Not familiar: 170(75.2)	Labor Intensive: 41(18.1)		
Pit planting	Not familiar: 176(75.2)	Labor Intensive: 46(19.7)	Slow response: 6(2.6)	
Agroforestry trees	Not familiar: 94(50.3)	Lack Seedlings: 81(43.3)	Do not believe it: 4(2.1)	No space to plant: 3(1.6)
Compost making	Not familiar: 77(65.3)	Labor Intensive: 29(24.6)	Slow response: 5(4.2)	
Drought-tolerant maize	Don't know any variety: 121(91.7)	Lack money: 6(4.6)		

Source: Own survey data.

The perceived most promising technologies that had not yet been adopted are summarized and ranked in Table 4.7.3 based on the number of responses.

Table 4.7.3. Most promising technologies not adopted, farmer perceptions

Technology	Most important N(%)
Agroforestry trees	100(40.5)
Compost making	93(39.2)
Pit planting	85(32.4)
Mulching to conserve moisture	82(31.2)
Minimum tillage with herbicides	77(28.6)
Drought-tolerant maize	57(24.4)

Source: Own survey data.

These findings seem to indicate that there is a potential for more widespread adoption of these technologies if the familiarity with them can be improved through various extension efforts.

4.8. Food self-sufficiency situation of households

Households were categorized as net sellers, self-sufficient or net buyers of maize in the 2011/12 versus the 2010/11 seasons. We expect that the dry spells have resulted in a larger share of net buyer households in 2011/12 than in the previous year and than in the earlier survey rounds. Holden and Lunduka (2010a; 2013) estimated that 62% and 60% of the households were net buyers of maize in the 2007/08 and 2008/09 years. Table 4.8.1 presents the classification for the

two recent years. The share of net buyers increased from 45% to 50% from 2010/11 to 2011/12. We may argue that the full effect of the dry spells in 2011/12 only materializes fully in the 2012/13 season because crops produced in the 2011/12 production year must last up to the next harvest in 2013 and this may perhaps explain why the share of net buyers is not higher based on the previous production year. Nevertheless, the data seem to indicate that the situation of the households had improved since the 2007/08 and 2008/09 production years.

Table 4.8.1. Classification of households as being net sellers, self-sufficient or deficit producers of maize in 2010/11 versus in 2011/12

		2010/11		
2011/12	Net seller	Self-sufficient	Net buyer	Total
Net seller	**94**	7	18	119
Row-%	79	6	15	100
Column-%	76	10	12	34
Self-sufficient	8	**33**	12	53
Row-%	15	62	23	100
Column-%	7	49	8	15
Net buyer	21	28	**126**	175
Row-%	12	16	72	100
Column-%	17	41	81	50
Total	123	68	156	347
Row-%	35	20	45	100
Column-%	100	100	100	100

Source: Own survey data.

4.9. Farm plot level analysis of maize yields

The following is based on the analysis of maize plots in the 2011/12 production year. We used simple linear models with household random effects and district fixed effects while controlling for farm plot characteristics in form of soil type, slope, weed infestation, plot size (measured by GPS). A sequence of models was run. The first model (m1) was run with the specification above. The second model (m2) included a dummy variable for whether the household respondent perceived that s/he had been exposed to drought/dry spell during the production year. The third model (m3) included dummy variables for the type of maize variety grown on the plot (HYV, OPV, or local). The forth model (m4) also includes interaction variables for Drought*OPV and Drought*Local maize varieties. The results of the models are presented in Table 4.9.1. The total sample was 578 maize plots.

Table 4.9.1. Farm plot level analysis of maize yields in 2011/12: Linear panel data models with household random effects

	Model 1	Model 2	Model 3	Model 4
Distance to plot, meters	0.012	0.007	0.005	0.006
Baseline: Soil type=sandy				
Soil type=loam	400.825***	394.302**	397.988***	409.178***
Soil type=clay	186.884	186.789	195.950	196.890
Baseline: Slope=flat				
Slope=slight	-127.106	-102.625	-106.539	-111.980
Slope=steep	-861.371****	-870.490****	-907.532****	-907.445****
Baseline=Weed inf.=high				
Weed infestation=medium	198.626	186.704	191.333	195.823
Weed infestation=low	155.669	150.271	160.222	172.711
Plot size in ha	-530.712****	-529.463****	-529.063****	-530.976****
Baseline: Thyolo district				
Zomba district	-1104.277****	-1101.619****	-1049.447****	-1050.566****
Chiradzulu district	-955.184****	-949.780****	-888.504****	-882.262****
Machinga district	-450.488	-489.185*	-485.355*	-493.676*
Kasungu district	-106.901	-396.550	-355.496	-378.873
Lilongwe district	-575.226**	-608.693**	-597.434**	-609.604**
Drought 2011/12, dummy		-403.557*	-368.154	-464.788*
Baseline: Maize variety: HYV				
Maize variety: OPV			-5.879	-318.918
Maize variety: Local			-281.078**	-309.790
Interaction: OPV&Drought				532.198
Interaction: Local&Drought				35.628
Constant	1752.467****	2151.794****	2204.341****	2280.655****
Prob > F	0.000	0.000	0.000	0.000
Number of observations	578	578	578	578

Note: Significance levels: *: 10%, **: 5%, ***: 1%, ****: 0.1%.

Our main interest in this analysis is to assess the impacts of droughts on maize yields and whether these effects vary systematically across HYV, OPV and local maize varieties. We see from model m2 that the drought dummy variable was significant at 10% level, with a negative sign and a coefficient that indicates that drought affected plots on average had a yield that was 404 kg/ha lower than plots not affected by drought. After including two dummy variables to distinguish the three types of maize varieties in model m3, the drought dummy is no longer significant but still has a negative sign and the coefficient indicates a reduction in yield of 368 kg/ha. The dummy for local maize is significant at 5% level and indicates that the yield of local maize is 281 kg/ha lower than that of HYV maize. Note that we have avoided inclusion of endogenous input variables in these regressions. When we include interaction variables for drought and maize varieties in Model 4, the drought dummy variable again becomes significant

at 10% level and indicates that the yields are 465 kg/ha lower on plots affected by drought than on other plots planted with HYV maize. The coefficient on OPV variety alone is insignificant but is negative and indicating 319 kg/ha lower maize yield than that of HYV maize without drought. The interaction variable for Drought*OPV was also insignificant but had a positive sign and a value of 532 kg/ha which is at least a weak indication that the OPVs were less negatively affected by drought than the HYV varieties. The coefficients for local maize were also insignificant with values of -319 kg/ha for the Local maize dummy and with a very low value of 36 kg/ha for the interaction effect, indicating that Local maize was about as negatively affected by drought as the HYV varieties on average.

