Raising labour productivity to solve the paradox; labour shortage in the labour surplus economy; Malawi
(Is Targeted Fertilizer Subsidy the solution?)

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List of Acronyms

MoAFS –Ministry of Agriculture and Food Security

TIP-Targeted Input Program

AISP- Agricultural Input Subsidy Program

GPS-Geographical positioning System

PSU- Primary Sampling Units

EAs- Enumeration Areas

OLS- Ordinary List squares

MK-Malawian Kwacha

Abstract

Rural Malawian households are facing seasonal labour shortage problem at the peak time of their agricultural season while they are farming in a generally labour surplus economy. This problem is shared by many developing economies and several factors could cause it. Malawi's economy is characterized by low level of labour productivity which partly accounts for this seasonal labour shortage problem. Thus, it is paramount to increase labour productivity in Malawi as it affects the performance of the agricultural sector. In line with this, the government of Malawi designed Agricultural Input Subsidy Program in 2005 with a major objective of improving labour and land productivity. This paper aims at investigating the most influential factors through which labour productivity can be improved and on assessing how the targeted fertilizer subsidy program affects labour productivity in agriculture in Malawi. Most of the previous studies take labour shortage as one of their many problems to deal with, had wider geographic coverage (like sub-Saharan Africa), tried to deal with agricultural productivity in general and endogeneity of variables is the main thing hidden in many of the studies. Thus, this study focuses on the labour shortage problem in Malawi and gives the attention it deserves. It focuses on raising the smallholder's labour productivity. We use a large sample from six districts of the economy and panel data regression methods are used to minimize the problem of endogeneity. We also use treatment effect model to further minimize the endogeneity of "participation in the subsidy program" variable when assessing the effect of the program on labour productivity. Land per labour and fertilizer per labour ratios are found to be the most significant factors for farm labour productivity. But, female-headed households, which are less probable to get the fertilizer subsidy, are found to be as productive as male-headed households. It is also found that the targeted fertilizer subsidy enhanced farm labour productivity in Malawi.

Key words: Labour shortage, Labour productivity; panel Data, treatment effect model.

1 Introduction

1.1 Introduction

Like many other developing countries, which base their economy on traditional agriculture, the rural households in Malawi are experiencing seasonality in labour demand. While labour is underemployed or unemployed (in surplus) in most of the years, there exists labour shortage at the peak of cropping seasons. This is what has been termed as rural labour shortage in the labour surplus economy. For the adult work force, the average level of working hours peaks in the period between December and January, which is the busy part of the cropping season. At that time, the adult work force employs an average of more than five hours more per week than the annual mean of 31.32 hours and 41.77 hours for adult male and female work force respectively (Beegle 2006). High seasonal labour demand suggests the existence of labour shortages in peak times of the cropping season, despite underemployment in other periods of the year. This paper seeks to investigate the influential factors causing the labour shortage problem and suggests the possible solution to the problem with the focus on how smallholder's labour productivity could be improved.

Many Sub-Saharan African countries face the paradoxical situation of a rural labour shortage within a labour surplus economy with high population growth rates and high rates of unemployment. This is due to the generally low level of labour productivity which reflects smallholder's limited access to information and resources that would enable them to adopt different technologies and increase labour productivity (A. Saito, Hailu Mekonnen et al. 1994). In Malawi, low labour productivity and poor yields are central to the poverty problem. Low returns to labour and land contribute to household food insecurity and a vicious cycle of poverty (Alwang and Siegel 1999). Therefore, increasing labour productivity is paramount for raising labour productivity, achieving food security and breaking the vicious cycle of poverty (Simler 2005). But, the question is 'what are the most influential ways through which labour productivity could be improved?'

The government of Malawi started to implement Agricultural Input Subsidy Program in 2005 with the objective of improving smallholder productivity and food and cash crop production and reducing vulnerability to food insecurity and hunger. In particular, the program aimed at

improving land and labour productivity and production of both food and cash crops by smallholder farmers that faced heavy cash constraints restraining them from purchasing the necessary inputs (Dorward 2008).

Some evaluations have been done to see the effects of the subsidy program. The Ministry of Agriculture and Food Security has released the evaluation report for the program implementation in 2006/07(Dorward 2008). However, this report shows that the effect of the subsidy program on labour productivity was not part of the evaluation objectives and therefore was not covered in the evaluation.

It is important to assess the impact of the program on labour productivity in order to identify areas of improvement. Therefore, this paper also aims at assessing how the targeted fertilizer subsidy affects labour productivity in agriculture in Malawi.

The labour shortage problem attracts the researcher's attention because labour shortage at the peak of the cropping season negatively affects the ability of households to use the most of their endowments. In addition, labour scarcity constrains the adoption of soil erosion control practices (Mangisoni 1999) and household fish production (Brummett 2002). Moreover, a large sample study for Malawi by Tango International (2003) identified the scarcity of labour as an important constraint to the development of rural farming. Lack of labour was identified as the second most important reason cited by 45% of the sampled households for not cultivating all of their land, following lack of inputs such as fertilizer and pesticides (cited by 63% of households)(Beegle. 2006).

Solving the labour shortage problem has many implications; the seasonality of labour demand which gives rise to labour shortage at the peak season of cropping is mostly affecting the small land holders, which constitute most proportion of the rural households in Malawi(Beegle 2006). For landless households, the labour shortage at the peak times will reflect demand for ganyu work (short term, temporary rural daily labour work). In turn, it is the larger land holder who hires such labour. The smallholder does not hire labour facing insufficient income to do so. In addition, with low average and marginal return to labour, male family members seek employment possibilities off the farm(A. Saito, Hailu Mekonnen et al. 1994). This reduces

family labour supply and with insufficient income to hire labour, the worst effect of the seasonal labour shortage problem lies on the smallholder; (Beegle. 2006). Alwang, who uses simple linear programming model, states that the paradox of on-farm labour shortages on small landholdings can be explained by the multiple constraints smallholders face including lack of finance (Alwang and Siegel 1999). In summary, the labour shortage problem is making the smallholder poor more poor while affecting the rich landlord less. This shows that solving the labour shortage problem has implication in narrowing down the gap between the rich and the smallholder poor.

Smallholders try to adjust cropping patterns and farming systems to fit labour availability and they do this by limiting the area cultivated and planted (leaving some portion of their land fallow), the amount of weeding or fertilizer applied, or by growing less labour-intensive crops (A. Saito, Hailu Mekonnen et al. 1994). This coping strategy leaves the smallholders with less output and food insecure; affecting their capacity both in terms of buying inputs for the farm and also being nutritionally fit for the farm activity in the coming season and creating a vicious circle of hunger and deep poverty. Thus, there is a need to break this vicious circle by solving the labour shortage problem.

It is also important to see the opportunities that solving this problem will create. The fact that labour is scarce at some periods of the year has implications for the ability of farmers to diversify and enter in new activities which needs them for the whole year(Beegle 2006). Solving the labour shortage problem by implementing programs that effectively create the possibility for free surplus labour throughout the year makes household members ready for permanent activities like non-farm permanent job or education where they stay throughout the year. This creates the chance for income source diversification which is in line with the concept of agricultural transformation.

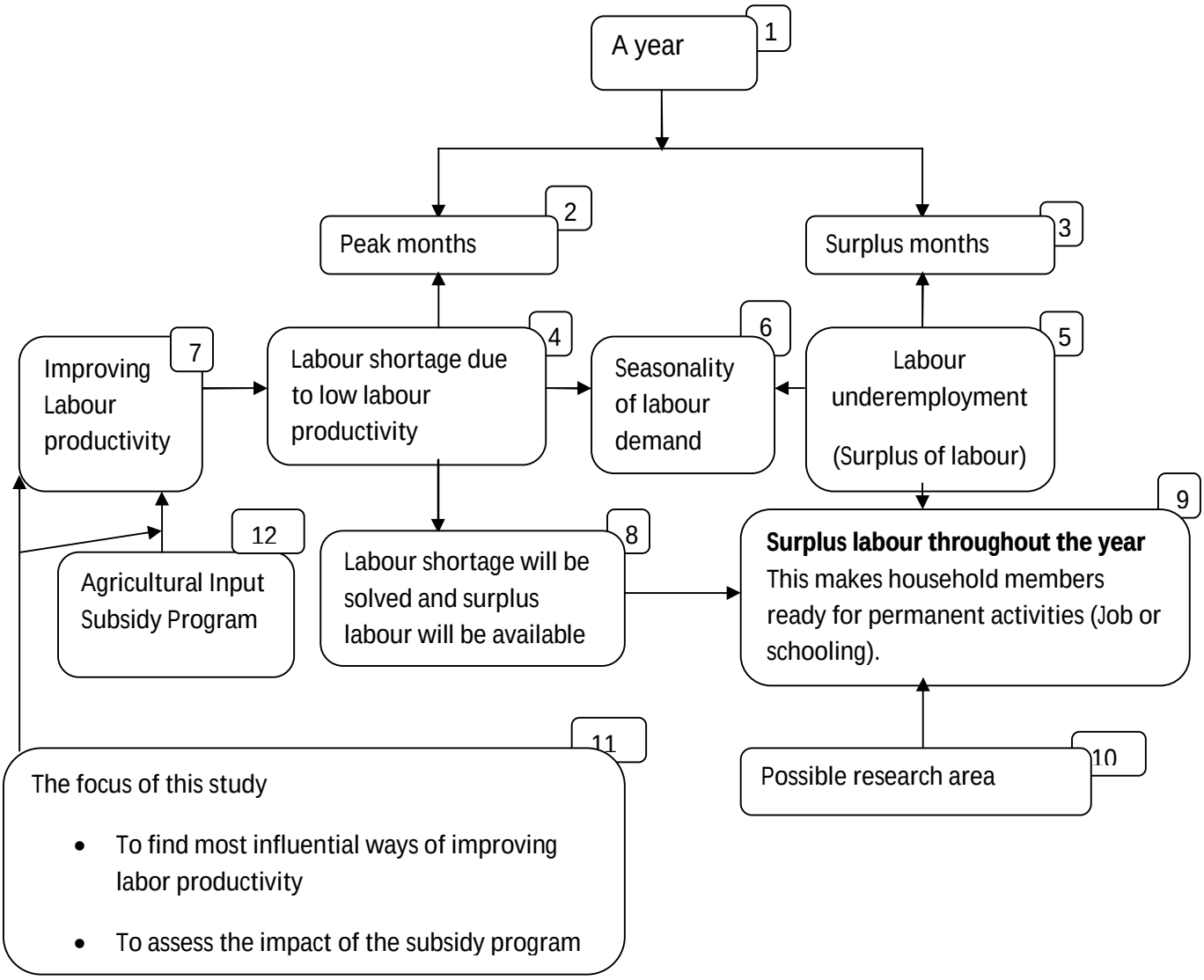
There are also signs that the problem of lack of labour is being exacerbated by the HIV/AIDS crisis. Apart from the direct impact of death itself, caring for the sick, and burying the dead has led to a reduction in the time available for productive activities(Beegle 2006). So, the significance of finding the most influential ways through which the labour shortage problem could be solved is undeniable.

Previous researchers have tried to address similar problems indirectly in one way or another in Malawi and at Sub Saharan African level using data from other countries. But, they haven't dealt with the problem this research raises directly. Some dealt with the seasonality of demand in general and try to address both the labour shortage and surplus problems simultaneously (Beegle 2006). Others have done on determinants of agricultural productivity generally (including land), not only labour(Stella 2005). Some others also focus on raising women farmer's productivity but at Sub-Saharan African level (A. Saito, Hailu Mekonnen et al. 1994). Endogeneity of variables is the main thing hidden in many of the above studies. Therefore, this study focuses on the labour shortage problem in Malawi and gives the attention it deserves by focusing on raising the smallholder's labour productivity. The study uses panel data regression methods by instrumenting key endogenous variable to come up with best estimates and minimize the endogeneity problem. In looking at the impact of the targeted fertilizer program on labour productivity, the main issue raised in previous studies is the issue of separating the combined impact of the program and good weather on production. The panel data methods used in this study control for any difference in weather both spatially and inter-temporally.

This study answers two research questions, which have direct contribution to the basic objectives of this research; is there labour productivity difference between female-headed and male-headed households? If so,why? And how does the targeted fertilizer subsidy affect labour productivity in agriculture in Malawi? Finding out weather there exists productivity difference between female-headed and male-headed households and identifying the possible causes helps to find ways on how to raise the labour productivity. Checking how the targeted fertilizer subsidy program is affecting labour productivity helps to improve the program and ensures that it meets its objectives. Thus, this study contributes to the few but expanding literatures in the area and can be part of the inputs to guide rural development policy.

1.2 Conceptual framework

The conceptual framework of the study can be explained by the following figure.



Boxes 1, 2, 3, 4, 5 and 6

The upper part of the figure shows the fact that some months of the year are peak months (box-2) and others are surplus months (box-3). Peak months are those months when agricultural activities will be at their high peak level. Thus, household members are too busy during these months spending much of their time on their fields. In other words, agricultural labour demand is high

during this time. Surplus months are those when agricultural activities are not at their high peak level. Thus, household members have surplus time. In other words agricultural labour demand is less. The high level of agricultural activities would have been passed well, had household member's productivity been high. But, due to the low labour productivity, labour shortage appears to be a problem during the peak months (box-4). During the surplus months, the problem is the opposite. There is surplus of labour resulting in underemployment of labour (box-5). The high agricultural labour demand during peak months coupled with less agricultural labour demand during the surplus months makes seasonality of labour demand problem (box-6).

Boxes 7, 8, 9, 10 and 11

Improving labour productivity (box-7) will solve the labour shortage problem. The Government of Malawi implemented Agricultural Input Subsidy with the objective of improving labor productivity. And if we successfully improve labour productivity, we might experience labour surplus even during the peak months (box- 8) not only during the surplus months. This makes household members ready for permanent activities like job or schooling where they stay throughout the year (box-9). The extended details after the household members are ready for permanente activities is one possible research area (box-10). But, the focus of this study is on how to improve labour productivity and assess the impact of the subsidy program (box-11).

2 Previous studies and theories

2.1 Previous studies

Labour productivity and Gender

A study, by Sridhar (2008), analyzes productivity differentials between men and women in the peasant agriculture in Nepal. Evidence is found for higher value of marginal product of adult family male than adult female labour. Male managed farms produce more output per hectare with higher command in market input use, obtaining credit, and receiving agricultural extension services than female managed farms. Overall, adult male labour is found to contribute more in production process than adult female labour(Thapa 2008).

A productivity study, by Saito (1994), on four sub Saharan African countries, looks at gender productivity differential. It tries to see how the value of women's output increases if they had the same access to resources as men. It appears that women's value of their output would increase by 22 percent which would more than fully close the gap between male and female output. Thus, concluded that women may be better farm managers than men(A. Saito, Hailu Mekonnen et al. 1994)

Labour productivity and other inputs

Labour productivity can be increased substantially when internal farm household inputs are combined with selectively applied external inputs. The balanced use of organic and chemical fertilizers, herbicides, and pesticides can help farmers consistently raise land and labour productivity and maintain sustainable resource management practices (Ruerd and Lee 2000).

Restuccia (2004) found that differences in economy-wide productivity and barriers to the use of modern inputs in agriculture generate sizeable differences in labour productivity and labour allocation in agriculture between rich and poor countries. The study also recommends that these barriers need to be removed before a significant improvement of agricultural and aggregate productivity can be seen(Restuccia, Yang et al. 2008).

Labour Productivity and Age

A literature survey by Skirbekk (2004), after reviewing many studies on the area, concluded that physical productivity follows an inverted U-shaped profile where significant decreases are found after the age of 50. As it is stated on the study, an important cause of these age-related productivity declines is likely to be age-specific reductions in cognitive abilities. Some abilities, such as perceptual speed, show relatively large decrements already from a young age, while others, like verbal abilities, exhibit only small changes throughout the working life. The study recognizes that experience boosts productivity up to a point beyond which, however, additional tenure has little effect. It further explains that older individuals learn at a slower pace and have reductions in their memory and reasoning abilities. In particular, senior workers are likely to have difficulties in adjusting to new ways of working (Skirbekk 2004).

Individuals' job performance tends to increase in the first few years of one's entry into the labour market, before it stabilizes and often decreases towards the end of one's career. Productivity reductions at older ages are particularly strong when problem solving, learning and speed are important, while older individuals maintain a relatively high productivity level in work tasks where experience and verbal abilities matter more (Ibid).

Labour productivity and Education

Fafchamps and Quisumbing (1998), who study the effect of human capital on productivity, find that education has no significant effect on productivity in crop and livestock production. It states that the effect of human capital on household incomes is partly realized through the reallocation of labour from low productivity activities to nonfarm work. Female education and nutrition do not affect productivity and labour allocation in any systematic fashion, consistent with the marginal role women play in market oriented activities in Pakistan. Although there is little doubt that better educated workers earn higher wages in the modern sector, whether education raises farm productivity remains a contentious issue. The study proceeds and mentions that using market-oriented activities as sole criterion, female education seems to be a wasted investment in rural Pakistan (Fafchamps and Quisumbing 1999).