Among the other results in Table 4.9.1 we see that maize yields were particularly low in Chiradzulu, Zomba and Lilongwe districts, while they were high in Thyolo district despite the fact that dry spells also affected most households in this district. The finding of higher yields in Thyolo district is consistent with the findings in earlier survey rounds (Holden and Lunduka 2010b). In this analysis we cannot rule out endogenous placement of maize varieties on plots with specific characteristics so we should be careful in drawing causal inferences. We face the risks of bias due to unobserved heterogeneity and omitted variables. Inclusion of endogenous variables may, however, not reduce these biases unless valid instruments can be identified. We have also relied on simple linear regressions that facilitate simple interpretation of average marginal effects. We think these models give a reasonable and good assessment of yield effects given our objectives. However, more robustness analyses may reveal additional insights. A first step in this direction follows.

As a further inspection of the robustness of the results and the possible effect of access to subsidized inputs we ran separate regressions for maize plots that had not and had received subsidized fertilizer. Identifying strong valid instruments that predict allocation of subsidized inputs is difficult and we have therefore resorted to this type of exogenous switching regression approach. Table 4.9.2 presents the results for plots that have not received subsidized fertilizers. The sample size is 405 plots showing that the majority of plots did not receive subsidized fertilizer (173 plots received subsidized fertilizer, see Table 4.9.3).

Table 4.9.2. Farm plot models for plots that **did not receive subsidized fertilizer**: Linear panel models with household random effects

	m1	m2	m3	m4
Distance to plot, meters	0.019	0.016	0.012	0.014
Soil type=loam	203.941	203.797	225.065	261.103
Soil type=clay	128.390	131.359	166.103	200.188
Slope=slight	-127.213	-106.156	-104.110	-120.279
Slope=steep	-978.006***	-989.292***	-1063.220****	-1108.861****
Weed infestation=medium	296.130**	287.860*	294.431**	301.502**
Weed infestation=low	215.923	217.783	240.517	249.799
Plot size in ha	-920.506****	-929.666****	-915.963****	-950.744****
Zomba district	-1112.160****	-1115.076****	-1050.251****	-1055.482****
Chiradzulu district	-971.073***	-967.806***	-912.558***	-900.554***
Machinga district	-739.262*	-810.150**	-810.636**	-803.493**
Kasungu district	-37.373	-339.482	-278.210	-321.535
Lilongwe district	-694.170**	-734.050**	-721.910**	-741.277**
Drought 2011/12, dummy		-414.698	-333.956	-588.728*
Maize variety: OPV			161.397	-416.823
Maize variety: Local			-313.954**	-584.061*
Interaction: OPV&Drought				1022.412*
Interaction: Local&Drought				318.952
Constant	1964.999****	2372.474****	2371.595****	2577.568****
Prob > F	0.000	0.000	0.000	0.000
Number of observations	405	405	405	405

Note: Significance levels: *: 10%, **: 5%, ***: 1%, ****: 0.1%. Standard errors corrected for clustering at household level.

Table 4.9.2 shows some small but interesting differences from Table 4.9.1. The parameter values for the drought dummy indicate similar negative effects of drought in the range from 415 kg/ha in model m2 to 589 kg/ha in model m4, slightly stronger negative effects than in the previous Table. Local maize had yields that were 314 kg/ha and 584 kg/ha lower than that of HYV maize in models m3 and m4 and these differences were significant at 5 and 10% levels. The dummy for OPV varieties was insignificant with value +161 kg/ha in model m3 without interaction effect but changed to -417 kg/ha in the model with interaction effect. This indicates that OPV varieties did at least as well as HYV varieties overall but has lower yields than HYV on plots not affected by droughts. The interesting finding though is that the interaction between Drought*OPV was significant at 10% level and with a positive yield effect of 1022 kg/ha. The OPV varieties therefore seemed to do significantly better than HYV varieties on plots affected by drought. The interaction between Drought*Local maize was not significant but had a value of 319 kg/ha possibly indicating that the yield reduction for Local maize compared to HYV was lower on plots affected by drought than on other plots.

Table 4.9.3. Farm plot models for **plots receiving subsidized fertilizer**: Linear panel models with household random effects

	sm1	sm2	sm3	sm4
Distance to plot, meters	-0.061	-0.071	-0.067	-0.076
Soil type=loam	818.560***	796.011***	743.820***	739.134***
Soil type=clay	107.100	102.144	74.160	68.639
Slope=slight	-663.885***	-649.846***	-654.801***	-661.783***
Slope=steep	-1316.574****	-1332.098****	-1316.181****	-1347.080****
Weed infestation=medium	517.907**	512.102**	476.217**	512.212**
Weed infestation=low	364.334	354.390	318.686	352.664
Plot size in ha	-433.989****	-431.501****	-422.655****	-420.318****
Zomba district	-1793.466****	-1772.508****	-1728.617****	-1724.215****
Chiradzulu district	-1415.707***	-1390.103***	-1308.038***	-1292.289**
Machinga district	-480.419	-462.945	-457.419	-448.155
Kasungu district	-357.732	-701.379	-713.207	-695.806
Lilongwe district	-273.873	-316.603	-329.285	-314.637
Drought 2011/12, dummy		-486.885	-524.360	-409.981
Maize variety: OPV			8.316	81.142
Maize variety: Local			-216.989	44.970
Interaction: OPV&Drought				-93.248
Interaction: Local&Drought				-306.234
Constant	2022.837****	2507.797****	2643.229****	2527.300****
Prob > F	0.000	0.000	0.000	0.000
Number of observations	173	173	173	173

Note: Significance levels: *: 10%, **: 5%, ***: 1%, ****: 0.1%. Standard errors corrected for clustering at household level.

The models with plots receiving subsidized fertilizer are presented in Table 4.9.3. The negative drought effects are in the same range as for plots not receiving fertilizer, from -410 kg/ha to -524 kg/ha but the differences between maize varieties and interaction effects are smaller and none of these effects was significant. This could be due to the more limited number of observations in each category and too much noise in the data.

In Table 4.9.4 we have included dummy variables for the most commonly grown improved maize varieties. We also included an interaction variable between the CIMMYT variety ZM523 and the drought dummy variable. As can be seen, many of the hybrid maize varieties produced significantly higher yields than the local maize. The ZM523 variety did not have significantly higher yields than the local maize. This could partly be due to the relatively small number of observations (4.3%) planted with this variety. When it was interacted with the drought dummy, the interaction effect was also not significant but the coefficient was quite large (+856 kg/ha), possibly illustrating the drought tolerance of this variety.

Table 4.9.4. Farm plot models with maize variety dummy variables: Linear panel models with household random effects

	md1	md2
Distance to plot, meters	0.016	0.014
Baseline: Soil type=sandy		
Soil type=loam	418.326***	396.477***
Soil type=clay	168.313	160.027
Baseline: Slope=flat		
Slope=slight	-139.162	-132.108
Slope=steep	-794.319****	-813.677****
Baseline=Weed inf.=high		
Weed infestation=medium	160.135	160.399
Weed infestation=low	99.188	91.433
Plot size in ha	-552.501***	-566.761***
Maize variety dummies: Baseline=Local maize		
DK8033 dummy	673.575**	682.556**
SC627 dummy	577.390**	591.516**
SC403 dummy	119.941	122.216
DK8053 dummy	591.167**	624.101**
MH18 dummy	193.79	190.606
Other hybrid varieties, dummy	662.778*	667.247*
ZM523 dummy	301.257	-262.454
Drought2011-12 dummy		-287.061
Interaction ZM523Xdroughtdummy		855.611
Baseline: Thyolo district		
Zomba district	-918.712***	-877.222***
Chiradzulu district	-713.994**	-682.822**
Machinga district	-138.785	-162.424
Kasungu district	204.226	55.105
Lilongwe district	-321.922	-335.356
Constant	1281.987****	1545.027****
Prob > F	0.000	0.000
Number of observations	580	580

Note: Significance levels: *: 10%, **: 5%, ***: 1%, ****: 0.1%. Standard errors corrected for clustering at household level.

4.10. Fertilizer experiments and shadow prices of fertilizer

We carried out simple input demand experiments with fertilizer similar to those done by Holden and Lunduka (2012). The first was an hypothetical "thought experiment" where we first asked whether the households would be willing to resell a full input package (consisting of one 50 kg bag 23-21 basal fertilizer, one 50 kg bag urea fertilizer and a 5 kg bag of improved maize seeds), where the price offered for resale was randomized by throwing a die and varied from full subsidy

price to commercial price. Second, the households were asked what they would do in the situation that they have not received the input package but are offered to buy the full package at a price randomized by throwing a die and with the same price range as in the first case. The responses are presented in Figure 8 as share of households keeping or buying the package at the y-axis and the randomized price range along the x-axis. We see that more than 80% of the households preferred not to resell the package even at the full commercial price, demonstrating the high value put on these inputs even if they were given free. On the other hand, the share of households willing to buy the package if they had not received it declined significantly more rapidly with increasing price and only about 50% of the households stated that they were willing (and able) to buy it at the full commercial price. This may illustrate the problem the households face of mobilizing cash for input purchase given that we trust the responses from these hypothetical framed field experiments that were not incentivized.

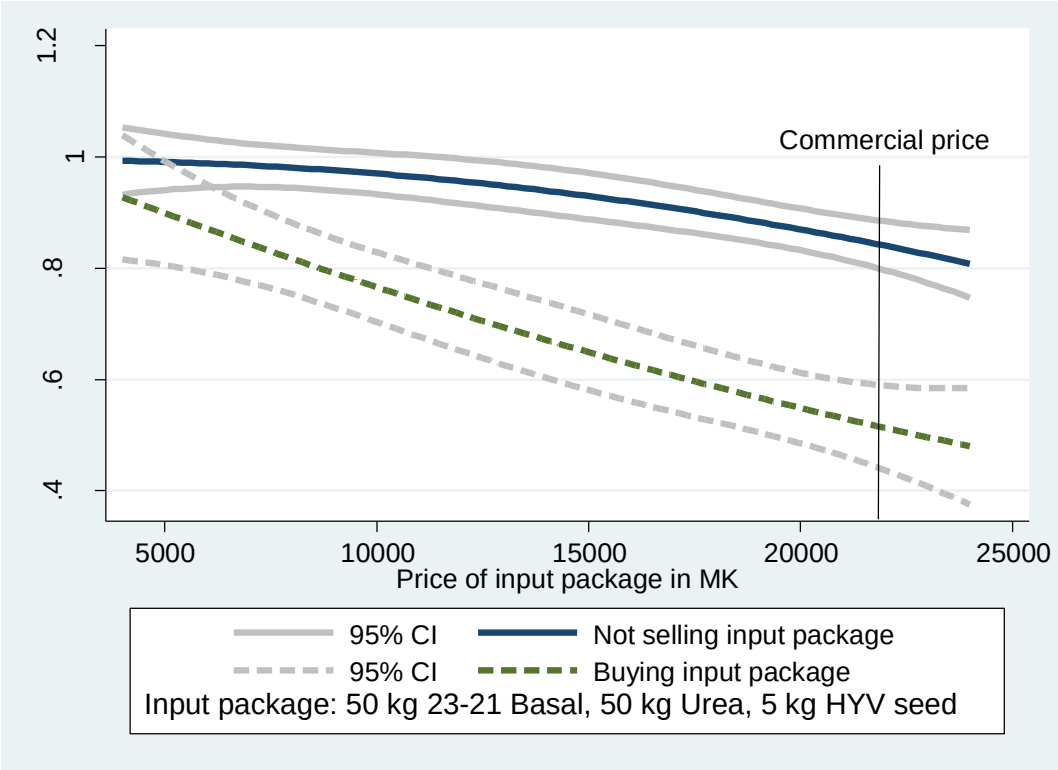

Figure 4.10.1. Input package experiments: Willingness to sell versus Willingness to buy input package at varying prices

As a remedy to the incentive compatibility issue we also introduced small scale real experiments using 5 kg 23-21 basal fertilizer where the choice was free between taking the 5 kg fertilizer and a random amount of cash and where the random amount of cash varied from full subsidy to the commercial price. This experiment should give an idea of the distribution of "cash-unconstrained" shadow prices of fertilizer among the sample households in the sense that the experiment did not require the households to mobilize any additional cash in order to get the

fertilizer rather than the cash. We see that close to 100% of the households had a shadow price higher than the 200 MK/5 kg while about 70% had an unconstrained shadow price at or above 2000 MK/5 kg which was about the double of the commercial price at the time of the experiment. We may conclude on the basis of this that fertilizer is a highly valued input.