Labour and its productivity in Malawi

A paper by Beegle (2006) used basic descriptive data from a 2004 nationally representative household survey to assess the typical workload of the population.

Generally, labour in Malawi is assumed to be in surplus supply, with extensive under-employment. However, low mean hours in income-generating activities mask the existence of labour shortages at the peak of the cropping season. This seasonality in labour supply can have potentially large negative impacts on the ability of households to make the most of their endowments such as land (Beegle. 2006)

Evidence for Malawi and other developing countries suggests the existence of labour shortages at the peak of the cropping season. At the same time, for most of the year, there is substantial underemployment, especially in rural areas. It could therefore be argued that seasonality in the demand for labour is leading to both underemployment and labour shortages (Ibid).

Generating sustained economic growth in Malawi requires increases in productivity, which in turn requires significant investments in human and physical capital, and accelerated technological change. As labour power is the most important asset controlled by the poor, equity considerations suggest that increases in labour productivity are paramount. Recent moves to expand smallholder opportunities for high value (export) crop production, and to promote the use of high yielding maize varieties, are good examples of public policies to improve labour productivity (Simler 2005).

In Malawi, the proportion of total person-days on smallholder plots supplied by hired labour is relatively low: about 5 per cent for all smallholders and only 1.6 per cent for the core poor. Since approximately 85 per cent of gross margins on crops such as maize is attributed to the labour input, and only about 15 percent to land, doubling the land available to the poor, even if feasible, would at most increase their income by about 13 percent. This suggests that low labour productivity and poor yields are central to the poverty problem. However, low yields and low productivity of land and labour are directly related to the low intensity of agricultural production. The result is chronic food insecurity among households and increased pressure to meet immediate food requirements, at the expense of improved long-term land management (Beegle 2006)

Labour is by far the most important input into conservation of land. About 95 per cent of the total labour available to smallholders is from the farm household. The opportunity cost of this source of labour is a key determinant of its use in conservation. Given the generally low productivity and underemployment of unskilled labour throughout Malawi, it could be presumed that this opportunity cost is very low. However, there are other factors that also affect the use of labour for soil conservation. For example, although the availability of farm labour may be limited only in certain seasons and localities e.g., during the peak period of planting and weeding during the growing season, and in areas where many off-farm employment opportunities exist, it may significantly affect soil conservation. The peak period of labour demand also coincides with times when household stocks of food and cash are lowest or non-existent for the poorest households. Households dependent on wage income may have little choice but to sell their own labour and forego timely planting and weeding on their own fields. At this time, labour for conservation may have a high opportunity cost, particularly for the poor households with income and credit constraints (Beegle 2006).

Brief history of input subsidy program in Malawi

Malawi eliminated universal fertilizer subsidies for smallholders in the mid-1990s, but it reintroduced limited subsidies in 1998 through the Starter Pack program, which gave all farmers, free of charge, 10–15 kg of fertilizer and enough improved seed to plant 0.1 ha. After two years, this program was converted into the Targeted Input Program (TIP), which distributed the packs to a targeted group of farmers. In 2005, the program was redesigned as the Agricultural Inputs Subsidy Program (AISP), a voucher based universal subsidy program that allows farmers to buy 100 kg of fertilizer at about one-fifth of the market price, thus dramatically increasing both the quantity of fertilizer being subsidized and the fiscal cost of the subsidy. The combination of increased fertilizer use and good rainfall has resulted in substantially increased maize production over the past few years, leading to improved food security and even some maize exports(Minot 2009).

Vouchers have been used in Malawi fertilizer programs since the TIP in 2000, but the distribution of the subsidized inputs has been managed largely by two state-owned enterprises.

Private importers are contracted to deliver the subsidized fertilizer to distribution points, but private agro-input dealers have generally not been involved in distribution. Under the TIP program, these dealers still maintained a large market share because the subsidized fertilizer accounted for just 9–24 percent of the total fertilizer market in Malawi. With the AISP, however, the proportion of subsidized fertilizer has increased to about half and the market share of private input distributors has fallen to 58 percent. Although the government experimented with allowing fertilizer vouchers to be redeemed at private distributors, this effort has been discontinued because of allegations of misuse of the vouchers. The theoretical virtues of input vouchers as a smart subsidy to strengthen private input supply networks are thus negated by the way the AISP is implemented (Ibid).

The direct impact of Malawi's input subsidy program on rural households[1]

The increase in food production is reported to have had a number of positive effects on household welfare: Food security indicators – namely number of meals consumed each day, number of malnutrition cases and the time which food stocks are lasting – are all reported to have improved. Income and access to cash has increased as more households have produced a surplus to sell.

Other reported direct impacts of the programme include:

Increased access to cash is resulting in other types of investments. Households now have money to buy school uniform from the sales they make or indirectly from cash that would otherwise have been spent on fertilizer (Beegle 2006).

Increased utilization of technologies including fertilizer and hybrid seeds. Households are increasingly exposed to examples of how technology can work and are taking it up with increasingly enthusiasm. In some districts they are also adopting other changes in their cropping systems, including Sasakawa techniques. Even in Chikwawa, where flooding washed away many crops and where consumption of fertilizer is low because many people work on already fertile soil, there is recognition that fertilizer can be positive for production. People who have never used fertilizer before are reported to be planning to use it next season to increase yields.

[1] This is from Dorward 2008.

Less tangible, though very important, is the change in attitudes of people towards their land. Feelings of hopelessness have been replaced with confidence and enthusiasm about households' own capacity to be more productive and increase their income earning potential in agriculture. Intra-household disputes are fewer. More widely there is anecdotal evidence of increased social capital – people are now able to do the 'right thing' at social events such as weddings and funerals. They can invite their neighbors and feed them.

There are also some less positive signs. The most important of these is that the call for more coupons so that all rural households can receive them is interpreted by many as a sign that the subsidy may increase the dependency of households on subsidy support. For example, one respondent commented that the subsidy has increased the dependency syndrome and as such, that is why people are refusing to target and everyone just wants to benefit. It is clear that the program has benefited from two good rainy seasons in many districts. The importance of maximizing the benefits of these good years and using them to make households more resilient to problems and less reliant on programs in subsequent years is recognized by some respondents.

The administrative criteria and its efficiency in targeting the poor as a beneficiary for the Subsidy Program

The criteria for beneficiary identification that Malawi's Ministry of Agriculture and Food security uses include:-

- A Malawian that owns a piece of land
- Vulnerable household, with low purchasing power
- Guardian looking after physically challenged persons who are unable to farm
- Hard working household
- Adopter of new technologies
- Resident of the village
- The vulnerable group – female headed, child headed households, elderly but hard working household

A combination of these is used in identifying the beneficiaries. One beneficiary per household was registered(Mwale 2009).

Holden and Lunduka (2010) assessed the administrative targeting efficiency related to the MoAFS-criteria for targeting particularly poor, vulnerable (child-headed, female-headed, orphan headed, guardian) landowning households. It is stated in the study that a significant smaller share of female-headed households received a full package of fertilizer (2 bags) than that of male-headed households. They found those households receiving coupons through administrative distribution being on average better off than those not receiving coupons in form of having a significantly higher livestock endowment. On the other hand these households were also found to have relatively larger number of children children but having more children was not positively correlated with poverty(Holden and Lunduka 2010).

2.2 Theories and testable hypotheses

Peasant households are both families and enterprises and thereby are both consumers and producers (Mendola 2007). Households maximize utility through the consumption of all available commodities (i.e., home-produced goods, market-purchased goods, and leisure), subject to full income constraints(Sing 1986).

If all markets exist and all goods are tradable, prices are exogenous and production decisions are taken independently of consumption decision. In such conditions the decision making process could be regarded as recursive (or separable), because time spent on leisure and time used in production becomes independent; utilization of family labour will be directly linked to the market-determined wage rate, and income is singled out as the only link between production and consumption (Ibid).

In the absence of a labour market or any other missing market, the decision may not be recursive because the family will be left to decide about the percentage of its total available time to be devoted to production (the difference being assumed to be used for leisure). Therefore, there is no separability between consumption and production. The decision process becomes circular as consumption affects income and income affects consumption. Hence, the validity of recursive modeling of household resource allocation depends on the household being a price taker and the

absence of missing or imperfect markets (for output or input, including labour and capital) (Mendola 2007). In reality, households operating in developing countries are likely to face more than one market imperfection, which prevents first-best transactions and investments from taking place (Sadoulet 1995).

Thus, their production and consumption decisions are linked. As producers, households choose the allocation of labour and other inputs to crop-production and asconsumers, they choose the allocation of income from farm profits and labour sales to the consumption of commodities and services. Farm profit includes implicit profits from goods produced and consumed by the same household, and consumption includes both purchased and self-produced goods and leisure (Taylor and Adelman 2003).

To make it more clear taking labour markets, labour markets in developing economies are imperfect due to many reasons one of which is the imperfect substitutability of family and hired labour(Jacoby 1991). In such a case, the production and consumption decisions of farm households must be treated as non-separable in the sense that their labour supply choices cannot be considered independently of their labour needs on the family farm (and vice versa). Then, it will be the shadow wage which will determine the labour hour that the household allocates for the farm and leisure (Jacoby 1991).

The household (specifically the head) endogenously decides how much labour to allocate for farm and leisure based on the shadow wage. The head, thus, have crucial role in this process. The productiveness of the decision of the household head, basically, dependence on many of its characteristics like sex, age, experience, education …etc. But, it is quite vague in what way these characteristics affect the labour productivity of the household. Whether the household is female-headed or male-headed may affect labour productivity of the household positively or negatively. Thus, there is a need to empirically test and develop base for our knowledge on the issue. We can put our hypothesis more formally as follows;

H1: Female-headed households have less labour productivity than male-headed households.

In order to support the poor rural farming households, governments in developing countries like Malawi, implement targeted fertilizer subsidy program. When the subsidy reaches the poor, it is

expected to enhance land and labour productivity of those people. But how does it affect different households like the labour poor and the land poor? It may or may not affect these households in the same way. It is important to empirically test and come up with something which can contribute for our body of knowledge in the issue. The following are two specific hypotheses that this study will test in line with this idea.

H2: The targeted fertilizer subsidy enhances labour productivity of labour poor households

H3: The targeted fertilizer subsidy enhances labour productivity of land poor households

2.2.1 [2] Theoretical Model as a base for empirical model

This study is on the rural farm households of Malawi. The rural farm household acts as a producer, consumer and worker at the same time. Thus, we need to combine producer's and consumer/worker's problems to come up with the correct farm household's problem.

Producers have an objective of maximizing profit subjected to production function (technology) constraint;

$$\text{Max } \pi = P_a q_a - P_x x - wl, \text{ profit function}$$

$$\text{S. t.: } g(q_a, x, l; z^q) = 0, \text{ production function}$$

Where π= profit

z^q = Fixed factors and firm characteristics

q_a = The product to be produced with price P_a

x = A variable factor with price P_x

l =Labour with price w

The rural farm households are not only producers. But, they are also Consumers and workers. As a consumer/ worker, they maximize utility from consumption including leisure, subjected to budget and time constraint.

[2] This is based on Sadoulet and de Janvery (1995)

Max $U(c_a\, c_m c_l\,; z^{cw})$, Utility Function

S. t.: $P_a\, c_a + P_m\, c_m = w l^s = y$, Budget constraint

$c_l + l^s = E$, Time constraint

These two constraints can be collapsed in to one equation;

$P_a\, c_a + P_m\, c_m + w c_l = wE$, full income constraint

Where c_a = Agricutural product to be consumed with price p_a

c_m =Manufactured to be consumed with price p_m

c_l = Home time

y =Disposable income

z^{cw} = Consumer/worker household characteristics

l^s = Time worked

E= Total time endowment available

The real farm household engaged simultaneously in production, consumption and work decision. The above problems must be integrated in to one single household problem.

Max $U(c_a\, c_m c_l\,; z^{h})$, Utility Function

S. t.: $g(q_a, x, l; z^q) = 0$, production function

$P_x\, x + P_m\, c_m = P_a\,(q_a - c_a) + w(l^s - l)$, Cash constraint

$c_l + l^s = E$, Time constraint

Where; z^h = Household Characteristics

The last two constraints can be collapsed in to one equation;

$wc_l\, x + P_m\, c_m + P_a\, c_a = \pi + wE = y^*$, Full income constraint

Where $\pi = P_a\, q_a - P_x\, x - wl$, Farm restricted profit

Since this study is on one of the developing economies, we should consider imperfection of markets in our theoretical model. Farm household models in the case of market imperfections see the consumption and production decisions to be recursive. The recursive nature of the model implies that we have to include factors which affect consumption and also production in the right hand side of the output supply equation to be taken out from the farm household model discussed above.

3 Data and Methods

3.1 Study area, data source, sample size and sampling technique

The study uses both primary and secondary sources of data. The secondary data includes price data from Malawi's Ministry of Agriculture and Food Security and data collected from rural Malawian households (for 2006 and 2007) and organized by a research team from Norwegian University of Life Sciences. These were done at the end of each agricultural season in June, visiting the same households in both years. A detailed questionnaire was administered to the 450 households on household and plots information. Physical measurement of the plot size was done using Geographical Positioning System (GPS) equipment(Lunduka 2009).

The data we use in this study is from six districts of Malawi; Thyolo, Chiradzulu, Zomba, Machinga, in the southern region and Lilongwe and Kasungu in the central region. These districts were purposively selected by the team mentioned above to capture pressing and varying land issues in Malawi. Thyolo and Chiradzulu were selected because they are the most populated districts in Malawi. They have the highest rural population's density of 343 and 379 people per square kilometer respectively. Zomba and Machinga are in the south but not as populate so were selected to represent the medium density. These four districts are all in the matrilineal land inheritance society. The central region districts of Lilongwe and Kasungu are in patrilineal land inheritance society and were selected because of close proximity to the city for the case of Lilongwe hence easy market for farmers and large land sizes and estates for the case of Kasungu. These are also relatively low density as compared to the southern region districts (Ibid).

The primary sampling units (PSU) were the Enumeration areas (EAs) following the integrated household survey of 2004 by the National Statistical Office, Malawi. The household population figures used for the EAs are those from the 1998 Population census. In Thyolo, Chiradzulu and Machinga districts two EAs were randomly selected and in Zomba, Kasungu and Lilongwe districts three EAs were randomly selected. In each EA, 30 households were randomly selected giving a total of 450 households[3](Ibid).

[3] APPENDIX B shows the districts and the main villages in the EAs selected for the study.

The primary data was collected for the year 2009 by making some changes and distributing the questionnaire which was used by the team to 378 of the same households. Thus, this study mainly uses a three-year panel data spanning from 2006 to 2009 inclusive.

To avoid dealing with crops which are grown by very few observations, we dropped those plot observations with crops which are grown by less than 3% of our observations at the plot level. This leaves us with five mainly grown crops; maize (hybrid, composite and local), groundnuts, tobacco, rice and sweet potato. Since we do not have data for the price of sweet potato, we also drop plots with sweet potato. This means, the study is on the four mainly grown crops; maize, ground nuts, rice and tobacco.

Although intercropping may have some effect on labour productivity analysis, with the assumption that the effect of considering intercropping is insignificant, we consider only the main crop grown on each plot of the household. We have also tried to drop outliers and those households with missing values of our dependent variables for our econometric regressions.

After all this cleaning, in the panel data spanning from 2006 up to 2009, excluding 2008, we have 905 observations for this study. Around 23% of these observations are female-headed while the rest are male-headed households.

3.2 Empirical models

The study uses econometric analysis. Specifically, panel data regression and treatment effect models are used to test the study hypothesis and to attain the study objectives. Simple statistical tools like percentages, averages, medians, frequencies, cumulative frequencies, graphs...etc are used to present data and to support some findings.

Model One: Panel data regression model

The model to be specified starts with output supply equation which is taken out from the theoretical farm household model described in the previous chapter. The output supply equation includes inputs, farm characteristics and household characteristics.

$$Q = f(A, L, S, M, F, P, Ag, E, G, R, RAV) \text{ ----------eq1}$$

Where;

Land (A), labour (L) seed (S) manure (M), fertilizers (F) pesticides (P), Age of the household head (Ag), Education of the household head (E), Gender of the households head (G), Residence (R) and real asset value of the household (RAV).

This relation can be presented by a more formal econometric equation as follows

$$Q_{it} = \beta_0 + \beta_1 A_{it} + \beta_2 L_{it} + \beta_3 S_{it} + \beta_4 M_{it} + \beta_5 F_{it} + \beta_6 P_{it} + \beta_7 Ag_{it} + \beta_8 Ag^2_{it} + \beta_9 E_{it} + \beta_{10} G_{it} + \beta_{11} R_{it} + \beta_{12} RAV_{it} + e_{it} \text{ ----------eq 2}$$

Where subscripts i and t counts for each household and year respectively.