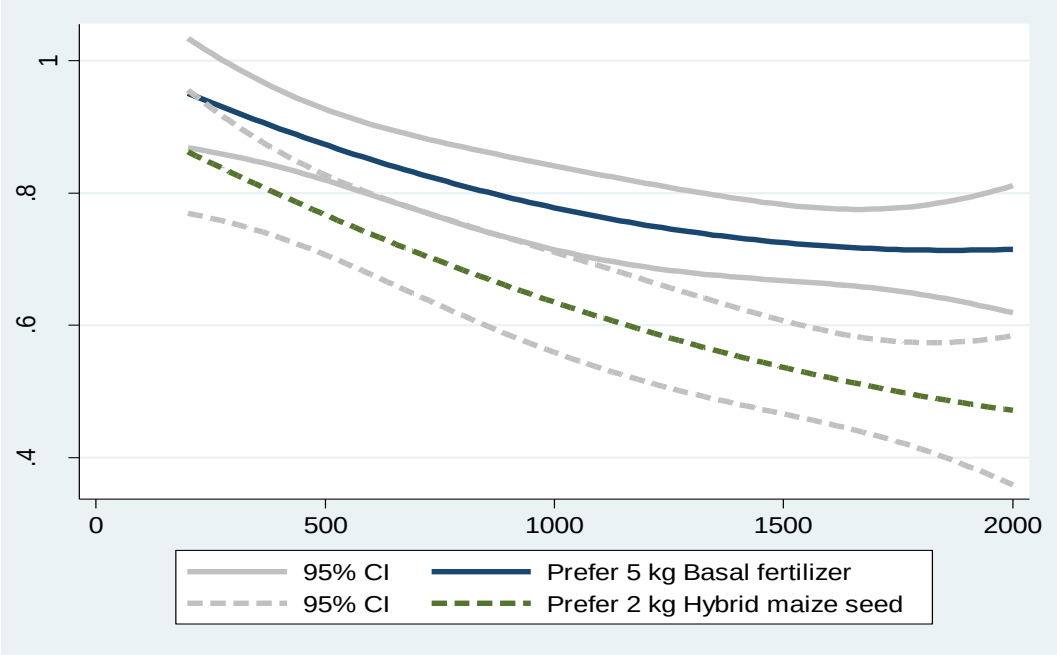

Figure 4.10.2. Choice experiment for 5 kg basal fertilizer (23-21) and 2 kg hybrid seed of maize at alternative random prices per package (MK).

Figure 4.10.2 also derives a demand curve for hybrid maize seeds in form of 2 kg bags of seeds where the design of the experiment was similar to that for fertilizer and the choice was between receiving the 2 kg of seeds or a randomized amount of cash based on the throwing of a die. Figure 4.10.2 shows that close to 90% of the households preferred the seed at the price of 200 MK/2 kg seed while about 50% preferred to keep the seed when the price was 2000 MK/2 kg seed. We should remember that these experiments were carried out in the middle of the dry season. The average maize seed price was 800 MK/2 kg in 2011/12. We see from Figure 4.10.2 that about 70% of the households had unconstrained shadow price for maize seeds at this level or higher. At the time of the experiment the price for one kg seed in nearby shops in Lilongwe district was 1300 MK/2 kg. About 55% of the households preferred to keep the seed at this price. The seed variety used in the experiments was SC403.

To further assess factors that influence or are correlated with the input demand as revealed in these hypothetical and real artefactual field experiments we used parametric regressions in form of linear probability models. A set of simple models are presented in Table 4.10.1 where the coefficients are elasticities. In addition to the own price elasticities the table includes farm size,

exposure to drought (dry spell in 2011/12), relative risk aversion (elicited in separate experiments), and district dummy variables to assess whether there is geographical variation.

Table 4.10.1. Input demand experiments: Linear probability Base models.

	Keep input package[a] Elasticity	Buy input package[a] Elasticity	Choose 5 kg fertilizer Elasticity	Choose 2 kg HYV seed Elasticity
Price of input (randomized)	-0.135****	-0.319****	-0.130****	-0.241****
Farm size	-0.034**	0.028	-0.042**	0.012
Affected by dry spell 2011/12	-0.020	0.009	-0.077**	-0.026
Relative risk aversion	0.556	2.640****	0.276	1.137
District: Baseline=Thyolo				
2.district=Chiradzulu	0.017	0.325****	-0.057	0.098
3.district=Zomba	-0.083	0.037	0.008	-0.045
4.district=Machinga	0.004	0.180	-0.144	-0.001
5.district=Kasungu	0.019	0.114	0.058	0.171*
6.district=Lilongwe	-0.064	-0.056	0.084	0.027
Constant	0.566	-1.789**	0.784	-0.277
Prob > F	0.000	0.000	0.000	0.000
Number of observations	333	333	333	333

Note: [a] Input package consisting of 50 kg 23-21 basal fertilizer, 50 Urea topdressing and 5 kg hybrid seed. Significance levels: *: 10%, **: 5%, ***: 1%, ****: 0.1%.

We see that a one percent increase in the price of the input package reduces the probability that the input package will be bought by 0.32% while it reduces the probability by 0.14% that a package that has been received for free will be sold. The price elasticity for the small input package (5 kg) is very similar (-0.13) to the elasticity for keeping an input package that has been received for free. The price elasticity for a small (2 kg) package of improved maize seeds was higher in absolute value (0.24).

The demand for fertilizer in the experiments was correlated with farm size and with higher demand for keeping the input package and preferring the 5 kg of fertilizer by households with smaller farm sizes (both significant at 5 % levels). Smaller farms have a stronger pressure and incentive to intensify their production in order to be self-sufficient with maize. This is consistent with the findings of Holden and Lunduka (2010b). The drought/dry spell dummy was only significant (at 5% level) in one of the models, in the 5 kg fertilizer experiment, where exposure to drought reduced the probability that households kept the 5 kg fertilizer by 7.7%. We used separate experiments to elicit risk preferences of household members (details on experiments in other paper). The household level of relative risk aversion was used and included in the models. We see that the coefficient was positive in all models but only significant (at 0.1% level) in the model for purchase of input package. While pure producers are theoretically expected to demand

less inputs the more risk averse they are (Sandmo 1972), we may find the opposite effect for producer-consumer households, especially if they are net buyers of food and that face price risk (Finkelshtain and Chalfant 1991). The finding is therefore not so surprising. It is also possible that households perceive that they reduce their risk exposure by buying the input package as compared to not buying it.

A larger set of variables are added to these regression models in Table 4.10.2. These variables include livestock endowment, a tool index capturing how well equipped households are with farm equipments (higher number implies more well equipped), an information index generated from the number of sources of information that households have easy access to (see Appendix for details), a dummy for whether they received subsidies in 2011/12, a dummy for whether they purchased any fertilizer at full commercial price in 2011/12, a dummy for whether they have cash savings for purchase of fertilizer, a dummy for whether they have non-agricultural business income, a dummy for whether they have members with formal employment, and a dummy for whether they had applied for loan during 2011/12.

We see that the variables included in Table 4.10.2 remained stable with the addition of these new and potentially endogenous variables while most of the new variables were insignificantly correlated with the dependent variables. Households that purchased commercial fertilizer in 2011/12 were significantly more likely (at 10 % level of significance) to buy the input package. Surprisingly, households that had cash savings for purchase of fertilizer were less likely to prefer the 5 kg fertilizer to the random amount of cash (significant at 5% level). And households that had applied for loan were more likely to prefer the package of improved seeds (significant at 10 % level).

Table 4.10.2. Input demand experiments: Linear probability models with additional covariates.

	Keep input package Elasticity	Buy input package Elasticity	Choose 5 kg fertilizer Elasticity	Choose 2 kg HYV seed Elasticity
Price of input (randomized)	-0.132****	-0.316****	-0.137****	-0.247****
Farm size	-0.027**	0.021	-0.046**	0.015
Tropical livestock units	-0.003	-0.011	0.000	-0.002
Tool index	0.062	0.035	0.020	0.047
Information index	-0.042**	0.039	0.013	0.015
Received subsidy 2011/12	0.030	0.021	-0.008	0.007
Purchased fertilizer at commercial price 2011/12	-0.005	0.045*	0.008	0.002
Affected by dry spell 2011/12	-0.019	0.001	-0.075**	-0.021
Have cash savings for input purchase	-0.001	0.003	-0.022**	-0.009
Have non-agric. Business income	-0.001	0.034	0.005	-0.004
Have formal employment	-0.003	0.001	-0.013	0.001
Applied for loan	0.015	0.025	0.016	0.028*
Relative risk aversion	0.564	2.405****	0.245	2.560
District: Baseline=Thyolo				
2.district=Chiradzulu	0.010	0.363****	-0.044	0.123
3.district=Zomba	-0.075	0.070	0.028	-0.002
4.district=Machinga	0.004	0.247*	-0.139	0.017
5.district=Kasungu	0.020	0.158*	0.050	0.172*
6.district=Lilongwe	-0.057	-0.001	0.090	0.037
Constant	0.496	-1.774**	0.797	-0.298
Prob > F	0.000	0.000	0.000	0.000
Number of observations	325	325	325	325

Note: Significance levels: *: 10%, **: 5%, ***: 1%, ****: 0.1%.

5. Overall discussion

Below we discuss our key research questions and try to answer them based on our survey findings.

5.1. How has the distribution of subsidized fertilizer and seeds been affected by the cut-back of the subsidy program in the 2011/12 season as compared to earlier years?

It appears that the cutback of the subsidy program has had less impact in terms of probability of access to subsidized inputs than could have been expected. There appears to be a trend toward splitting the input packages such that each household gets a smaller share but then a larger share of the households at least gets some subsidized inputs. It was most common to get one bag of fertilizer and quite often two or three households shared one 50kg bag of fertilizer. In reality this implies that the program is moving back towards how the TIP program was operated about ten

years ago when each household received smaller amounts of subsidized inputs. This seems also to be in line with the egalitarian mindset of the people and may also be the best exit strategy for the program if or when further cutbacks of the program will take place. Many households perceived that the chiefs still controlled much of the distribution of input subsidies and that poor and vulnerable households were less likely to get a share with the cutback of the program.

5.2. What types and varieties of maize seeds are grown and to what extent are there supply constraints hindering adoption of the most preferred varieties?

We found that SC403, SC627, DK8053 and DK8053 were the most commonly grown varieties while the CIMMYT variety that also was distributed through the input subsidy program since 2009 was grown on 4.3% of the maize plots of the sample households. The most commonly grown varieties were also the most popular varieties and cash constraints and access problems were important constraints to their level of adoption. The ZM523 variety was not yet in high demand.

5.3. To what extent has the leakages from the program been reduced through the tighter control of distribution of coupons by the Ministry of Agriculture and Food Security (MoAFS)? To what extent has the targeting of subsidies been improved by the tighter control by MoAFS?

We found that the leakages had declined after the focus on reducing the leakage of fertilizer coupons from the 2008/09 season. However, we see an increase in the leakages again from 2009/10 to 2011/12 and particularly so for fertilizer rather than fertilizer coupons.

It appeared that households perceived the problems with targeting to be largely the same as before with the chiefs still being powerful and deciding much of the distribution of the subsidized inputs.

5.4. How widespread were the dry spells (droughts) and what were their impacts in the 2011/12 season on the yields of improved maize and local maize varieties? And how did households respond to these droughts?

We found that 74% of the sample households had experienced a dry spell in the 2011/12 season. About 42% of the households had replanted their maize at least once during the season because of the dry spell.

5.5. How large share of the maize area is planted with improved maize varieties and how large share of this area is planted with drought-tolerant maize and how much better do these varieties do than other improved and local varieties?

About 65% of the maize plots were planted with improved maize varieties in the 2011/12 season. Average plot size was almost identical for plots planted with local maize and plots planted with improved maize. About 4.3% of the maize plots were planted with the CIMMYT ZM523 variety but the size for these plots was on average 0.68 ha against the average plot size of 0.36 ha for other maize plots. This implies that close to 7.5% of the maize area was planted with ZM523. The yields were not significantly higher for ZM523 than local maize but it appeared to do

relatively better in areas exposed to the dry spell although this effect was also not significant due to the relatively small sample size with such plots.

5.6. What is the potential effect of scaling up the distribution of the best-performing drought tolerant varieties; in drought years and in normal years? How high is the demand for the input package and small quantities of fertilizer and improved maize seeds?

While we would have liked to answer this question with confidence our results are not providing any strong evidence in direction of the drought tolerant variety ZM523. On the contrary some of the hybrid varieties gave significantly higher yields than local maize in this drought year. Overall, it appears that access to improved maize seeds has improved in recent years but many may still fail to find the preferred variety and many households are cash constrained and may fail to buy as much improved seeds and fertilizer as they would like to meet their food needs. Only 55% of our respondents preferred to keep 2 kg maize seed rather than the cash price of MK 1300 at the time we carried out our input demand experiments (August-September 2012). This reflects their unconstrained shadow price at this time. About 75% of the households preferred a small quantity of fertilizer (23-21) rather than the cash price of MK 1250 at the same point in time showing that fertilizer is higher in demand than improved maize seeds.