Our objective is to come up with labour productivity equation. Thus, let us divide Q by L, which definitely results in dividing the variables on the other side by L also. Then, we will have aggregated output per labour as a measure of labour productivity and taking log of both sides of the equation will give us;

$$\ln\left(\frac{Q}{L}\right)_{it} = \beta_0 + \beta_1 \ln\left(\frac{A}{L}\right)_{it} + \beta_2 \ln L_{it} + \beta_3 \ln\left(\frac{S}{L}\right)_{it} + \beta_4 \ln\left(\frac{M}{L}\right)_{it} + \beta_5 \ln\left(\frac{F}{L}\right)_{it} + \beta_6 \ln\left(\frac{P}{L}\right)_{it} + \beta_7 Ag_{it} + \beta_8 Ag^2_{it} + \beta_9 E_{it} + \beta_{10} G_{it} + \beta_{11} R_{it} + \beta_{12} \ln\left(\frac{RAV}{L}\right)_{it} + e_{it} \text{ ----------eq3}$$

Where $\ln(\frac{Q}{L})$= is a measure of partial labour productivity (Ramirez 2006). It is worth to mention that our productivity measurement is partial. The main limitation of partial measurement of productivity is it does not deduct change in labour productivity due to other inputs other than labour(Thapa 2008).

Let us say;

$X_1 = ln\left(\frac{A}{L}\right)$ $X_2 = \ln L$ $X_3 = \ln\left(\frac{S}{L}\right)$

$X_4 = \ln\left(\frac{M}{L}\right)$ $X_5 = \ln\left(\frac{F}{L}\right)$ $X_6 = \ln\left(\frac{P}{L}\right)$

$X_7 = Ag$ $X_8 = Ag^2$ $X_9 = E$

$X_{10} = G$ $X_{11} = R$ $X_{12} = ln\left(\frac{RAV}{L}\right)$

Equation 3 can be written in a compact format as follows;

$\frac{\ln Q}{L} = \beta_0 + \sum \beta_j X_j + e_i$ j=1, 2, 3....12----------Eq.4

Where

e_{it} = is the error term for the model.

We estimated the above equation using pooled OLS, household fixed effects and household random effects estimations. We used the F-test with the null hypothesis that all household-specific intercepts are identical and houseman test to choose the best model among OLS, fixed effects and random effects model. The choice among panel data regression models usually lies between fixed and random effect models. The problem with the fixed effects models is, it does not give coefficient estimates for time invariant variables, and its estimates may appear to be inefficient. The problem with the random effect is it assumes the individual effects, which were to be captured by the dummies of the fixed effect model, to be uncorrelated with the other independent variables. But, there is no justification to assume this, and its estimates may suffer from inconsistency.

The Hausman test checks the more efficient but not consistent model against a less efficient model to make sure that the more efficient model also gives consistent results. Thus, it tests the null hypothesis that the coefficients estimated by the efficient random effect model are also consistent. Failing to reject this null hypothesis results in leading to a conclusion that the random effect model is appropriate, while rejecting it tells us fixed effects model are better.

Let us proceed explaining how the variables in our productivity equation are generated and measured. The output (Q) is measured in Malawian Kwacha. It is calculated by summing monetary value of the harvest of each crop in kilogram. For aggregation purpose, we multiplied harvest of each crop by its respective price. It is clear that changes either in output or price over years will affect monetary value of the harvest of the household. But, the change which comes due to price change is not real change in output. Thus, there should be a mechanism which deducts the change which comes due to price. We take price of crops in one arbitrary year (2009) to aggregate harvest of different crops as a solution for the above problem. Thus, we did not allow the price to change over years in calculating the monetary value of the harvest of households. It would have been nicer to use farm gate prices but due to lack of adequate data, we used retail market prices.

We divided the monetary value of harvest by labour to come up with labour productivity. The labour variable is in man days and is the summation of household labour and hired labour devoted to the production of crops in the household. The household labour comes from the time that each member of the household spends on the household's farm field during peak and lean times of the agricultural season. Female and male adults were given equal weight while we give less weight (0.5) for children (between ages of 8 and16 years). Members of the household below age of 8 years were not considered. Since it was practically impossible to ask the time that members spend on farm in each and every day of the season, they were asked to tell the average number of hours that they spend on the field separately for peak and lean times of the season. Then we multiplied these hours with the number of days of the peak and lean times of the season accordingly.

Group of households, on focus group discussions, were asked to identify the activities they feel are peak time activities and the same was done for lean time activities. They identified weeding and fertilizer application as peak time activities while land preparation, planting and harvesting as lean time activities. Thus, we used the number of days the household spends on weeding and fertilizer application to come up with peak time number of days and the number of days that household uses for lean time activities to come up with lean time number of days.

Unfortunately, we had the number of days for the different activities only for year 2009. Thus, we calculated the number of days for 2006 and 2007 based on the land endowment and labour

devoted for crop production of each household in those years. We believe the number of days the household takes for the peak and lean time activities mainly depend on the land endowment and the labour hour the household allocates for crop production. Thus, the number of days of the activities depends mainly on the labour to land ratio of the households in each year. Labour to land ratio of the household and the corresponding peak and lean time number of days in 2009 helps to calculate the number of days for the activities in 2006 and 2007 using labour to land ratios of the households in those years. Mathematically;

$$\text{PNDays in 2006 for } hh_i = \text{PNDays in 2009 for } hh_i * \left(\frac{\frac{laborP06_i}{land06_i}}{\frac{laborP09_i}{land09_i}} \right)$$

$$\text{LNDays in 2006 for } hh_i = \text{LNDays in 2009 for } hh_i * \left(\frac{\frac{laborL06_i}{land06_i}}{\frac{laborL09_i}{land09_i}} \right)$$

Where

The subscript i counts for each and every household.

PNDays = peak time number of days

LNdays= lean time number of days

$labourP06_i$ =average labour hour the household i devoted to crop production during the peak season in 2006.

$Land06_i$= land endowment of the household i in 2006

$labourP09_i$= average labour hour the household i devoted to crop production during the peak season in 2009.

$Land09_i$= land endowment of the household i in 2009

The same formula works just by changing the year for 2007. It would be more accurate calculation of household labour if we had the number of days for all the three years like 2009.

The hired labour is measured by man days hired in different plots. Thus, we summed the hired man days in different plots to come up with hired labour man days for the household. The household labour hours were converted to man days dividing it by 7.5[4]. Finally, we sum the household labour with hired labour to come up with total labour of the household devoted to crop production in man days.

Our land variable comes by summing the area of all the plots on which the household grows its crop. This includes plots the household owns and rents in to grow its crops. The plots were measured in meter square but we converted it to hectare to avoid dealing with very small coefficients of regressions.

We have explained how we come up with our total labour variable above. But, for the labour variable in the right hand side, we put female labour, male labour, children labour and hired labour as separate variables recognizing the imperfect substitutability of these categories especially household and hired labour. We also want to see the marginal effect of these different categories on labour productivity of the household.

Table 1 presents description, proxies, measurement units, expected signs and some other remarks of each variable. It summarizes what we have presented above for some of the variables and gives first hand information about the other variables.

[4] This is assumed to be the normal number of hours one adult person can work per day

Table 1: Descriptions, proxies, measurement units, expected signs and other remarks of improtant varibles

Variables	Description	Expected signs for the coefficients	Remark
A= Land size	This is summation of land sizes of all household plots.	-	
L = Labour	Male labour, female labour, children labour and hired labour are used as separate variables	-	
Ag = Age	Age of the household head in years and being squared are used	Age= + Age(squared) = -	
E= Education	The number of years of schooling of the household head	+	
G = Gender	The sex of the household head	-	1=Female-headed and 0=male-headed
S=Seed	The monetary cost of fertilizer (in Malawian kwacha) used for crop production by the household	+	
M = Manure	The total amount of manure (in kilogram) used for crop production by the household	+	
F = Fertiliser	The monetary cost of fertilizer (in Malawian kwacha) used for crop production by the household	+	
P = Pesticids	The monetary cost of pesticide (in Malawian kwacha) used for crop production by the household	+	

Variables	Description	Expected signs for the coefficients	Remark
R=residence	This is where the family is living; in the "Wife's village", in the "Husband's village" or "Neutral village". This variable is used as a proxy for land tenure security.	-/+	It makes two dummy variables whose coefficients can be interpreted comparing with the third and reference category
RAV	The monetary value of the assets (in Malawian kwacha) of the household deflated for any price change between 2006 and 2009 is used	+	

Note: - sign represents inverse relation is expected with labour productivity. + sign represents direct relation is expected with labour productivity.

Many input variables on the right hand side of equation three above are endogenous. The fact that we use panel data regression methods to estimate our productivity equation minimizes the endogeniety due to time invariant unobserved heterogeneity. But, we have also taken measures and discussed the implications of the endogeniety problem in the model estimates and conclusions.

Model Two: Treatment effect model

We also want to see the effect of the targeted fertilizer subsidy on labour productivity. This can be captured by including a binary variable for whether the household used subsidized fertilizer or not (Di) as one of the explanatory variables in the labour productivity equation above:

$$\ln\left(\frac{Q}{L}\right) = x_j\beta + \alpha D_i + \varepsilon_i \text{----------eq 5}$$

Where; ε_i is the random component or error term of the equation, α is the treatment effect of the targeted fertilizer subsidy, x_j includes the variables included in the labour productivity equation in the previous model, excluding variables which may have serous collinearity and causality relation with the subsidy variable like fertilizer and manure. Since those who get the subsidy are likely to show more use of fertilizer, the subsidy will be the cause for more use of fertilizer. If we include the subsidy and the fertilizer variables in the labor productivity equation together, the effect of the subsidy cannot be seen from the subsidy variable coefficient as it is affected by the existence of the fertilizer variable in the equation.

Since D_i is likely to be correlated with ε_i, regression estimates of eq. (5) do not estimate α consistently. Thus, we need to instrument D_i using variables which are correlated with D_i but uncorrelated with $\ln\left(\frac{Q}{L}\right)$. In this way, we are modeling the decision to be beneficiary of the subsidy program or not as an outcome of an unobserved latent variable, D_i^*. We are also assuming that D_i^* is the linear function of the exogenous covariates (W_j, to be used in instrumenting the variable) and a random component μ_j. specifically,

$$D_i^* = W_j\Theta + \mu_j \text{----------eq 6}$$

And the observed decision is

$$D_i = \begin{cases} 1 \text{ if } D_i^* > 0 \\ 0 \text{ otherwise} \end{cases} \text{----------eq 7}$$

The big question here is what are the variables included in W_j. That is, what are the instruments that can be used for the 'participation in the fertilizer subsidy program' variable?

Based on the criteria the Government of Malawi puts for a household to be beneficiary of the program, we tried to come up with list of potential instrumental variables which can serve as an indicator as to whether the household fulfils the criteria or not. These variables are;

Land size, quality of house, and live stock units as an indicator for wealth,

Sex of the household head as female-headed household are expected to be targeted

Elder heads variable which is a dummy variable showing heads with age of above 65 and below 65 to serve as an indicator for elder heads which are categorized as vulnerable groups

But, we also included other variables which we found them important although don't serve as an indicator for the criteria the government of Malawi puts. These variables are number of children and consumer worker ratio.

From the above list of potential instrumental variables, we excluded some of them from being instruments since they are crucial variables in our outcome (labour productivity) equation. These variables are land size and sex of the household head. Thus we keep the other variables as instruments for the participation equation. With these variables, the participation equation can be presented in the following form:

$$FS_{it} = \beta_0 + \beta_1 C_{it} + + \beta_2 QH_{it} + \beta_3 TLU_{it} + \beta_4 EH_{it} + e_{it}$$ ----------eq 8

Where;

C= Number of children

QH= Quality of house

TLU= Total live stock units

EH = Elder heads

e_{it} = the error term for the equation

The variable quality of house is an index found by aggregating the quality of window, door, roof and the floor of the house. Thus, the higher value shows better quality while lower value shows poor quality. In addition to the above mentioned variables, we have also included district dummy variables to control for district level differences.

After running our treatment effect model in STATA using '*treatreg'* command, it is possible to read whether our participation variable is really endogenous or not. That means it is possible to check whether instrumentation was really necessary or not. For the variables to serve as instruments, they should be partially correlated with the endogenous variable. We can see this from our treatment effect model results by looking at how they significantly explain the participation variable. But they should also be uncorrelated with the error term of the outcome equation. But, it is not possible to test this using post estimation commands after 'treatreg' command unlike after instrumental regression command 'ivregress' in STATA. Thus, we do the test manually. We predicted the error term of the outcome equation and run simple OLS regression putting the instrument variables on the right hand side. Then, we tested whether the coefficients are jointly zero. Failing to reject the null hypothesis shows that the instruments are exogenous or uncorrelated with the error term of the outcome equation.

Since, the criteria for the subsidy was changing over years, we found it difficult to get good instruments when trying to instrument the participation equation for the three years together. Thus, we first get the predicted value of the participation variable for each year separately. Then, we append one year after the other to get predicted exogenous participation variable for the three years.

After getting the exogenous participation variable as explained in the above paragraph, we applied panel data regression methods to minimize the endogeneity of other input variables in our productivity equation to see how the fertilizer subsidy program affected the labour productivity of our whole observation, labour poor households and land poor households.

4. Descriptive Analyses

In this chapter, we provide the descriptive analyses focusing on the research questions and the three hypotheses that we want to test. The first section of this chapter is about labour productivity difference between female and male-headed households while the second section focuses on the impact of the targeted fertilizer subsidy on labour productivity. Although it is not possible to come up with final conclusion by descriptive analyses, it helps us to put ground for the more advanced econometric analysis to be done in the next chapter.

4.1 Labour productivity difference between female and male-headed households

When we think of comparing labour productivity of female and male-headed households, we should first see differences of these groups in terms of variables which may theoretically affect labour productivity. Considering these differences will help us to get the actual difference in labour productivity which is not caused by other differences. Table 2 shows the mean, median Pearson chi2 value and standard deviations of quantitative variables in our labour productivity equation, to be estimated later, for female-headed and male-headed households. Means are usually misleading as they don't control for other possible differences among the groups and are affected by outliers, but they still give us the overall picture of the dataset to be used on the econometric analysis in the next chapter. To support the defect of mean being affected by outliers, medians are also presented.

It is possible to test the mean difference of the variables in Table 2 by t-test if the variables are normally distributed and have equal variance for female-headed and male-headed households. We run Shapiro-Wilk normality test to see if the variables are normally distributed and the result shows that none of the variables are normally distributed. This means, we have to use a test of comparison which does not need normality of the variables. We use median test with a null hypothesis of equal medians to see if female-headed and male-headed households differ in terms of these variables.

Table 2: Mean, median, standard deviation and Pearson chi2 value for mean differences test on quantitative variables in the productivity equation for whole observations, female-headed and male-headed households

Sex of head(0=male and 1=female)	Male-headed households			Female-headed households			Pearson chi2 value	Total observation		
	Mean	Meadian	Standard deviation	Mean	Meadian	Standard deviation		Mean	Meadian	Standard deviation
Labour productivity_log (in MK* per man days)	6.06	6.19	1.59	5.89	5.89	1.74	2.82	6.02	6.10	1.62
Land size divided by total labour_log (in hectare per man-days)	-4.41	-4.66	1.79	-4.21	-4.42	2.01	4.85	-4.37	-4.58	1.85
Total children labour _log (in children days)	1.18	0	1.81	1.02	0	1.74	1.54	1.14	0	1.79
Total household male labour _log (in man-days)	3.72	3.68	1.53	2.00	2.20	1.98	59.40	3.32	3.49	1.79
Total household femalelabour_log (in man-days)	3.55	3.58	1.51	3.38	3.58	1.67	0	3.51	3.58	1.56
Hired labour_log (in man days)	1.08	0	1.59	.78	0	1.49	5.47	1.01	0	1.58
Real asset value of the house hold_log (in MK)*	3.37	3.54	2.08	2.83	2.78	2.26	10.87	3.24	3.36	2.13
Age of the house hold head (in years)	42.71	40	14.41	51.36	50	16.13	54.55	44.74	43	15.26
Number of schooling (in years)	5.47	6	4.21	3.14	2	3.34	37.14	4.92	5	4.13
Seed cost divided by total labour_log (in MK* per man days)	1.92	2.08	1.68	1.81	1.81	1.74	0.76	1.89	2.03	1.69
Manure amount divided by total labour_log (in Kg per man days)	0.67	0	1.72	.84	0	1.67	0.26	.73	0	1.71
Fertilizer cost divided by total labour_log (in MK* per man-days)	2.99	3.15	1.92	2.76	2.95	2.01	1.84	2.94	3.07	1.94
Pesticide cost divided by total labour_log (in MK* per man-days)	.22	0	.92	.14	0	.74	1.85	.20	0	.88
Number of observations	200	200	200	649	649	649		849	849	849

Note: * Malawian Kwacha

The mean and median of labour productivity of female- headed households are smaller than that of male-headed households. A median test on the statistically significance difference between the medians rejects the null hypothesis and lets us to conclude that the difference is statistically significant at 10 % significance level. But, we should not forget that we are not controlling for other possible differences between female- and male-headed households. Econometric analysis, in the next chapter, shows us the result controlling for other possible differences. The following paragraphs highlight some of these differences.

Female-headed households have larger land per labour ratio and the median test shows the difference is statistically significant at 5% significance level. We tried to see the median of the land size and total labour separately to further explore how female-headed households appear to have larger land per labour ratio. It appears that female-headed households have smaller land size and total labour devoted to farm production. But, the total labour difference is statistically significant while the land size difference is not. Thus, this results in larger land per labour ratio.

Female- and male- headed households have similarity in the level of different categories of labour they use except on household male labour; male- headed households use more male house hold labour and a median test shows that the difference is statistically significant at 1%. But, they use equal female household labour, children labour and hired labour. Their use of children and hired labour is very small to the extent of none.

Rural Malawian households have got very small number of years of schooling with female-headed households being in the worst case and the median test shows this difference is statistically significant at 1% level of significance. In terms of fertilizer, female-headed households spend less than the males. But they use averagely larger manure than the males. The median test on real asset value per labour variable shows female-headed households have significantly lower ratio as compared to male-headed households at 1% level of significant.

In summary, female-headed households are characterized by significantly larger land per labour ratio, older age of household head and lower level of labour productivity while male-headed households are characterized by larger level of labour productivity with significantly larger use of male labour, relatively better educational level, and significantly larger real asset value per labour devoted to farm production.

The difference of labour productivity between male and female-headed households can also be seen using kernel density distribution. Let us proceed to look at the labour productivity difference using kernel density distribution, keeping in mind the above differences between female-headed and male-headed households.

The kernel density distribution of labour productivity for female-headed and male-headed households separately shows male-headed households have larger labour productivity. This is in line with our result above. But, this is a bit subjective judgment as we are judging just by looking at the figure below. We run Kolmogorov-Smirnov equality-of-distributions test to test if the distributions are equal or not objectively. The test fails to reject equality of the distributions with an exact p-value of 0.27. We should still keep in our mind that we cannot reach to a final conclusion before we make a more advanced econometric analysis.

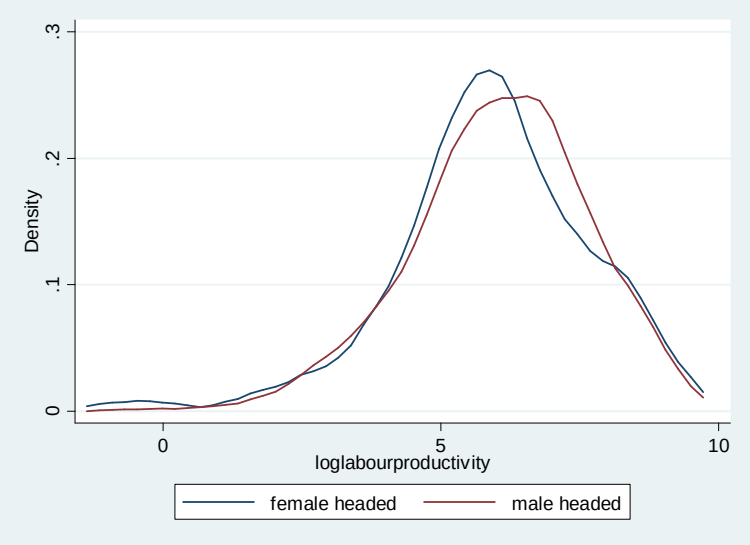


Figure 1: Kernel density distribution on log of labour productivity for male and female-headed households

Note: labour productivity is measured in Malawian kwacha per man-day of labour

4.2 Targeted fertilizer subsidy and agricultural labour productivity

Out of 849 observations, around 66 % received the targeted fertilizer subsidy, which is intended to improve labour and land productivity. From those who received the subsidy around 76 % are male-headed households.

Any analysis which intends to look at the impact of this program on labour productivity, using household level data, should start with a question of what determines getting the subsidized fertilizer for the household. There were some criteria that the government listed out for a household to be beneficiary. But, the question is; were these criteria really determining who gets the subsidy?

What determines getting the subsidized fertilizer?

The first basic question which should be answered before going to look at the impact of the subsidy on anything is what determines whether a given household gets the subsidized fertilizer or not. This is because, if there are criteria practically implemented to choose beneficiaries of the subsidy program, the variable 'whether the household receives a subsidized fertilizer or not' is endogenous which means it needs careful treatment in any assessment especially assessing the impact of the subsidy program. Even if the criteria were not practically implemented, if there are other variables which are actually determining the household which should get the subsidy, the variable will be endogenous. Thus, in any way it needs careful treatment before passing to see the impact of the program.

With the intention of improving the performance of the program, the criteria to select a beneficiary has been subjected to continual change over years. Thus, it is more interesting to see what determines getting the subsidized fertilizer or not in each year separately.

Table 3 presents the mean, median and Pearson chi2 value for the median difference between beneficiaries and non beneficiaries of the subsidy program in 2006. We use median test and present the Pearson chi2 value instead of using t-test because our variables appear to be not normally distributed by Shapiro-Wilk normality test. The results shows beneficiaries were characterized by smaller land size, real asset value per a unit of consumer, livestock units, larger number of children, age of the household head and almost similar consumer worker ratio and quality of house. It should however be noted that a median test on the median differences shows none of these differences were statistically significant.

Table 3: Mean, median and Pearson chi2 value for the median difference between beneficiaries and non beneficiaries of the subsidy program in 2006

Fertilizer subsidy (1:beneficiaries)	Number of observations	Land size (in hectare)	Number of children	Cons worker ratio	Quality of house (higher value indicates better quality)	Real asset value per cu* (in MK** per adult person)	Total livestock units	Age of the household head
0	84	1.22	2.12	1.31	8.83	2135.02	1.56	40.09
		.93	2	1.29	9	663.09	.6	38.5
1	158	.99	2.79	1.28	8.74	2017.94	1.18	44.11
		.78	3	1.28	9	580.88	.5	42
Pearson chi2(1)		0.46	4.02	0.05	0.18	0.16	0.00	0.57
Total	242	1.07	2.56	1.29	8.78	2058.58	1.31	42.72
		.83	2	1.28	9	605.14	.6	41

Note: * cu=consumer units; the 1st row presents mean and the 2nd row presents median in each category/**MK= Malawian Kwacha

In 2007, beneficiaries were those who have relatively smaller land size, consumer worker ratio, age of the household head and real asset value per a unit of consumer. In terms of other households' characteristics, beneficiaries had larger number of children and similar quality of house and total livestock units. A median test on the mean differences shows that all the above differences are statistically insignificant except the difference in number of children which is significant at 10% significance level.

Table 4: Mean, median and Pearson chi2 value for the median difference between beneficiaries and non beneficiaries of the subsidy program in 2007

Fertilizer subsidy (1:beneficiaries)	Number of observations	Land size (in hectare)	Number of children	Cons worker ratio	Quality of house (higher value indicates better quality)	Real asset value per cu* (in MK** per adult person)	Total livestock units	Age of the household head
0	86	1.45	2.66	1.27	8.81	3181.46	1.38	43.38
		.93	2.5	1.26	9	723.98	.5	43.5
1	190	1.24	2.84	1.28	9.16	1879.49	1.19	45.06
		.88	3	1.24	9	669.17	.5	43
Pearson chi2(1)		0.42	2.78	0.42	0.67	0.02	0.01	0.12
Total	276	1.30	2.78	1.27	9.05	2283.49	1.25	44.53
		.89	3	1.25	9	693.59	.5	43

Note: * cu=consumer units; the 1st row presents mean and the 2nd row presents median in each category/**MK= Malawian Kwacha

In line with the criteria, households with smaller land size, real asset value per a unit of consumer, and livestock units were beneficiaries in 2009. But these households had larger number of children, consumer worker ratio, and similar quality of house and age of the household head. A median test of the above differences shows the differences in land size and number of children are statistically significant at 10% and 1 % level of significance.

Table 5: Mean, median and Pearson chi2 value for the median difference between beneficiaries and non beneficiaries of the subsidy program in 2009

Fertilizer subsidy (1:beneficiaries)	Number of observations	Land size (in hectare)	Number of children	Cons worker ratio	Quality of house (higher value indicates better quality)	Real asset value per cu* (in MK** per adult person)	Total livestock units	Age of the household head
0	118	.85	2.16	1.28	8.78	2960.96	1.42	45.59
		.74	2	1.25	9	833.14	.73	44
1	213	.86	2.89	1.28	9.06	2143.05	1.11	46.67
		.63	3	1.26	9	622.42	.6	45
Pearson chi2(1)		3.10	6.96	0.01	3.24	1.69	1.34	0.01
Total	331	.86	2.63	1.28	8.96	2434.63	1.22	46.29
		.67	3	1.26	9	709.81	.6	45

Note: * cu=consumer units; the 1st row presents mean and the 2nd row presents median in each category/**MK= Malawian Kwacha

As it was mentioned earlier, our analysis on each and separate year is more realistic than pooling all the three years together in search of determinants of being beneficiary in the program. But, for the purpose of summarizing the above discussion, Table 6 presents the mean, median and Pearson chi2 value for the median difference between beneficiaries and non beneficiaries of the subsidy program in all the three years together. The result shows that beneficiaries were characterized by smaller land size, real asset value per a unit of consumer, larger number of children, age of the household head and almost similar consumer worker ratio, quality of house and total livestock units. It should be noted that a median test on the median differences shows none of these differences are statistically significant except the difference in number of children which is significant at 1%level of significance. It should also be noted that this mean and median comparison is not perfect measure of comparing two groups. Econometric methods should also be used to confirm or reject the outcomes of such a comparison.

Table 6: Mean median and Pearson chi2 value for the median difference between beneficiaries and non beneficiaries of the subsidy program in all the three years

Fertilizer subsidy (1:beneficiaries)	Number of observations	Land size (in hectare)	Number of children	Cons worker ratio	Quality of house (higher value indicates better quality)	Real asset value per cu* (in MK** per adult person)	Total livestock units	Age of the household head
0	288	1.14	2.30	1.28	8.80	2785.90	1.45	43.33
		0.83	2	1.26	9	756.50	0.6	42
1	561	1.03	2.85	1.28	9	2018.21	1.16	45.41
		0.75	3	1.26	9	622.42	0.59	43
Pearson chi2 (1)		1.96	19.61	0.02	1.84	1.96	0.42	0.14
Total	849	1.06	2.66	1.28	8.94	2278.63	1.26	44.70
		0.78	3	1.26	9	664.28	0.6	43

Note: * cu=consumer units; the 1st row presents mean and the 2nd row presents median in each category/**MK= Malawian Kwacha

Labour productivity impact of the subsidy

After considering what factors are determining to be beneficiary in the targeted fertilizer program, we can pass to looking at how the fertilizer subsidy program affects labour productivity of rural households.

A kernel density distribution on natural log of labour productivity for beneficiaries and none beneficiaries, Figure 2, shows that beneficiaries have slightly larger labour productivity and the Kolmogorov-Smirnov equality-of-distributions test on our distributions fails to reject the null hypothesis that these distributions are equal with exact p-value of 0.89. But, it is worth remembering that such comparisons do not control for other possible differences between beneficiaries and none beneficiaries and it does not also consider the existence of initial differences which affect the probability of being beneficiary and also labour productivity at the same time, in short it does not consider the endogeneity of the participation variable. Thus, there is a need for a more advanced econometric analysis which consider these issues.

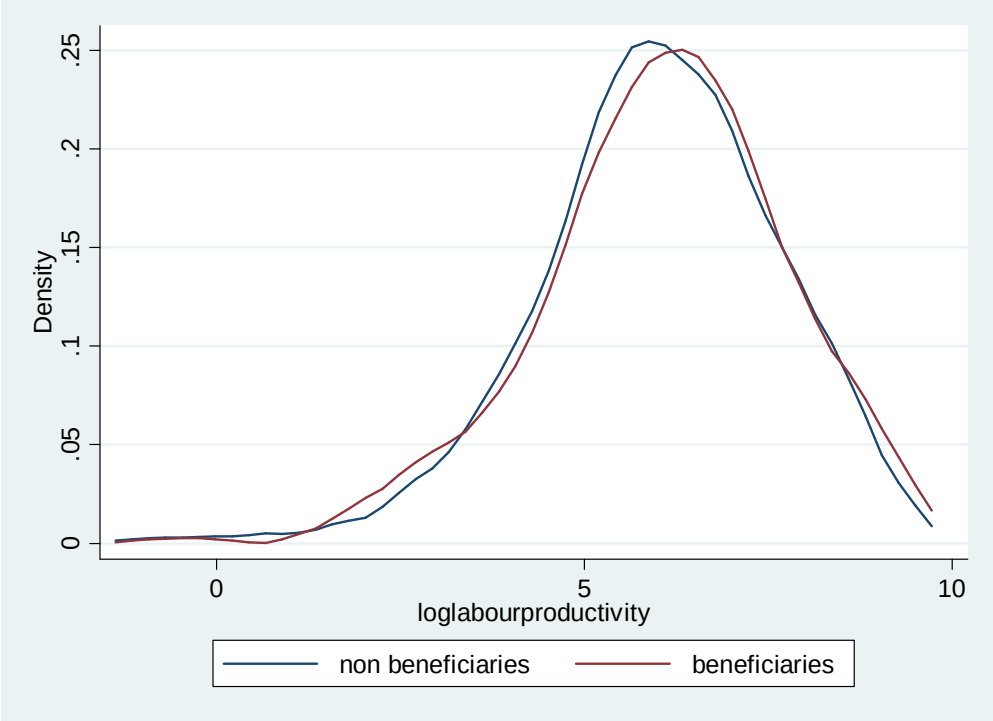


Figure 2: kernel density distribution on log of labour productivity for beneficiaries and none beneficiaries of fertilizer subsidy program

Note: Log of labour productivity is measured in Malawian Kwacha per man day of labour

We may also want to see how the subsidy program affects labour productivity of different parts of the society; like those who are labour poor or those who are land poor households. A two way graph, Figure 3, on labour and land endowment of households shows the distribution of our observations in four categories. It shows the distribution of observations in terms of labour and land endowments. The median labour endowment is 2.8, which is approximately equal to 3 man days per household, while the median land endowment is .78 hectare. Around 33 % of the households lie in the 1st quadrant which is below the median value of land and labour endowment while only around 25% lie in the 3rd quadrant which is above the median land and labour endowments. Households in the 2nd quadrant constitute 17% while those in the 4th quadrant constitute around 25%.

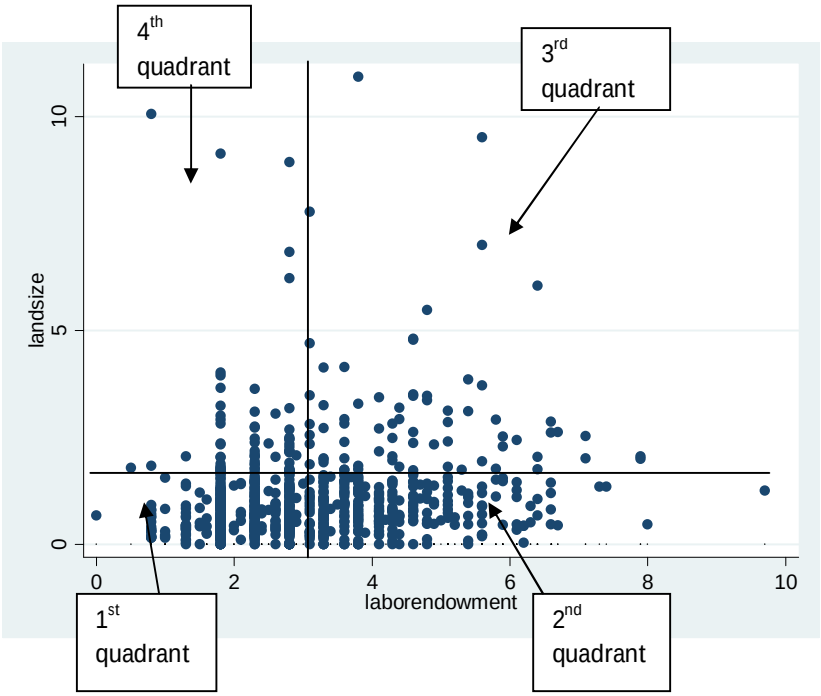


Figure 3: Distribution of observation in terms of labour and land endowments

Note: land size is in hectares and labour endowment is in man days

We are interested to see how the subsidy program affects the labor poor and land poor households. For this study, we can define labour poor households to be those households which have labour endowment below the median endowment and land poor households to be those which have land endowment below the median endowment for our observations. According to this definition, those households in the 1st and 4th quadrant are labour poor and those households in the 1st and 2nd quadrant are land poor. This way of classification helps to

focus on the poor households in terms of land and labour. Among land poor households, around 69 % are beneficiaries while we have 66% beneficiaries among labour poor households, which is relatively smaller as compared to land poor households.

When we compare the median of labour productivity for beneficiaries and non beneficiaries of labour poor and land poor households, we found a shocking result where we get beneficiaries having less labour productivity in both categories. This is unexpected as the program is intended to enhance labour productivity of beneficiaries.