6. Conclusions

Maize continues to be the main staple food crop in Malawi for rural as well as urban consumers. The consumer preferences for maize as the main source of food continue to be strong and may be a partial explanation for the large scale input subsidy program that was implemented in Malawi from 2005/06 after weather calamities that caused serious food shortages in the country. The large-scale input subsidy program (FISP) appears to have stabilized the maize production at higher level and reduced the need to import maize into the country. Partly this may be due to good rainfall in subsequent years, until a somewhat more serious drought hit the country in form of dry spells in the early rainy season in 2011/12. This study has assessed the outcomes from this drought for a sample of 350 households located in six districts in Central and Southern Malawi. Our analysis has taken into account that the input subsidy program also was scaled down in this year due to shortages of foreign exchange. High international fuel and fertilizer prices have made the input subsidy program a heavy load to carry for the Malawian government and donor support for the program has dwindled as many donors see the program as only a temporary solution and have since asked the GoM to develop an exit strategy from the program. The high demand for continuing the program within the country has, however, made it very difficult for Malawian politicians to commit to such an exit strategy.

Since maize is susceptible to droughts, the Malawian economy and households remain vulnerable and will become even more so with continued population growth and increasing climatic variability which is a likely outcome of the ongoing human-induced climate change. Development of drought tolerant maize varieties may be one way to go as it is impossible to develop really drought resistant maize varieties. Our study allowed us to assess the effects of the

2011/12 drought and the performance of alternative maize varieties. The impacts of the dry spells were less negative than we had anticipated but maize yields may on average have been reduced by about 400 kg/ha. Many of the most commonly used hybrid varieties performed significantly better than the local maize. The hybrid varieties had yields about 600 kg/ha higher than that of local maize. The drought tolerant maize variety ZM523 was grown on about 4.3% of the maize plots surveyed and did not perform any better than the hybrid maize varieties. Its yield was not significantly higher than that of local maize although it appeared to do better in areas harder hit by drought. We also assessed access and demand for improved maize seeds. About 35% of the households stated that they were unable to obtain the most preferred maize variety in the 2011/12 season. The most popular varieties were also those most commonly grown so these varieties appear to have potential for further expansion. They also performed well in the drought year compared to local maize. Cash constraints and high prices for seeds may also limit the demand for improved maize seeds. About 55% of the households preferred a 2 kg package of improved maize seed rather than the going cash price of MK 1300 at the time of the experiment when they had the choice between receiving the seed and the cash which could then be used for other things. About 75% chose a small bag of 5 kg fertilizer (23-21) instead of the going cash price of MK 1250 at the same time (August-September 2012) which was the middle of the dry season. These experiments reveal the unconstrained shadow prices of households and the real demand when they have to take the cash from their own pocket to buy these inputs would reflect their constrained shadow price which are likely to be lower and leading to even lower shares of the households willing to buy these small input packages (Holden and Lunduka, in press).

Finally, we also assessed the knowledge, use and demand for various conservation technologies and whether the Agricultural Sector Wide Approach – Support Program (ASWAp-SP) which is the GoMs approach to promote more climate smart agriculture, has made any impact in our study areas. Compost making and use of agroforestry trees were the most popular and most well known conservation technologies, while pit planting, mulching, minimum tillage with herbicides and drought tolerant maize varieties were other technologies that were known by a significant share of the households. This is partly due to the ASWAp-SP program but also most households still lack sufficient knowledge and those with the knowledge reported various constraints to their adoption. We think that integration of these technologies into the maize farming system may enhance the moisture conservation and the fertilizer use efficiency and this can be another way to reduce the dependency on and cost of expensive imported fertilizers.

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Appendix 1. Variable generation

We assess some alternative asset endowment indicators in form of indexes based on ownership or not of specific asset items. We do this both for consumption items and production assets.

Tool index generation:

Gen toolindex=ownwheelbarrow+ownhoe+ownpanga+ownaxe+ownsickle+owntreadlepump+ ownhandsprayer

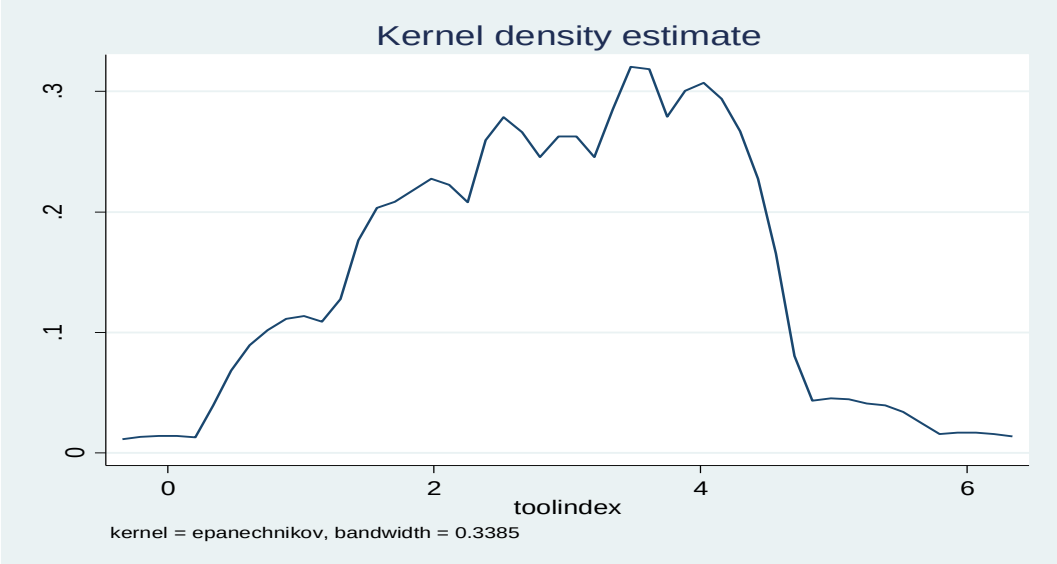

Figure A1. Tool index distribution

Information index generation:

gen infoindex=ownradio + owntv +owncellphone

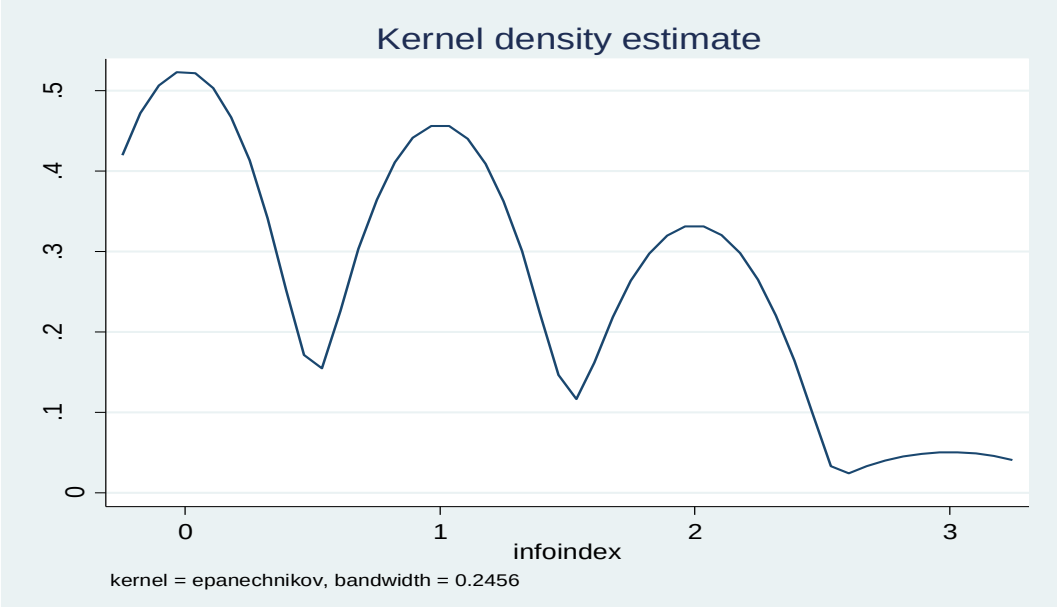

Figure A2. Information access index

Appendix 2. Rainfall distribution in Malawi 2011/2012 season: Dry Spell distribution

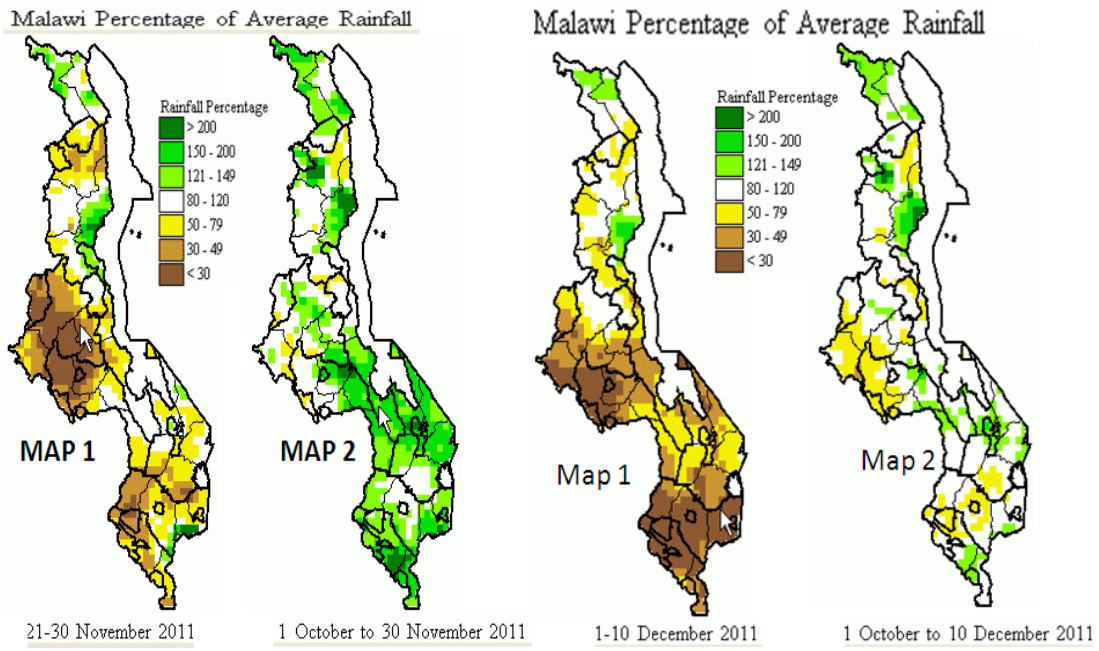

Fig. A11. Rainfall distribution late November-early December 2011 in Malawi. Sources: Department of Climate Change and Meteorological Services, Malawi 10-day Rainfall & Meteorological Bulletins, Issues 6-7 2011.

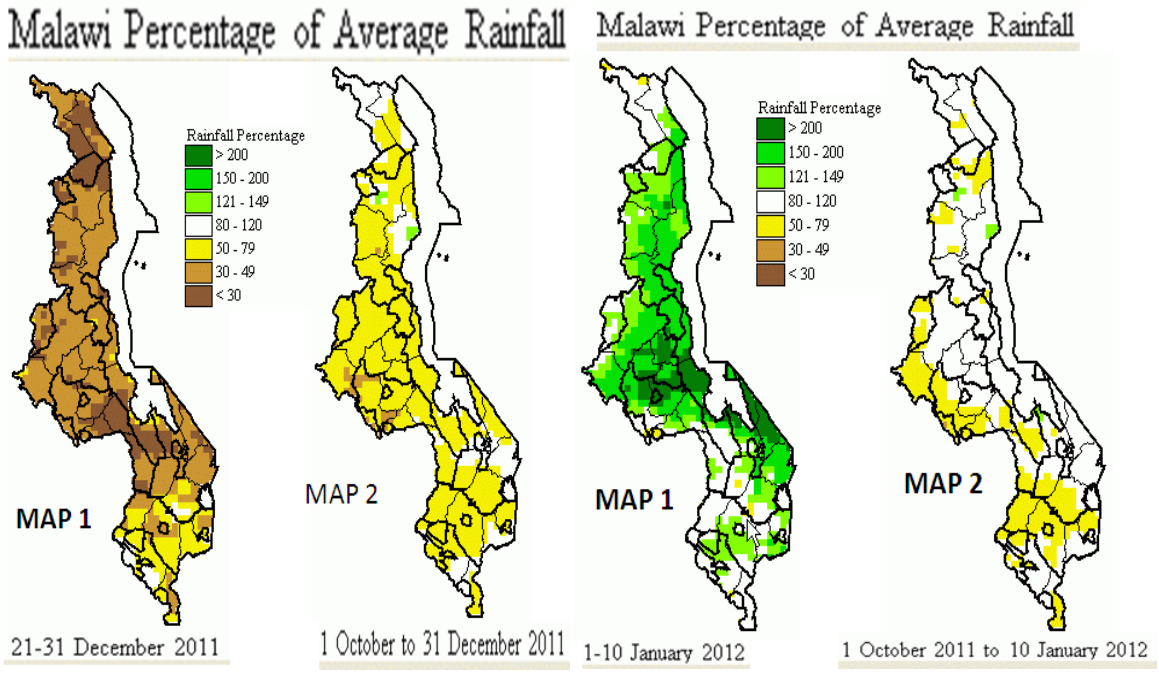

Fig. A12. Rainfall distribution late December 2011-early January 2012 in Malawi. Sources: Department of Climate Change and Meteorological Services, Malawi 10-day Rainfall & Meteorological Bulletins, Issues 8-9, 2012.