Table 7: Mean and median of labour productivity for beneficiaries and non beneficiaries of the subsidy program among land poor households

Fertilizer subsidy (1= beneficiaries)	Number of observations	Labour productivity (mean)	Labour productivity (median)
0	133	894	375
1	290	834	305
Total	423	853	340

Note: *Median; labour productivity is measured in Malawian Kwacha per man day of labour; the numbers are approximated to zero digits

Table 8: Mean and median of labour productivity for beneficiaries and non beneficiaries of the subsidy program among labour poor households

Fertilizer subsidy (1= beneficiaries)	Number of observations	Labour productivity (mean)	Labour productivity (median)
0	167	1252	550
1	325	1323	517
Total	492	1299	528

Note: *Median; labour productivity is measured in Malawian Kwacha per man day of labour; the numbers are approximated to zero digits

We also do the above comparison for each year separately; we found beneficiaries having relatively better mean and median of labor productivity in 2007 and in 2006 for labor poor households. But, for land poor households in 2006 and for both land poor and labor poor households in 2009, the beneficiaries had less median of labour productivity.

As it was mention again and again, such kind of mean and median comparisons are rough in a sense that they don't control for other possible differences between the groups we are comparing. Thus, a further detail econometric analysis which controls for other possible differences between the groups is required to confirm or reject what we found here by our descriptive analyses.

5. Results and Discussions

This chapter presents and discusses results from econometric regression estimates of the models introduced in the data and methods part of this paper. We focus on our objectives, research questions and hypotheses. The first section of this chapter is about finding out the most influential factors of labour productivity and also the labour productivity difference between female and male-headed households in agriculture. The second section focuses on assessing the impact of targeted fertilizer subsidy program on labour productivity of households in agriculture.

5.1 The most influential factors of labour productivity

The most influential factors of labour productivity are those with larger magnitude of coefficients in our labour productivity equation. The labour productivity equation specified earlier, in chapter 3 section 3.2, is estimated using three different methods: pooled OLS, Household fixed effects and household random effects models from which we could choose the best. Table 9 presents the estimates of labour productivity equation for the three methods. An F-test of the null hypothesis that all household-specific intercepts are identical rejected the null hypothesis at 1% significance level. The Hausman test of the random versus fixed-effects specification rejects the fixed-effects specification. This suggests that the random-effects specification is the preferable specification.

Table 9: Labour productivity equation OLS, Fixed-Effects and Random-Effects estimates

Variables (measurement units in brackets)	OLS	Fixed-Effects	Random-Effects
Land per labour_log (in ha per man-day)	0.27****	0.26****	0.30****
	(0.03)	(0.03)	(0.06)
Children labour_log (in children days)	-0.03	-0.04	-0.06*
	(0.02)	(0.03)	(0.04)
Household male labour_log (in man-days)	-0.05	-0.04	-0.01
	(0.03)	(0.03)	(0.06)
Household female labour_log (in man-days)	-0.11***	-0.11***	-0.13**
	(0.04)	(0.04)	(0.06)
Hired labour_ log (in man-days)	0.10****	0.10****	0.07
	(0.03)	(0.03)	(0.06)
Seed per labour (in MK* per man-day)	0.09****	0.09****	0.09**
	(0.02)	(0.02)	(0.04)
Manure per labour_log (in kg per man-day)	-0.01	0	0.02
	(0.02)	(0.02)	(0.04)

Fertilizer per labour _log (in MK* per man-day)	0.26****	0.25****	0.20****
	(0.02)	(0.03)	(0.04)
Pesticides per labour_ log (in MK* per man-day)	-0.04	-0.05	-0.09
	(0.05)	(0.05)	(0.07)
Real asset value per labour_log (in MK*per man-day)	0.11****	0.12****	0.14***
	(0.02)	(0.02)	(0.05)
Age of head the house hold head	0.03**	0.03	0.01
	(0.02)	(0.02)	(0.04)
Age of the household head_squared	-0.00**	-0.00*	0
	(0.00)	(0.00)	(0.00)
Number of years of schooling	-0.01	0	0
	(0.01)	(0.01)	(0.03)
Sex of the household head (1=female, 0=male)	-0.12	-0.11	-0.14
	(0.12)	(0.10)	(0.28)
Constant	5.78****	5.76****	6.39****
	(0.40)	(0.50)	(0.97)
Prob > chi2	0.000	0.000	0.000
Number of observations	849	849	849

Note: Standard errors in parentheses: Dependent variable is log of labour productivity measured in MK* per man-day. All equations include the following additional explanatory variables: residence, year and region dummies; their coefficients are not reported here; *MK= Malawian kwacha; significance level (* 10% ** 5% *** 1% **** 0.1%); the estimations are done with bootstrapped standard errors of 250 replications.

Now, we will proceed with the random effects model, leaving the OLS and random effects model behind. But, it is logical to be worried about the endogeneity of input variables in the above model. To see what the coefficients would be after minimizing endogeneity, we replaced the land and labor variables by land and labor endowments as endowments are relatively exogenous than actual land and labor allocated for production. We also dropped one endogenous variable on which we have less interest to estimate its coefficient; pesticides per labor. And, we keep important, but endogenous, variables like fertilizer per labor and manure per labor in the model and we interpret their coefficients showing the implication of the endogeneity problem. But, we don't want to completely rely on the estimates of the model after these changes. Because, the land and labor variables are not the variables that we exactly want, they are just proxies for the variables that we want. So, the results we present in the coming paragraphs are from the 1st model on table 10 above, but only those which are also supported by the second model where we incorporated the changes. See Table 13, in Appendix A, for results of the second model.

Among those which are significantly correlated with labour productivity, land per labour and fertilizer per labor variables appear to have the largest absolute value of coefficients. Since we have log-log model, the coefficients represent the respective variable's elasticity of labor productivity. This tells us that a lot of household level labour productivity gain could be attained if we focus on improving the land per labour and fertilizer per labour ratios of household.

Hired labor is positively and significantly correlated with labor productivity. This could be because households use generally less hired labor. Seed per labour and manure per labour variables also have statistically significant coefficient showing the fact that household's use of manure and more seeds enhances labour productivity.

As it was mentioned earlier, the fertilizer per labor variable is one of the most significant variables positively correlated with labor productivity. But, households endogenously decide whether to use fertilizer or not, mainly considering the soil fertility of their plot. Thus, the fertilizer per labor variable is endogenous if soil fertility is not included in the labor productivity equation. The same is true for manure per labor variable since households apply manure mainly considering the soil fertility of their plot. Since it will be collinear with fertilizer per labor and manure per labor variables, we have not included soil fertility in our model. This implies the estimated coefficients for the fertilizer per labor and also for manure per labor variables are biased. The endogeneity bias on the estimated coefficients can be explained by the following formula(Saridakis 2009);

$$E(\hat{a}) = a + b\,\frac{\mathrm{cov}\,(F_{it},\ SF_{it})}{\mathrm{var}(F_{it})}$$

Where; a is the population coefficient for the endogenous variable, b is the correlation between labor productivity and soil fertility.

We know that the correlation between labor productivity and soil fertility is positive. Thus, b is greater than zero and the previous paragraph can guide us to tell the covariance between fertilizer per labor and soil fertility, which is negative. This implies the estimated coefficient is underestimated. So, the coefficients for fertilizer per labor and manure per labor are larger than what we have estimated. This strengthens the conclusions that we made about the correlation of these variables with labor productivity.

We hypothesized that female-headed households have less labour productivity than male-headed households. The coefficient for sex of the household head and its corresponding significance test can help us to objectively test this hypothesis. It appears to be negatively and insignificantly correlated with labour productivity. The negative coefficient shows that female-headed households are less productive and the insignificance tells us that the difference is not statistically significant given that they have equal value in terms of the variables included in the model. And, since it is a coefficient from panel data regression, it is relatively better in controlling even for differences on unobserved variables. Thus, it is the best measure of productivity difference between these groups. Unlike the previous rough (mean and kernel density) analysis on productivity differences, this parametric means of measuring the productivity difference is reliable. Thus, we can conclude that female-headed households are less productive than male-headed households but the difference is not statistically significant. Or, we can just say that female-headed households are as productive as male-headed households, *ceteris paribus*.

Until now we were looking at the regression for all observations together. But, we may separate our observations for female-headed and male-headed households and see if different variables are explaining the variation in labour productivity for female-headed and male-headed households. We run OLS, fixed effects and random effects model again for female and male-headed households separately to see if the household effects (if they exist) are random or fixed within the two groups. Hausman test of fixed effects over random effects fails to reject the random-effects specification both for male-headed and female-headed households. The following table presents the productivity equations estimated separately for male and female-headed households using random-effects specification.

Table 10: Labour productivity equation Random-Effects estimates for female and male-headed households separately

Variables (measurement units in brackets)	Male headed Households' estimates	Female-headed households' estimates
Land per labour_log (in ha per man-day)	0.26****	0.21**
	(0.04)	(0.09)
Children labour_log (in children days	-0.03	-0.05
	(0.03)	(0.06)
Household male labour_log (in man-days)	-0.11**	-0.02
	(0.05)	(0.06)
Household female labour_log (in man-days)	-0.02	-0.25***
	(0.05)	(0.08)
Hired labour_ log (in man-days)	0.10***	0.05
	(0.04)	(0.07)
Seed per labour (in MK* per man-day)	0.08***	0.13**
	(0.03)	(0.06)
Manure per labour_log (in kg per man-day)	0.01	-0.05
	(0.03)	(0.05)
Fertilizer per labour _log (in MK* per man-day)	0.23****	0.30****
	(0.03)	(0.06)
Pesticides per labour_ log (in MK* per man-day)	-0.01	-0.2
	(0.05)	(0.15)
Real asset value per labour_log (in MK*per man-day)	0.10****	0.12**
	(0.03)	(0.05)
Year dummy for 2007	0.03	-0.12
	(0.11)	(0.28)
Year dummy for 2009	-0.22*	0.03
	(0.13)	(0.26)
Dummy for central region	0.26***	0.2
	(0.09)	(0.22)
Constant	5.98****	5.30****
	(0.56)	(0.98)
Prob > chi2	0.00	0.00
Number of observations	649	200

Note: Standard errors in parentheses: Dependent variable is log of labour productivity measured in MK* per man-day. All equations include the following additional explanatory variables: age of the head (both with and without squaring), educational level of the head (number of schooling years), and residence dummies; their coefficients are not reported here; *MK= Malawian kwacha; significance level (* 10% ** 5% *** 1% **** 0.1%); the estimations are done with bootstrapped standard errors of 250 replications; year 2006 is the base reference for the year dummies; southern region is the base reference for the region dummy.

The estimates are telling us that the variables explaining the variation in labour productivity are not the same for male and female-headed households. They differ in household male and female labour, hired labour, and regional dummy variables. These variables are significant only in either female-headed or male-headed households' equations. But, land per labour, seed per labour, fertilizer per labour and real asset value per labour variables are significantly correlated with labour productivity in a similar way in female-headed and male headed households' equations.

Focusing on the variables which are significant in either of the equations above, the difference lies on labour variables. Male labour has negative and significant coefficient on the males' equation while it is insignificant on the females' equation. Female labour is significantly and negatively correlated with female-headed households' labour productivity while it doesn't have significant coefficient on the males' equation. This is in line with what we found in our descriptive analysis where male-headed households use significantly larger male labour resulting negative and significant coefficient for household male labour on male headed households' equation. Hired labour appears to have positive and significant coefficient on males' labour productivity while it is insignificant in the females' equation. From our descriptive analysis, we found that male-headed households use less hired labour than female-headed households, this coupled with the positive and significant coefficient on the males' labour productivity equation can make us to conclude that hired labour's elasticity of labor productivity is higher at its lowest level.

From the other input variables seed and fertilizer appear to be important for both female and male headed households. Our descriptive analyses show that large percent of those who received fertilizer subsidy are male-headed households. Previous studies on the fertilizer subsidy program in Malawi (Dorward 2008) shows that female-headed households are less probable to get the fertilizer subsidy. But fertilizer, as we have seen it in our analysis in this section, appears to be significantly and positively correlated with labour productivity in all of our regressions above. Our data shows that female-headed households spend less on fertilizer than male-headed households. This, coupled with being less probable to get the subsidized fertilizer may lead one to expect female-headed households to be less productive than male-headed households.

Surprisingly, female-headed households are not significantly less productive than male heads', why? We found that female-headed households have larger average manure per labour ratio, Thus, it might be because female-headed households substitute manure for fertilizer, to compensate their labour productivity difference, when they are denied to get the fertilizer through the subsidy program.

The most significant variable correlating with labour productivity is land per labour with a marginal effect of 0.26 on male headed households while it comes after fertilizer per labour and household female labour for female headed households. Thus, fertilizer per labour variable appears to be the most significant variable for female-headed households while land per labour is the most significant for male headed households. Fertilizer per labour is the 3rd most significant variable after land per labour and central region dummy variable for male-headed households. Thus, we can conclude that land per labour and fertilizer per labour ratios are very important in any effort to enhance labour productivity.

Alternatively we can see the labor productivity difference between female headed and male headed households using a simulation technique. As presented in Table 2, female headed households have smaller mean value of labor productivity than the male headed households. But, this mean comparison could be misleading because the difference could be because female headed households have different level of endowments than male headed households. The better way could be to give female headed households the level of endowment of the males' and compare their mean labor productivity with the males' or the other way round, giving male headed households the level of endowment of the females'.

First, we predicted the natural log of labor productivity of female headed and male headed households by giving the mean value of their own endowments. Female headed households appear to have smaller labor productivity (5.90 MK per man day) than males (6.05MK per man day). Then, we inserted the mean endowments of males to female headed households' labor productivity equation to see what would be the average level of labor productivity for female headed households if they have endowments like an average male headed household. The result shows that female headed households would almost be as productive as male headed households

if they have the same endowments like male-headed households. This result is exactly the same with what we found in our previous where we assessed the productivity difference by looking at the coefficient of the gender variable in a labour productivity equation.

5.2 Modeling the impact of targeted fertilizer subsidy on labour productivity

In this section, we look at the impact of the targeted fertilizer subsidy on labour productivity econometrically. We assess the impact for the whole observations, labour poor households and land poor households separately. We do this for each year separately and finally we do it on the whole panel data using panel data regression methods.

Since the focus here is on the impact of the subsidy program, we give less attention in interpreting the coefficients for the other variables. As it was stated when we construct our empirical model, in section 3.2, there is causality relationship between subsidy for fertilizer and fertilizer per labor variables. Subsidy causes use of fertilizer. If we include both variables in the labor productivity equation, the impact of the subsidy will be hidden covered by the fertilizer per labor variable. Thus, we excluded fertilizer per labor variable to avoid its effect on the coefficient of the subsidy variable in the labor productivity equation to be estimated. The substitutability nature of manure and fertilizer makes us to drop manure per labor variable from the labor productivity equation for the same reason. We also drop endogenous input variables like pesticides per labor, seed per labor and hired labor variables since we don't get good instruments for them. And we replaced the labor and land variables by labor and land endowments as endowments are relatively exogenous than actual land and labor allocated for production.

Since 'the participation in the fertilizer subsidy program' variable is endogenous, we use instrument variables to predict it. Since the beneficiary criteria for the program was changing over years, we opted to find instrument variables and predict the 'participation' variable in each year separately. This gives exogenous 'participation' variable for each year and then we append this variable from each year to come up with exogenous 'participation' variable for the panel of the three years. After that, we applied panel data regression methods to see the impact of the subsidy program on labour productivity from the three years panel data.

We run treatment effect models by instrumenting the participation in the fertilizer subsidy program. Different instrument variables are used for different years. Number of children, quality of house, total livestock units, dummy variable for elder heads, and sex of the household head are variables included at least in one of the three years' participation equations. As it can be reviewed above, we have tried to give descriptive analysis for beneficiaries and non beneficiaries in terms of many of these variables. We promised to have econometric analysis on the issue and here is the time to present the results from the econometric analysis.

Table 11, below, presents the maximum likelihood estimation results of treatment effect models where we instrument the 'fertilizer subsidy' variable in the labour productivity equation for each year separately.

Table 11: Treatment effect Models showing the impact of fertilizer subsidy on labour productivity for different years separately

Variables (additional information in brackets)	Treatment effect model for 2006	Treatment effect model for 2007	Treatment effect model for 2009
Outcome or Treatment effect equation[5]			
Sex of the household head (1=female, 0=male)	-0.19	-0.31	
	(0.25)	(0.24)	
Fertilizer subsidy (1=beneficiary, 0=none beneficiary)	1.93****	2.61****	1.14****
	(0.46)	(0.38)	(0.31)
Age of the household head			0.03
			(0.02)
Age of the household head (squared)			0
			(0.00)
Constant of the outcome(labour productivity) equation	4.14****	3.91****	3.97****
	(0.50)	(0.48)	(0.59)
The first stage; predicting treatment;			

[5] See the note below the table for additional variables included in the model

Number of children		0.05	0.13***
		(0.04)	(0.05)
Quality of house (aggregated quality of roof, floor, window and door; higher value is better quality)	0.01	0.04	0.06**
	(0.03)	(0.03)	(0.02)
Total livestock units (aggregates different livestock by weights*; larger value is large units of livestock)	0.01		
	(0.04)		
Dummy for elder heads (1=for those who are above 65, 0= otherwise)	0.71***	0.43**	
	(0.24)	(0.21)	
Sex of the household head (1=female, 0=male)			0.16
			(0.14)
Constant of the participation equation	0.88***	0.33	-0.3
	(0.30)	(0.31)	(0.26)
athrho			
Constant	-0.91****	-1.11****	-0.92****
	(0.20)	(0.18)	(0.22)
lnsigma			
Constant	0.52****	0.61****	0.17*
	(0.09)	(0.08)	(0.09)
Prob > chi2	0.00	0.00	0.00
Number of observations	241	276	330

Note; Standard errors in parentheses Dependent variable of the outcome equation is log of labour productivity measured in MK* per man-day and dependent variable of the participation equation is Fertilizer subsidy (1=beneficiary, 0=none beneficiary); all equations include the following additional explanatory variables in the outcome equation: log of land per labour (in hectare per man-day) , log of household male labour in man days, log of household female labour in man-days, log of household children labour (in children days), log of real asset value per labour (in MK* per man day) number of schooling years and Region, soil fertility and residence dummies; their coefficients are not reported here; land and labor variables are endowments of the household; all the participation equations include district dummies, Thyolo being the base reference; *MK= Malawian kwacha;significance level (* 10% ** 5% *** 1% **** 0.1%)

The Wald test for independence of the outcome and participation equations rejects the null hypothesis that the equations are independent at 1% level of significance for all the years. This means, our fertilizer subsidy variable is endogenous and we indeed need to instrument it in all years. But, the instruments used should be exogenous or uncorrelated with the error term of the outcome equation. Since we don't have built in post-estimation commands to check exogeniety of instrument variables with the 'treatreg' estimation in STATA, we predicted the error term of

our outcome equation and regress it putting the instrument variables on the right hand side to check if they are not correlated with the error term. An F-test with a null hypothesis that all the coefficients (jointly) are zero fails to reject the null hypothesis at 1% level of significance for all years' equations. This shows that the instruments are not correlated with the error term of the outcome equation.

In 2006, the statistically significant coefficients of the participation equation shows households with smaller livestock units and with elder household heads were most probable to get the subsidy. The district dummies for Machinga, Kasungu and Lilongwe appear to have negative and significant coefficients. This means, households in these districts were less probable to get the subsidy as compared to households in Thyolo district.

In 2007, like the case in 2006, households with elder heads were most probable to get the subsidy. The coefficient for Kasungu district also appears to be significant and negative showing that households in Kasungu district were less probable to get the subsidy than those in Thyolo.

In 2009, we found number of children significant and positively correlated with the probability of getting subsidy, showing that households with larger number of children were more probable to get the subsidy. This result is similar with recent researches on the fertilizer subsidy program in Malawi (Holden and Lunduka 2010).

The coefficient for the treatment or subsidy variable is positive and significant in all years showing that the program enhanced labour productivity of rural households significantly.

We constructed an exogenous 'participation' variable from each year's instruments of the variable above. Then, we append these exogenous 'participation' variables from different years to come up with one panel exogenous 'participation' variable for all the three years. Then, we run random effects panel data regressions for the whole observations, labour poor households and land poor households separately.

We hypothesized that the targeted fertilizer subsidy program enhances labour productivity of labour poor and land poor households. Table 12 presents regression results of the random effects estimation where we test these hypotheses. The coefficient for fertilizer subsidy variable appears to be positive and significant for labour poor and also land poor households and even for all

observations. This means, the targeted fertilizer subsidy program enhances labour productivity of rural Malawian households significantly.

Table 12: Labour productivity equations showing the impact of fertilizer subsidy on labour productivity; for the whole observations, labour poor and land poor households

Variables (measurement units in brackets)	The whole observations (Random-effects estimation)	Labour Poor (Random-Effects estimation)	Land Poor (Rand-Effects estimation)
Land per labour_log (in ha per man-day)	0.34****	0.37****	0.21***
	(0.05)	(0.07)	(0.07)
Children labour_log (in children days	0	0.11	0.04
	(0.11)	(0.15)	(0.14)
Household male labour_log (in man-days)	-0.13	0.01	-0.21
	(0.11)	(0.23)	(0.17)
Household female labour_log (in man-days)	0.07	0.35	-0.08
	(0.13)	(0.23)	(0.18)
Age of the household head	0.01	0.02	-0.02
	(0.02)	(0.02)	(0.03)
Age of the household head (squared)	0	0	0
	(0.00)	(0.00)	(0.00)
Number of schooling years	-0.02	0.02	0.02
	(0.01)	(0.02)	(0.02)
Sex of the household head (1= female, 0=male)	-0.03	-0.05	0.05
	(0.13)	(0.18)	(0.18)
Real asset value per labour_log (in MK*per man-day)	0.35****	0.34****	0.35****
	(0.02)	(0.03)	(0.03)
Fertilizer subsidy (1=beneficiary, 0=non beneficiary)	1.38***	1.60***	2.38****
	(0.44)	(0.60)	(0.65)
Constant	4.53****	3.97****	3.72****
	(0.59)	(0.74)	(0.78)
Prob > chi2	0.00	0.00	0.00
Number of observations	847	491	428

Note; Standard errors in parentheses; Dependent variable is log of labour productivity measured in MK* per man-day. All equations include the following additional explanatory variables: region, residence, soil fertility and year dummies; their coefficients are not reported here; land and labor variables are endowments of the household *MK= Malawian kwacha; significance level (* 10% ** 5% *** 1% **** 0.1%)

Finally, it is worth to remind on what conditions our results depend. We assumed intercropping to have insignificant effect on our results, we used retail market prices to aggregate production of different crops produced by a household and we use partial measurement of productivity. Thus, it is important to note that we may get different results if we use farm gate prices to aggregate production of different crops in a household, if we use better measurement of productivity and if we relax the assumption we made about the insignificant effect of considering intercropping on our results.

6. Conclusions, Implications and Recommendations

We believe it will be easy for the reader to link where this study starts and where it is ending if we put two sentences about the problem this study raises before we pass to our conclusions. While labour is underemployed or unemployed (in surplus) in most of the years, there exists labour shortage at the peak of cropping seasons in Malawi. It has been argued that improving labour productivity in Malawi is paramount to solve the labour shortage in the labour surplus economy paradox and low labour productivity has been found to be central to the poverty problem in Malawi.

Results show that land per labour and fertilizer per labour variables are the most significant variables through which we may improve labour productivity. It can be implied that a lot of household level labour productivity gain could be attained if we focus on improving the land per labour and fertilizer per labour ratios of households. However, improving land per labour ratio is more challenging than improving fertilizer per labor ratio with increased population pressure especially in the southern region of Malawi. But, both ratios can be improved by investing on labour saving mechanisms especially those which save the labour devoted for weeding. This is because focus group discussions with the rural Malawian households showed that weeding and fertilizer application are labour intensive peak time activities.

The labour shortage problem that we raised in this study is during the peak times of the agricultural season. Thus, techniques which help to save the labour devoted for peak time activities especially for weeding help much. The solution starts from the household itself. Weeding after weeds are well established takes much more labour hours than doing well before. Thus weeding earlier is recommendable. Row planting and appropriate planting pattern can also be a good solution to easily weed when the weed appears and saves the time spent on weeding. It is also of interest, for the government, to study which seed varieties are weed tolerant and encourage and teach farmers to use such seed verities.

Helping farmers to use herbicides through teaching them about it and subsidizing to make it affordable for farmers minimizes the labour hour devoted for weeding. However care should be taken on the type of herbicide to be advocated. Care should also be taken on educating farmers

through extension programs how and how much to use. Herbicides have health and environmental side effects if we are not careful on which type, how and how much to use.

Female-headed households are older, less educated, endowed with less real asset value and are characterized by lower spending on fertilizer. But, female-headed households are found to be as productive as male-headed households, *citrus paribus,* although they are less probable to get the subsidy for the very important input on labour productivity, fertilizer. The underlying reason behind this may be because they substitute manure for fertilizer, to compensate their labour productivity difference, when they are denied to get the fertilizer through the subsidy program.

It is found that the targeted fertilizer subsidy program enhances labor productivity of rural Malawian households significantly. It is, thus, recommendable to strengthen the fertilizer subsidy program making it to work for the poor as it also have positive contribution in improving fertilizer per labor ratio. Elderly headed households and households with large number of children were more probable in most years to get the subsidy. Other recent studies also confirm the result that households with large number of children are more probable and female headed households are less probable to get the subsidy.

There are new changes on the input subsidy program for 2009/2010; like no cash crops such as tobacco, cotton, coffee, tea will be included in the program. The program will concentrate on maize fertilizers, maize seed, legume seed (groundnuts, pigeon peas, soya beans, beans) and storage pesticides. Interests to see the effects of these changes on the program are emerging.

Finally, we would like to remind the reader that this study has its own limitations like the assumption of insignificant effect of considering intercropping on results, lack of farm gate price data to aggregate production of different crops in a household and partial productivity measurement for labour. Thus, results might be different when one does this research with access to farm-get prices, with a better measurement of labour productivity and relaxing the assumption about intercropping.

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Appendices;

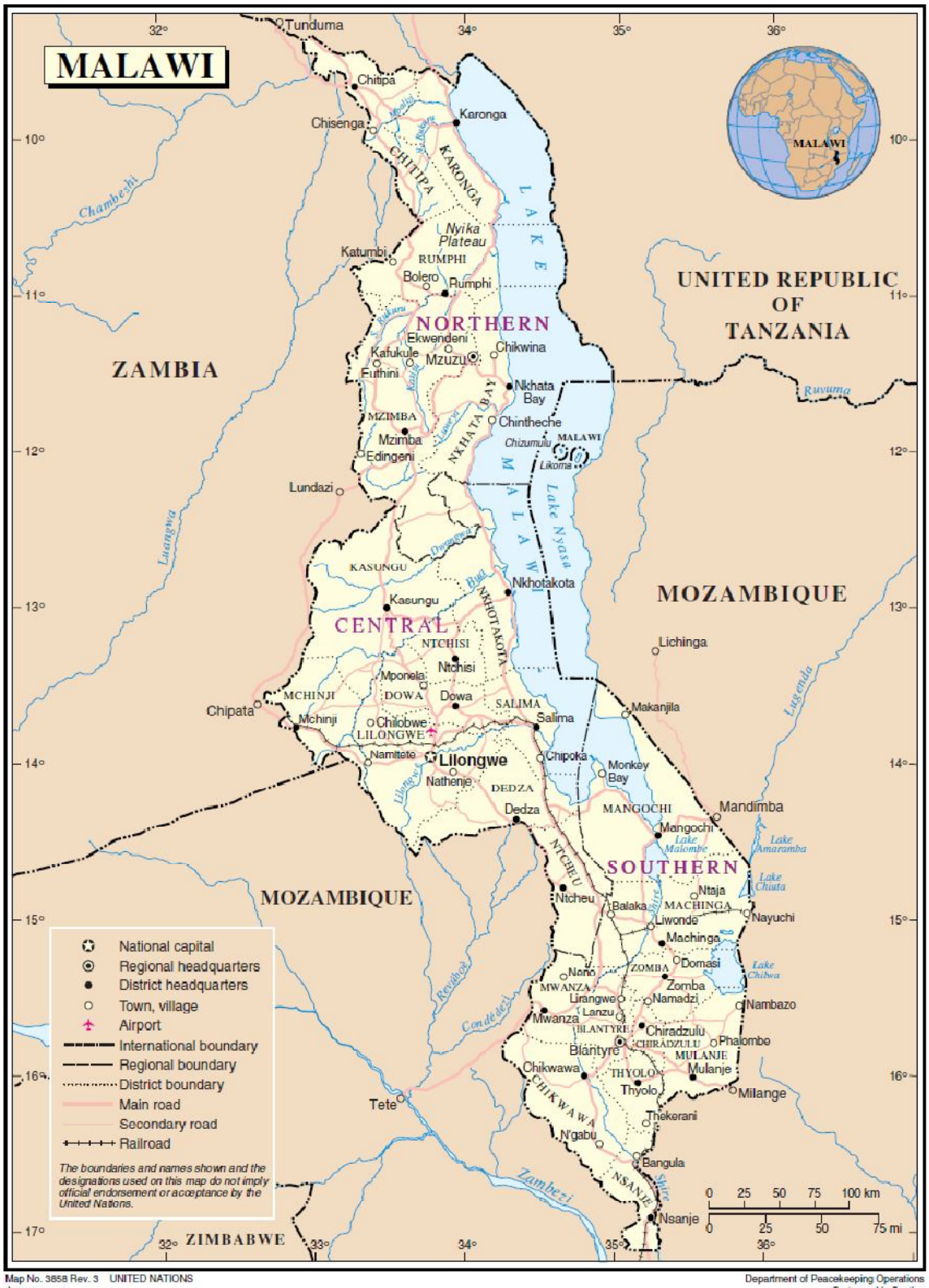
Appendix A: Table of regression results

Table 13: Labour productivity equation OLS, Fixed-Effects and Random-Effects estimates; after minimizing endogeneity of variables problem

Variables (measurement units in brackets)	OLS	Fixed-Effects	Random-Effects
Land per labour_log (in ha per man-day)	0.30****	0.31****	0.41****
	(0.05)	(0.05)	(0.09)
Children labour_log (in children days)	-0.11	-0.08	0.07
	(0.09)	(0.09)	(0.21)
Household male labour_log (in man-days)	-0.03	-0.05	-0.2
	(0.09)	(0.10)	(0.22)
Household female labour_log (in man-days)	0.03	0.02	0.1
	(0.12)	(0.11)	(0.26)
Hired labour_ log (in man-days)	0.07**	0.06**	0.02
	(0.03)	(0.03)	(0.06)
Seed per labour (in MK* per man-day)	0.23****	0.23****	0.20****
	(0.03)	(0.03)	(0.05)
Manure per labour_log (in kg per man-day)	0.07***	0.08***	0.11**
	(0.03)	(0.03)	(0.05)
Fertilizer per labour _log (in MK* per man-day)	0.36****	0.35****	0.31****
	(0.02)	(0.03)	(0.05)
Real asset value per labour_log (in MK*per man-day)	-0.01	0	0
	(0.01)	(0.01)	(0.02)
Age of head the house hold head	0.03**	0.03*	0.03
	(0.02)	(0.02)	(0.05)
Age of the household head_squared	-0.00**	-0.00*	0
	(0.00)	(0.00)	(0.00)
Number of years of schooling	-0.02	-0.02	-0.02
	(0.01)	(0.02)	(0.04)
Sex of the household head (1=female, 0=male)	-0.06	-0.06	0.02
	(0.12)	(0.13)	(0.33)
Constant	4.40****	4.42****	4.16****
	(0.46)	(0.48)	(1.10)
Prob > chi2	0	0	0
Number of observations	849	849	849

Note: Hausman test chooses random effects estimation over the fixed effects estimation; Standard errors in parentheses: Dependent variable is log of labour productivity measured in MK* per man-day. All equations include the following additional explanatory variables: residence, year and region dummies; their coefficients are not reported here; *MK= Malawian kwacha; significance level (* 10% ** 5% *** 1% **** 0.1%); the estimations are done with bootstrapped standard errors of 250 replications.

Appendix B: Map of Malawi



Appendix C: Districts, main villages in enumeration area and number of households sampled

Region	*District*	*No of Enumeration areas*	*Main Village in enumeration area*	*No of households*
Southern	**Thyolo**	2	Chimbalanga	30
			Kapyepye	30
	Chiradzulu	2	Kasani	30
			Matikiti	30
	Zomba	3	Mtutuma	30
			Mayaka	30
			Chirombo	30
	Machinga	2	Kawinga	30
			Namanja	30
Central	**Lilongwe**	3	Mpingu	30
			Mtengenji	30
			Mpingira	30
	Kasungu	3	Kadifula	30
			Kankhande	30
			Kwengwere	30
Total				450

Appendix D: Questionnaire

Questionnaire number

NOMA
(2009)
Household Questionnaire

HOUSEHOLD IDENTIFICATION	NAME		CODE
Household head			
Name of village			
Traditional Authority			
District			
Region			
Name of interviewee			**Sex** 1= Male 2=Female
Enumeration area			
Residence area	Husband's village		
	Wife's village		
	Neutral Village		
Name of Enumerator			
Name of data entry			
Date of interview	**Date:……./……/2009** **Start time:……..:……..** **Finish time:……:……..**		**Checked by:** **……..** **Approved:** **…….....**
Reasons for not conducting interview:			**Household location GPS Coordinates:** **N……** **E……**

A. Provide the details of each household member

Member ID	Name of household member	Sex	Relationship with HH head	Marital status	Age	Education			Main occupation	How many months did the name live here in the last 12 months	If they left the home when did they live?	How many times did the name face serious illness in the past season for more than 3 weeks.
	A1	A2	A3	A4	A5	A6			A7	A8	A9	A10
						Number of years of schooling (a6.1)	*Highest class attended (a6.2)*	*Highest level of education completed (a6.3)*	*What is the name of proffesion or activity*			
01												
02												
03												
04												
05												
06												
07												
08												
09												
10												
11												
12												
13												
14												
15												
16												
17												
18												

Code

A2 1=female 2=male

A3 1= husband 2= wife 3= son 4= daughter 5= Grandchild 6=Brothet 7=sister 8=neice 9= nephew 10=other relatives (specify)

A4 1=Married 2=Widowed 3=Divorced 4= separated 5=Never married

A6.3 0=none 1=std 1-4 2= std 5-8 3= Attend sec 4=MSCE 5=Techn. Colle 7=University

A7 0=none 1= Farming 2=bussiness 3=ganyu (labour) 4=Salaried work 5=schooling 6=Unemployed 7=other (specify)

A10 0=none 1=once 2=twice 3=three times 4=whole season

This question is for new households in the survey those that got married after July 2007.