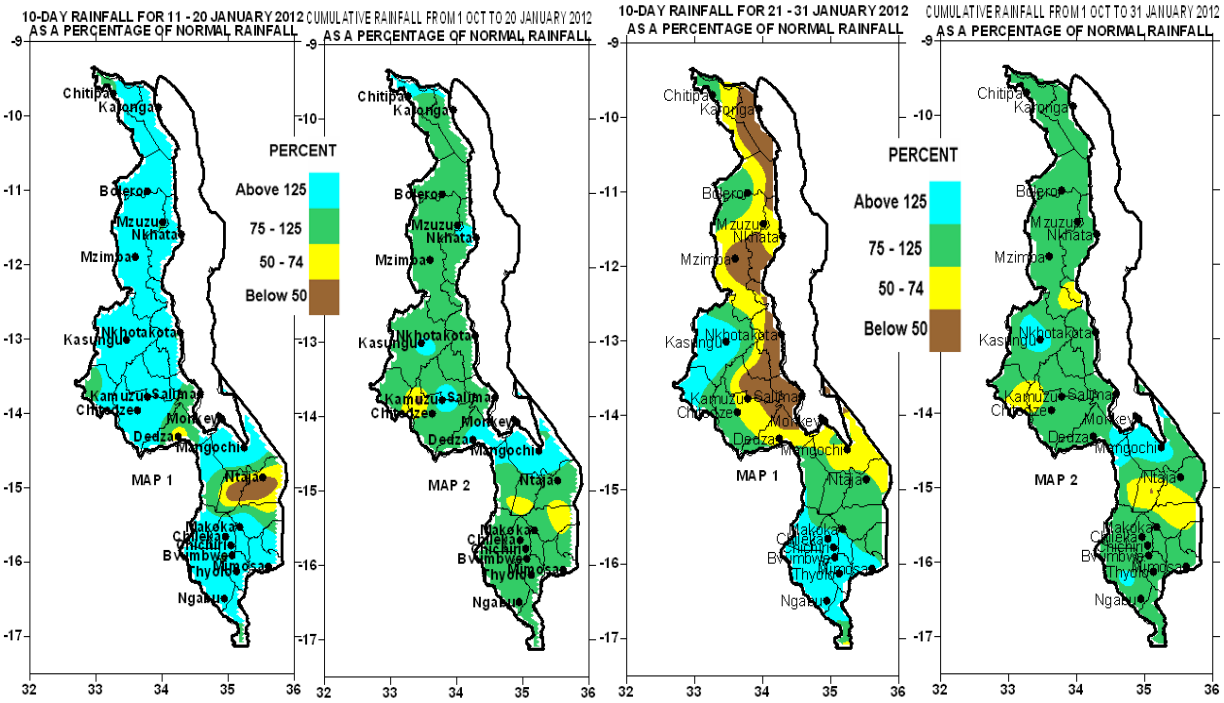

Fig. A13. Rainfall distribution mid January-late January 2012 in Malawi. Sources: Department of Climate Change and Meteorological Services, Malawi 10-day Rainfall & Meteorological Bulletins, Issues 11-12, 2012.

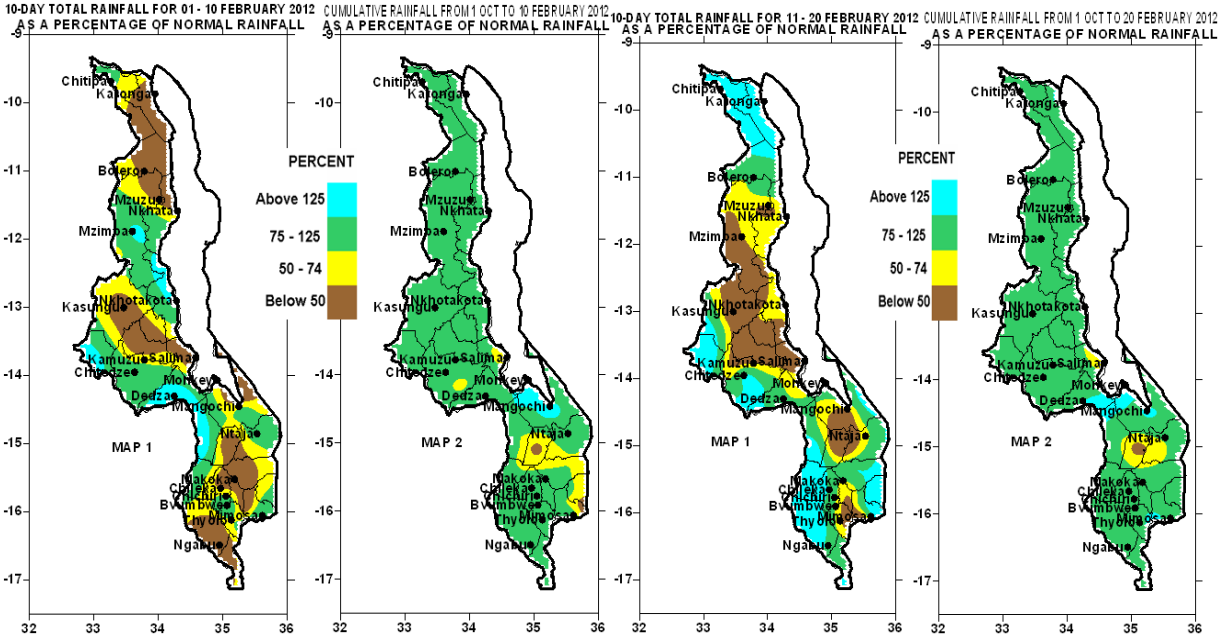

Fig. A14. Rainfall distribution early- and mid-February 2012 in Malawi Source: Department of Climate Change and Meteorological Services, Malawi 10-day Rainfall & Meteorological Bulletins, Issue 13-14, 2012.