B. Marital status and residential areas

ID	Name of wive(s) *B1*	Name of husband *B2*	When did you get married? *B3*	Number of children *B4*	Residence				
					District of origin *B5*	Village of origin *B6*	Village of residence *B7*	If B6 and B7 are different,	
								When did you come into this area? *B8*	Distance from village of origin *B9*
									Distance / Unit
							1= Wife's village 2=husband's village 3=neutral village		0 if B6 and B7 is same

This question is for new households in the survey those that got married after July 2007.

Br. Major resources brought into marriage

At marriage what did		What resources did parents have		Did husband pay Chitengwa?	If yes, how much?	
Husband bring *Br1*	Wife bring *Br2*	Husband's *Br3*	Wife's *Br4*	*1-yes 0-no* *Br5*	*Br6 Cash*	*Br6 Kind*

C. Social economic characteristics

Quality of Main house C1		Toilets owenership and type C2		Source of water C3		Source of energy C4	
Walls **C1a**		*Does house hold own a toilet* **C2a (0=No, 1=Yes)**		*Source* **C3a**		*Source lighting* **C4a**	
Roof **C1b**		*Kind of toilet* **C2b**		*quality* **C3b**		*Source cooking* **C4b**	
Floor **C1c**		*If no toilet, what is used* **C2c**		*availability* **C3c**			
Windows **C1d**							

Type of house						Water source C3			Energy C4	
Walls C1a	Roof C1b	floorC1c	windowsC1d	Kind of toilet C2	Altenative toilets	source	quality	Availability	lighting	cooking
1= Poles and mud 2= Sundried walls 3= compacted earth 4=burnt bricks walls 5= plastered and painted walls	1=Grass Thatched 2=Iron sheets 3=Tiled 4=cement sheets	1=cement 2=mud	1=wooden 2=glass 3=grass 4=without windows 5= opening 6=others	1=Flush sewer system 2=Flush septic 3=latrine with san plat 4=Traditional latrine 5=VIP latrine	1= bush 2= river/ lake 3=neighbours 4=others	1=river/lake 2=protected well 3=unprotected well 4=borehole 5=Communal piped 6=household piped 7=other	1= bad 2=moderate 3=good	1=All year round 2=In wet season only 3=some breakdowns	1=Electricity 2=paraffin 3=candles 4=wood 5=grass 6=torch 7=other	1=firewood collected 2=purchased firewood 3=made charcoal 4=purchased charcoal 5=paraffin 6=electricity 7=crop residues 8=others

D Assets owned by the household

Items	Does your household own the following items D1 1=yes 0=no (go to D6)	How many items do you have? D2	How much did you pay for it? (MK) D2.1			When did you acquire them? (year) D3			When acquired, was the item new? D3.1 1=yes 0=no			If you were to sell them today what will be the price? (MK) D4		
Car														
Ox cart														
Bicycle														
Wheelbarrow														
Hoe														
Panga														
Axe														
Sickle														
Handsprayer														
Treadlepump														
Engine pump														
Bed														
Chair table														
Chair sofa														
Ridger														
Table														
Sewing machine														
Radio														
Plough														
Pressing iron														
Television														
Cellphones														
Others (specify)														

D Assets owned by the household Cont'

Items	Did you lose or sell any item last year? 1=yes 0=no **D5**	Did you own any in the last five years? **D6** 1=yes 0=no **If no go to D10**	If yes what happened? **D7**	When did this happen? (year) **D7.1**	If sold why? **D8**	If sold what was the price? (Mkw) **D9**	Do you plan to buy any of these this year? 1=yes 0=no **D10**
Car							
Ox cart							
Bicycle							
Wheelbarrow							
Hoe							
Panga							
Axe							
Sickle							
Handsprayer							
Treadlepump							
Engine pump							
Bed							
Chair table							
Chair sofa							
Ridger							
Table							
Sewing machine							
Radio							
Plough							
Pressing iron							
Television							
Cellphones							
Others (specify)							
			1 =lose **2 =sell** **3 =stolen** **4 =other(specify)**				

E. Time use and labour

Member ID	What day of the week was yesterday? E1	How many days did you spend collecting firewood last week? E6	How many hours did you spend collecting firewood yesterday? E7	How many hours do you spend during lean seasons on agricutural actvities? E9	At peak time during the agricultural season, how many hours per day did you engage in ganyu? E11	At peak time during the agricultural season, how many hours do you spend in the field? E12
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						

E2. Proportion of Labor allocated to the different activities in a Year (Out of 20 matchsticks, how many would you give in terms of labor allocated to the following Activities)

Member ID	Household Activities E21	Collecting Firewood E22	Forest Activities E23	Maize Fields E24	Tobacco Fields E25	Other Agricultural Activities E26	Non Agricultural activities E27
	2	2	1	5			

E28: Indicate distance (in km) from home to forest thinning or forest clearing area:_____

E29: Indicate distance (in km) from home to firewood collection area:_____

E30: Indicate distance (in km) from home to forest based area of wage……

E31: Wage per hour of forest based wage work……

F.How many parcel does the household have?.....

Ask for each plot the household owns or rents in or rents out or fallow

Parcel ID	Plot ID	Name of plot	Distance from home to the plot	What is the size of your plot?		Physically measured size with GPS (meter square)			What is the general texture of the soil?	What is the slope of the plot?	What is the general fertility of the plot?	How did you acquire this plot?	If you were to sell this plot today how much could you sell it for?
		F1	*F2*	*Unit of measure F3*	*Amount F4*	*Coordinates N/S F5*	*Coordinates W/E F6*	*Size F7*	*F9*	*F10*	*F12*	*F13*	*F14*
	1												
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	Give name of crop grown or fallow See codes on FC								1=sandy 2=loam 3=clay	1-flat 2-slight 3-steep	1-very fertilie 2-average 3-not fertile		

Codes F13= 1=granted by local leaders, 2=Inherited from mothers side (wife) , 3=Inherited from fathers side(wife), 4=Inherited from mothers side (husband) , 5=Inherited from fathers side(hasband) ,6=Rented, 7=purchased , 8=farming as tenant

F15 If you need more land for cultivation do you have any available for you?

1-Yes……...How?.....

2-No…… why?.....

F16 If you were to buy land how much will you be willing to pay for one acre? (MK)……

Fs. -Security of the plots

Plot ID	Who will inherit this plot from you *Fs1*			Under what circumtances can you stop cultivating this plot *Fs2*	Who can grab the land away from you? *Fs3*			What are you doing to ensure that you don't lose the plot? *Fs4*		

Fs1 1=Sons, 2=daughters, 3=both (children) , 4=brothers, 5=sisters, 6=others,
Fs2 1=Divorce, 2=Death of spouce, 3=Emmigration, 4= end of contract, 5= none 6=others
Fs3 1=Village Chief, 2=Brother, 3=Brother in law, 4=Sister in law, 5=none, 6= owener, 7=government, 8= uncle, 9= others
Fs4 1=Plant tree, 2=Plant vertiva and 3=rhodes grass, 4= registered, 5=none, 6=others

Fri. If there is a plot that was rented in answer table below

Rented in plot (wobwereka)

Plot ID	Did you rent in land last growing season (2008/09)? *Fri1*	Why did you rent the plot? *Fri2*	Duration of rent *Fri5*	Type of contract *Fri6*	Will contract be renewed for the coming season? *Fri7*	Sharecropping		Fixed rent How much did you pay for the plot? *Fri10*
						Rate of share cropping paid *Fri8*	How much did you pay for the plot if sharecropping? *Fri9*	
	0- no 1- yes	1=increase land 2=grow cash crop 3=others (specify)	Number of seasons	1-Fixed rent 2-sharecroping 3-borowing free	0= no 1= yes 2=maybe			

Fri7: Give reason for above answer ……..

Fro : Rented out plot (wobwereketsa)

Plot ID	Did you rent out the plot? *1-yes 0-no* *Fro1*		Why did you rent out the plot? *Fro2*	To whom did you rent out the plot? *Fro3*	Duration of rent *Fro5*	Type of contract *Fro6*	Will contract be renewed this coming season? *Fro7*	Sharecropping		Fixed rent How much did get from the rent *Fro10*
	Year before last (2007/08)	*Last year (2008/09)*						Rate of share cropping received *Fro8*	How much did you get for the plot if sharecropping? *Fro9*	
			1=cash 2=assist others 3=excess land 4=others		Number of seasons	1-Fixed rent 2-sharecroping 3-borowing free	0= no 1= yes 2=maybe			

Fro3 1=person from same village, 2=other village, 3=immigrant, 4=urban dweller

FR07: Give reason for above answer ……..

Fsb: Plot bought

Plot ID	Where did you buy the plot? *Fsb1*	Why did you buy, the plot? *Fsb2*	How much did you pay for the plot? *Fsb5*
	1=same village 2=other village	1=secure more land 2=grow cash crop 3=grow food crops 4= seek fertile land 5=others (specify)	

Fss: Plot sold

Plot ID	To whom did you sell the plot? *Fss1*	Why did you sell, the plot? *Fss2*	How much did you get for the plot? *Fss5*
	1=person from same village 2=other village 3=immigrant 4=urban dweller	1=cash 2=assist others 3=more land 4=change in activity 5=others (specify)	

Fc: Crops grown on each plot

Plot ID	What crops were grown on this plot last season (2008/09)?				Identify type of Cropping System	What factors are taken into account in making decision on what crops to grow on each plot or leaving the plot fallow? (in order of priority starting with the most important)				What major reasons did the household have for monocropping or mixed cropping? (in order of priority starting with the most important)			
	1st *Fc1*	2nd *Fc2*	3rd *Fc3*	4th *Fc4*	*Fc5*	*Fc7*				*Fc8*			
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
	Crop codes **0 fallow** 1 Maize Hybrid 2 Compost Maize (OPV) 3 Maize Local 4 Beans Dry 5 Beans Green (Zitheba) 6 Peas 7 Ground nuts 8 Tobacco 9 Cassava 10 Pigeon peas 11 Irish potato 12 Sweet Potato 13 Cabbage		14 Tomatoes 15 Onions 16 Lettuce 17 Rape 18 Mpiru 19 Pumpkins 20 Garlic 21 Cucumber 22 rice 23 Millet 24 sorgum 25 sugarcane 26 soyabeans 27 other (specify)		1= Mixed cropping 2= Monocropping 3= Intercropping	1= Land availability 2= Labour availability 3= Prevailing market prices 4= Seeds, fertiliser, availability 5= Meeting household basic consumption needs Credit 6= Past crop performance (in previous seasons 7= Expected rainfall patterns. 8= Crop rotation 9= Other (specify)				1= Maximise revenue from land 2= Allow positive complementarity efects among crops (e.g. N-fixing,) 3= Save time and labour in crop management 4= To produce quality standards for exclusive for marketing 5= other			

Fer:Soil erosion and control measure

Plot ID	Do you have natural trees on the plot? *1-yes 0-no* *Fer1a*	How many trees are there? *Fer1b*	Name any 3 common natural trees on the plot *Fer1c*	Name trees that were planted on the plot *Fer2*		How much soil erosion was there on your plot last year (2008/09)? *Fer3*	What soil erosion control measures have you used on the plot? *Fer6*			What is the major reason for applying conservation mesures? *Fer8*		What costs are associated with applying this technique? (MKV) *Fer9*		
				Tree *Fer2a*	**How many** *Fer2b*									
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
			Write the chichewa names in the box and below the table	0= none 1-Gmelina 2-Eucalyptus 3-Mango 4-Cacia siamea 5-Oranges 6-others (specify)		0-none 1- slight 2-moderate 3-severe	1=vertivar/ elephant grass 2=Contour bunds 3=contour ridges 4- box ridges 5- ridges across the slope 6-terraces 7- manure 8- none 9- others			1-improve soil quality 2-incentives given 3-advise from extesion workers 4-increase yeild 5-control soil erosion 6-Other Specify…….				

G.Input use

List crops and inputs on each plot in the last cropping season (2008/09)

Plot ID	Crop Code	SEEDS					PESTICIDES					FERTILISER					
		Source	Type / Variety	Amount *G4*		Cost	Source	Type/ Name	*Amount G8*		Cost	Type/ Name	Source	Amount *G12*		Cost	Did you use subsidized fertilizer on this plot? *1-yes 0-no* *G14*
				Quantity	Unit				Quantity	Unit				Quantity	Unit		
	G1	*G2*	*G3*			*G5*	*G6*	*G7*			*G9*	*G10*	*G11*			*G13*	
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	

G2, G6 G10; 1=own 2=bought(own money) 3 bought (credit) 4= bought(coupon) 5 =gift 6=others
G9;1=CAN 2= Urea, 3=23:21:0, 4=20:20:0, 5=D compound, 6= super D, 7= SA, 8= others (specify)

Gi: Input use cont

Plot ID	Did you apply any manure on this plot? *1-yes 0-no* *G15*	Manure					
		What was the type of manure? *G16*	Amount of manure *G17*		Source of manure *G18*	If bought how much did it cost (MK) *G19*	How many days did it take you to apply the manure? *G20*
			Quantity	Unit			
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
		1=Compost 2=wastes 3=livestock 4=green manure 5= tobbacco stems 6=others		1= basket 2= oxcart 3=pail 4=wheeelbarrow 5=bags (50kg) 6=bags (90kg) 7= bales 8=Nkhokwe 9= lichelo (basin) 9=others	1 self made (compost) 2 own animla manure 3 given by friend relative 4 bought 5 other		

Did you have visits from extension staff last season (2008/09)? 1-Yes 0-No

……..

If yes how many time?

…….

What advice did you receive from the extension staff?

…….

Labour use on plots

For each of the plots and crops cultivated by the household indicate how many man-days did household member work in the following activities within the last season (2008/09)

Plot ID	Land preparation G21		Planting G23		Fertilizer application G25		Weeding G26		Harvesting G27	
	No of members	No of days	No of members	No of days	No of members	No of days	No of members	No of days	No of members	No of days
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										

Hired Labour						
Plot ID	**Did you hire any Nganyu labour to work on this plot?** *1-yes 0-no* ***G28***	**Why did you hire in labour on this plot?** ***G29***	**For how many man days did you hire the labour?** ***G30***		**How much did you pay for the labour?**	
			No of workers	**No of days**	**Cash *G31***	**In kind *G32***
1						
2						
3						
4						
5						
6						
7						
8						
9						

H. Harvest

How much did you harvest last season (2008/09)

Plot ID	Crop code	Harvest 2008/2009							Indicate the state of the yield in the 5 past years.	Indicate the major reasons for the change
		1st		2nd		3rd		4th Others		
	H1	*Quantity* *H2*	*Unit Code* *H3*	*Qunatity* *H4*	*Unit code* *H5*	*Quantity* *H6*	*Unit code* *H7*	*Estimated value* *H8*	*H10*	*H11*
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
	Use Crop codes									

Code H3, H5, H7: 1= basket 2=oxcart 3=pail 4=wheelbarrow 5=bags (50kg) 6=bags (90kg) 7= bales 8=Nkhokwe 9= lichelo (basin) 10=others
H10: 1=increasing 2=decreasing 3=constant

Hs: Sales and markets for crops and forest products

		If answer to Hs2 is YES							If answer to Hs2 is NO	
Crop code	**Did you sell your crops last season (2008/09)?** *0 = No* *1 = Yes* ***If no go to Hs11***	**How much of the harvest was sold?**		**Distance from home to the market**	**Type of market**	**Who bought your farm produce?**	**What was the total value of money you got from the sales?**	**How are/were prices dertemined**	**Why wasn't some of their produce sold?**	
		Qty	***Units***							
Hs1	***Hs2***	***Hs3***	***Hs4***	***Hs6***	***Hs7***	***Hs8***	***Hs9***	***Hs10***	***Hs11***	
				Walking 5 Km/hrs Oxcart 4km/hr Bicycle 15km/hr						

Hs4 1= basket, 2= oxcart, 3=pail, 4=wheeelbarrow, 5=bags (50kg), 6=bags (90kg), 7= bales, 8=Nkhokwe, 9= lichelo (basin), 9=others
Hs7 1= Farm-gate, 2= Local (primary) markets, 3= District Assembly markets, 4= Urban markets, 5 =Auction floor, 6=Other (specify)
Hs8 1= small scale traders, 2= NGOs, 3=Other villagers, 4=Wholesale buyers, 5=ADMARC, 6=NASFAM, 7= Auction, 8=Other (specify)
Hs10 1= Negotiated, 2=Predertemined by GoM/ADMARC, 3=Set by the traders, 4=Set by the farmer, 5=other (specify)
Hs11 1= Harvested too little, 2= Prices were too low, 3= Didn't know where to sell, 4= There were no potential buyers, 5= Other (Specify)

Ys:Forest Products, Sales and markets

			If answer to Ys2 is YES							If Ys2 is NO		Transport costs		State of yield in 5 years	Reasons for the change
Product code	**Estimate the amount of forest products**	**Did you sell your forest products last year (2008/2009)?** *1-yes 0-no*	**Harvest was sold?**		**Average price of the product**	**Distance to market**	**Type of market**	**Total value sales**		**Why wasn't some products sold?**	**Estimate the value not sold**	**Means of transport to the market**	**Average total cost of transport**		
			Qty	***Units***											
Ys1	***Ys1.1***	***Ys2***	***Ys3***	***Ys4***	***Y5***	***Ys6***	***Ys7***	***Ys8***		***Ys9***	***Ys11***	***Ys12***	***Ys13***	***Ys 14***	***Ys 15***

Ys1 *1= firewood, 2= charcoal, 3=timber or other wood , 4=food from the forest, 5= medicine, 6= forage 7= other specify*
Ys4 *1= basket, 2= oxcart 3=pail 4=wheeelbarrow 5=bags (50kg) 6=bags (90kg) 7=headload 8=others*
Ys6 *Walking 5 Km/hrs Oxcart 4km/hr Bicycle 15km/hr*
Ys7*1= Forest-gate, 2= Local (primary) markets, 3= District Assembly markets, 4= Urban markets, 5 = Other (specify)*
Ys9*1=home consumption 2=lack of market 3=other (specify)*
Ys12 *1=Head load, 2 Ox cart, 3 Bicycle, 4 Vehicle, 5 Wheel barrow, 6 others*
Ys14 *1=increasing 2=decreasing 3=constant*

H. Marketing. (For each crop that was sold, please ask)

Crop code	What was the means of transport to the market? *Hs12*	What was the cost of transport to the market? *Hs13*	When did the household sell the crop? *Hs14*	Why did the household opt to sell/store at that period? *Hs15*		If they stored, what kind of storage mechanisms did the household use? *Hs16*		How long was the produce stored in months? *Hs17*	Did you incur any problems when you stored your crops for sale? *Hs18*		Did you grade your produce before selling? *Hs19*
				Sell Hs15a	Store Hs15b						
Use crop code	1 Head load 2 Ox cart 3 Bicycle 4 Vehicle 5 Wheel barrow 6 others		1= Immediately after harvest 2= They stored and sold at later date 3=Sold some after harvest but stocked some for sale at later period 4= Other	1=Household needed an immediate source of income 2=To take advantage of prevailing high prices at the time 3=Lacked storage place/ mechanism 4= Wanted to wait for better prices after harvest season 5=Others (specify)		1=Granary (Nkhokwe) 2=In the home kept in Bags, sacks, baskets 3=Late harvest 4=pit storage 5=Others (specify)			0=No 1=Theft 2= Loss of quality 3=Destruction by pests 4= Prices never went up 5= Other (specify)		0= No 1= Yes

FO: Farmer Organisations

Fo1: Do you belong to a farmer farming organisation? 1=Yes 0=No If No go to Hm

If yes to Fo1						
What kind of organisation is it? *Fo2*	**How long have you been a member?** *Fo3*		**Why did you join the organisation?** *Fo4*	**What 3 important functions does the FO carry out?** *Fo5*		
	Years	Months				
1= Farmer cooperative 2=Farmer club 3=Association 4= Others (specify)				0= Nothing 1=Helps farmers access inputs on loan 2=Markets produce for farmers 3=Provides extension advice 4=Others (specify)		

Hm. Market Information

(NOTE: If they did not sell last season (2008/09) you can ask with reference to the years when they sold their produce in the past)

Crop code	Where did you source information about crop prices ***Hm1***			Where did you source information about potential buyers and business partners? ***Hm2***			Where did you source information about crop grades required on the market before you sell? ***Hm3***			Was the information you sourced received reliable? *1-yes* *0-no* ***Hm4***	Was it timely enough for you to make use of it? *1-yes* *0-no* ***Hm5***	What costs were incurred to acquire this information? **(Mkw)** ***Hm6***	How did you use the information? ***Hm7***
Use crop code													

Hm1 –Hm3: 0= Nowhere, 1=Relatives and friends (other farmers), 2=Government offices, 3=Traders, 4=NGOs, 5=Companies (agro processors), 6=Extension workers, 7=Radio, 8=Newspapers, 9=Own market research, 10=Potential buyers, 11=Others (specify)

Hm7: 1= To make production decisions , 2= To make the decision whether to sell their produce or not, 3= To make decision where to sell, 4= To negotiate for better prices for their produce, 5=Others (specify)

Hm8: If the information was not reliable explain why.

_____

I.Livestock ownership and livestock sales in the past 2 years

Livestock code I1	How many do you have now? I2	What is the estimated price if you were to sell today? I2.1		How many were sold? I3	When were they sold? I4		At what price were they sold? (Mkw) I5	Why were they sold? I7	How many were slaughtered and consumed in HH? I9	How many have been received? I10	How many bought? I11	How many were stolen? I13	How many have died? I14
		Young / old/ sick ones	Adult/ healthy ones		Years	Months							
Cattle													
Goats													
Sheep													
Pigs													
Chickens													
Doves													
Guinea fowl													
Rabbit													
Duck													
Turkey													
Bees													
Others													

J. Access to credit

J10 Did you apply for or look for any loans in the past 12 months? 1=Yes 0 =No **….**

J11 If you applied, were you given? 1=Yes 0 =No **…..**

J12 If not given, state reason

…….....

J13 If didn't apply, why? …….....

If J10 and J 11 are 1, fill the table below

Loan No J1	Source of credit J1.1	What was the total monetary value of loan? J1.2	Interest rate on the loan J1.3	From where did the household obtain a loan in the past 12 months: relationship to person or name of institution J2	Kind of credit? J3	In whose name was the loan received? (HH id) J4	What was the main reason for obtaining the loan? J7	If loan was used for inputs indicate the plots on which the input was used					
								Amount (Mkw) J8			PlotID J9		

J1.1: 1= formal 2=informal

J3: 1= cash 2=kind

K. Other sources of income
K1. Off-farm wage employment

K1a. Excluding Ganyu (For wage, salary, commission)

At any time over the past 12 months, did any member of the household engage in formal employment?
yes=1
no=0 ☐

If No go to K1b

K1b. Ganyu Labor employment

At any time over the past 12 months, did any member of the household engage in formal employment?
yes=1
no=0 ☐

Who in the household was engaged in this employment? K11	Who was the main employer for your main occupation in the last 12 months? K12	For how long did this hh member work during the last 12 months? K13		For how many days per month did normally do this work? K14	Place K15		What was the average salary per month? (Mkw) K16	Who in the household was engaged in ganyu labour? K17	For how many total days did you do *ganyu* labour over the past 12 months? K18	What was the average daily wage you received for working as ganyu over the past 12 months? K19	How often within the last 5 years was the person engaged in this work? K110	Why did the household engage in this activity? K111
Member ID		Months	Weeks	Days	Specify name K15a	Code K15b		Member ID				
			1=week 2=month									

***K** 12 1- private company 2- individual 3- government 4- (parastatal) 5- MASAF or other public works program 6-Other (specify).*
***K** 15b 1=Village 2=Other village same distict 3=Town same district 4=Town other district*
***K**110 1=very often 2=often 3=once*
***K** 111 1= high off-farm income 2=not enough own farm income 3=excess time 4=other*

K2. Household enterprises

Household enterprises

Over the past month, has anyone in your household operated any non-agricultural income generating enterprise (business) which produces goods or services or has anybody in your household owned a shop or operated a trading business? (Fishing, making mats, bricks or charcoal; mason; firewood selling; metalwork; tailoring; repair work; food processing, fish marketing, petty trading (sales of handicraft, beverages, etc.)) YES...1 NO....2 [ ]

Who in the household is responsible for this activity?	What income - generating enterprises did individuals in your household operate over the past 12 months?	From which month to which month do you usually operate this business?		How many months within the last 12 months did you engage in the enterprise?	Where do you operate the enterprise ?	How many years or months has this enterprise been in existence?		What was the main source of start-up capital for this enterprise? List up to 3			How much did you invest in this enterprise?	What was the average monthly revenue for the enterprise?	What are the average (operational) costs per month?	Why did the household engage in this activity?
K21	K22	K23		K24	K25	K26		K27			K28	K29	K210	K211
Member ID		From	To	Months		Years K26a	Months K26b	K27a	K27b	K27c				

K22 *1=Fishing 2=making mats 3=bricks 4=charcoal; mason 5=firewood selling 6=metalwork 7=tailoring 8=handyman 9=food processing 10=fish marketing 11=petty trading 12=sales of handicraft 13=beverages 14=others (specify)*

K25 *1=home, inside residence 2=home, outside residence 3=industrial site 4=traditional market 5=commercial area shop 6=roadside 7=other fixed place 8=mobile 9=other*

K27 *1= Loan/Gift from family friends 2=Sales of assets 3=Proceeds from other business 4=savings from Ganyu 5=savings from agriculture 6=other savings 7=Loan from bank or other institution 8=Loan from money lender 9=Inherited 10=Other (specify) 11=None*

K211 *1 = high income from the enterprise 2 =not enough own farm income 3=excess time 4=other*

K. Gifts received and given by the household

Over the past 12 months, did you or anyone in your household receive any gifts (in cash or in-kind) from any individuals (friends/family) outside your household? *1=yes* *0=no* **K6**	What was the total value of all cash received as a gift from individuals in the last 12 months? **K7**	What was the total value of all food received as a gift from individuals in the last 12 months? **K8**	What was the total value of all other in-kind gifts received from individuals in the last 12 months? **K9**

L.Expenditure in the household

Which of the following items did you buy or pay for in the last 7 days? **L1a**	*Yes=1* *No=0* **L1a**	How much did you pay for it? **L1b**	Which of the following items did you buy or pay for in the last month? **L2a**	*Yes=1* *No=0* **L2a**	How much did you pay for it? **L2b**
Food items for last 7 days			**Non-food items for last month**		
Maize (grain and flour)			Charcoal		
Rice			Paraffin or Kerosene		
salt			Public transport-bus fare,taxi fare		
soap			Clothes		
Sugar			Stationary items		
Cassava tubers and flour			Books		
Sweet potato			School fees		
Groundnuts			Medicines		
Vegetables			Funeral costs		
Meat			Other (specify)		
Fish					
Eggs					
Fruits					
Milk					
Cooking oil					
Tea					
Soft drinks					
Beer					
Beans					
other (specify)					

RS. Recent shocks to household welfare

Negative shocks are defined as sudden adverse events (NOT ANTICIPATED) that lead to a loss of household income, a reduction in consumption, a loss of productive assets, and/or serious concern about household welfare. Anticipated shocks such as death after a long illness, crop failure following a long dry spell or drought, etc will not be considered as shock in this study.

Has this household experienced ANY major shock since 2005

GO THROUGH THE ENTIRE LIST	**Did you experience a shock this year?** 1-yes 0-no **R1.1**	**The year shock occurred** **R1.2**	**Note down the three most significant shocks you experienced for each year R2**		**Degree of coverage R3**	**Duration of shocks in weeks R4**	**Effect of the shock R5**	**Estimated total value of loss** (not for 11-14) **R6**	**What did you do in response to this shock to try to regain your former welfare level? R7**		
1- Lower yields due to drought or flood 2-Crop disease or crop pests 3-Livestock dies or were stolen 4-Large fall in sale prices for crops 5-Household buisness failure 6-Loss of salaried employment 7-Non-payment of salary 8-End of regular assistance, aid, or remittances from outside HH 9-Large rise in price of food 11-Death of HH head 12-Death of working members of the HH 13-Illness or accident of household member 14-Death of other family member 16-Dwelling damaged, destroyed 17-Theft 18-Other (specify)		**2005**	1								
			2								
			3								
		2006	1								
			2								
			3								
		2007	1								
			2								
			3								
		2008	1								
			2								
			3								
		2009	1								
			2								
			3								

R3: 1=Own HH only 2=Some other HHs too 3=All HHs in community

R5: 1=Reduction in income 2=Reduction in assets 3=Both 4=Nothing

R7: 0=Nothing
1=Spent cash savings
2=Sold assests (tools etc)
3=Sold farmland
4=Sold animals
5=Sold more crops
6=Worked more (incl. other HH members, ganyu)
7=Started a new buisness
8=Removed children from school to work
9=Sent children to live with relatives
10=Went elsewhere to find work for more than one month
11=Borrowed money (relatives, bank, local money lender)
12=Received help (governent, NGO, etc)
13=Reduced food consumption (smaller proportions, fewer meals per day)
14=Diversify food consumption (Wild foods, meal sharing, no meat or fish)

S. Social capital and welfare perceptions

	Questions	Answers	Codes
S1	All things considered, how satisfied are you with your life over the past 12 months?		*1=very unsatisfied; 2=unsatisfied; 3=neither unsatisfied or satisfied; 4=satisfied; 5=very satisfied*
S2	Has the household's food production and income over the past 12 months been sufficient to cover what you consider to be the needs of the household?		*0=no 1=yes 2=reasonable (just about sufficient)*
S3	Compared with other households in the village (or community), how well-off is your household?		*1=worse-off 2=about average 3=better-off*
S4	How well-off is your household today compared with the situation 5 years ago? **If 1 or 3, go to S5. If 2, go to S6.**		*1=less well-off now 2=about the same 3=better off now*
S5	If **worse- or better-off**: what is the main reason for the change? *Please rank the most important responses, max 3.*		*1=off farm employment 2=land holding (e.g., bought/sold land) 3=forest resources 4=output prices (forest, agric,…) 5=outside support (govt., NGO,..) 6=remittances 7=cost of living (e.g., high inflation) 8= civil strife, unrest 9=conflicts in village (non-violent) 10=change in family situation (e.g. loss of family member/a major bread-winner) 11= illness 12=good infrustracture (access, e.g. new road…) 13=other (specify):*
S6	Do you consider your village (community) to be a good place to live?		*0=no 1=yes 2=partly*
S7	Do you in general trust people in the village (community) when cooperating on ...?		*0=no 1=yes 2=partly, trust some and not others*
S8	Can you get help from other people in the village (community) if you are in need, for example, if you need extra money because someone in your family is sick?		*1=Definitely 2=Probably 3=Probably not 4=Definitely not*
S9	About how many friends do you (HOUSEHOLD HEAD) have in your community these days? These are people you feel at ease with, can talk to about private matters or call on for help.		
S10	About how many friends do you/does your SPOUSE have in your community these days? These are people she/he feels at ease with, can talk to about private matters or call on for help.		
S11	In the past 12 months, how many people with personal problems have turned to you for any form of assistance?		

Focus group discussion questions

1. Infrastructure: How is the access to services? Distance from village to these?
   - electricity
   - water
   - credit (informal and formal)
   - education/schooling
   - health services
   - market access for: consumption goods, agricultural products and forest products
   - road

2. Enterprise:
   - What are the most important income generating activities in the community?
   - What are the five most important enterprises for people in this community?
   - What are the reasons for this?

3. Labour allocation
   - What was the typical daily wage rate for unskilled agricultural/casual adult male/female labour during the peak/slack season in this village over the past 12 months?
   - What is the typical daily wage rate for a common forest employee?

4. Markets
   - In the previous three consecutive seasons have you ever achieved surplus of maize, but lacked access to market?
   - What was the highest price for maize during the past 12 months?
     tobacco
     groundnuts
     head load of firewood
     100kg bag of charcoal
   - What is the sales value of one hectare of good agricultural land in the village?

5. Shocks
   - What have been the major shocks in this village within the last two years?
   - What strategies have been used in the community to cope with these shocks? (NGOs, government, households)
   - How would the community assist a household that has experienced a shock?

6. Credit
    - What are the main types of credit in this area? (informal, formal)
    - What are the modalities for the access to informal credit?

7. Land markets
8. How have the livelihoods within this community changed over the past two years?
9. What is your perception of the subsidy programme? Have you benefitted from it?
10. What major forest types are available in this village? (Natural forest, managed forest, plantation)
11. Why do you undertake activities off your own farm? Attracted by higher payment? – If so, continue with these questions:
    - Why don't you engage in it permanently?
    - If there are good conditions, are you willing to engage on off farm activities permanently?
    - Are you willing to sell your land if you are engaged on off-farm activities permanently?