ASSESSING THE IMPACT AND ADOPTION OF AGRO-FORESTRY FOOD SECURITY PROGRAMMES ON THE RURAL LIVELIHOODS: EVIDENCE FROM SOUTHERN MALAWI

MASTER OF ARTS (ECONOMICS) THESIS

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UNIVERSITY OF MALAWI

CHANCELLOR COLLEGE

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Master of Arts (Economics) Thesis

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Thesis Submitted to the Department of Economics, Faculty of Social Science, in partial fulfilment of the requirements of the degree of Master of Arts in Economics.

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June, 2012

DECLARATION

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

LUCKY BONHILL MFUNGWE

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Signature

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Date:

CERTIFICATE OF APPROVAL

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

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Second Supervisor

DEDICATION

This project is dedicated to my Dad and Mum who tirelessly provided me with financial and moral support just for the purpose of seeing me excel in life. Dad, May your soul rest in peace.

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ABSTRACT

Agro-forestry Food Security Programme (AFSP) promoted fertiliser trees, fruit trees, fuel wood trees and fodder tress with an objective of positively impacting on the livelihoods of smallholder farmers and their families.

Using primary data from a sample of 141 households from two villages in Mulanje district the study addressed two specific objectives. These were to determine the factors that influence household decision to participate in AFSP and ascertain the effect of AFSP on the adopters' rural livelihoods. The Heckman two step procedure model and the Individual Household Model (IHM) were used to assess the two specific objectives.

The participation model in the first step of the Heckman's two step model showed that household size, access to extension services, formal employment and piecework significantly influenced the households' decision to adopt AFSP. The outcome equation in the second stage of the Heckman's showed that there is a positive correlation between own food income and AFSP adoption however the impact of AFSP did not make a significant difference between the adopters and non adopters.

The study therefore recommends that ICRAF and the stakeholders should intensify the farmer contact with the extension agents. This can be achieved by reducing the channels of resources flow to ensure that front line staffs are reasonably supported logistically to reach out to farmers; establishing a well linked communication channels for example mass media to disseminate information on agro-forestry practices; and promotion of exchange visits for the adopters as an incentive to the farmers. The self selection into the

programme should be regulated so that it is indeed those that are able and willing to be prioritised in the AFSP programme not piecework dependant

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LIST OF ACRONYMS AND ABBREVIATIONS

AFSP	Agro-forestry Food Security Programme
BNF	Biological Nitrogen Fixation
DAES	Department of Agricultural and Extension Services
DAHLD	Department of Animal Health and Livestock Development
DARS	Department of Agricultural Research Services
DFID	Department For International Development
DI/AE	Disposable income per adult equivalent
EPA	Extension Planning Area
FDGs	Focus Group Discussions
GoM	Government of Malawi
IFPRI	International Food Policy Research Institute
ICRAF	Centre for Research in Agro-forestry
IHM	Individual Household Modelling
K/AE	Kilocalories per adult equivalent
LRCD	Land Resource Conservation Department
NASFAM	National Association of Small holder Farmers of Malawi
NRM	Natural Resource Management
NSO	National Statistical Office
OLS	Ordinary Least Squares

PIP	Programme Implementation Plan
SOLT	Standard of Living Threshold
SPSS	Statistical Package for Social Scientists
WHO	World Health Organisation

CHAPTER 1

INTRODUCTION

1.0 Background

In a country like Malawi, where about 85% of the population is found in the rural areas and is dependent on agriculture soil fertility depletion is of major concern. Increasing population pressures on the land has led to land shortages and continuous arable cultivation. Continuous arable cultivation has in turn led to high nutrient soil losses in Malawi. The decline in soil fertility has led to reduced soil productivity and hence more food insecure households. According to Young (1987), considering high population growth rates, increasing poverty levels and scarcity of land, the need for technologies that would boost food production including crops and animals, forest and wood products as well as sustaining the use of land cannot be over emphasized. The international concern is to find alternative farming systems that are ecologically and economically sustainable and culturally acceptable by the farmers. Agro-forestry[1] is one such an alternative. Agro-forestry is a sustainable agricultural system being widely promoted all over the world, especially in Sub-Saharan Africa (Thangata *et al.*, 2002). Several development experts have recommended agro-forestry as a new solution to rural development needs (Rocheleau *et al.,* 1989). The combination of several types of products in agro-forestry,

[1] Agro-forestry is a dynamic, ecologically based, natural resources management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels (ICRAF 2006).

which are both for subsistence and income generation, help farmers to meet their basic needs and minimize the risk of total failure in crop and animal production. (ICRAF, 1993) as quoted by Boateng (2008).

Among other benefits, agro-forestry has the potential to improve soil fertility through the maintenance or increase of soil organic matter and biological nitrogen fixing from nitrogen fixing tree species. Agro-forestry also protects the soil from eroding, thereby improving the soil's productive potential. Some woody species also provide diversified outputs for smallholder farmers in the form of fuel wood and poles. In some cases, agro-forestry technologies such as fruit trees can provide a more diverse farm income and reduce food insecurity (Thangata *et.al*, 2002).

Given the presence of low land productivity and increasing cultivation on marginalised land in Malawi, it is not surprising that agro-forestry technologies are being promoted for adoption. This is because of the agricultural and environmental potential that agro-forestry technologies offer.

In Malawi, Agro-forestry research was introduced by ICRAF and Agro-forestry Commodity Team of the Department of Research and Technical Services in the late 1980's.

ICRAF has been testing agro-forestry technologies with farmers in Zomba district since 1994/95 agricultural season. Some of the technologies like mixed cropping *Gliricidia* and relay cropping *Sesbenia sesban* and *tephrosia vogelli* were intercropped with hybrid maize on station and on farm which proved to be feasible in improving soil fertility and increasing maize yields (Phiri, 2000).

In 1997 ICRAF introduced improved fallow technologies after initiating farmer to farmer contact with early adopters of improved fallows in eastern Zambia. In November of 1997, eighteen farmers from Kasungu crossed the border into eastern Zambia, where farmers are at an advanced stage in the testing of improved fallows, and were given hands-on training on the planting and management of improved fallows of *Sesbania sesban*, *Tephrosia vogelli*, and *Gliricidia sepium* tree species. Reportedly, they returned to Malawi determined to plant their own improved fallows trial plots (ICRAF, 2002).

Improved fallow technology was introduced in Kasungu because land availability is relatively adequate as compared to southern Malawi. In fact, ICRAF introduced the improved fallow technology in Kasungu because farmers there have relatively more land than average in Malawi. In addition, the improved fallow technology is targeted at those farmers with large landholdings. (Thangata *et al*, 2002).

The recent agro-forestry programme implemented in Malawi is the Agro-forestry Food Security Programme (AFSP) that was implemented in 2007 and phased out in 2011. The programme was pioneered by ICRAF in partnership with the Department of Agricultural and Extension Services (DAES), Department of Agricultural Research Services (DARS), Land Resource Conservation Department (LRCD), Department of Animal Health and Livestock Development (DAHLD), Forestry Department, National Association of Small holder Farmers Association of Malawi (NASFAM), University of Malawi and Mzuzu University. The programme was a four year nationwide programme known as the Agro-

forestry Food Security Programme (AFSP) implemented in eleven districts[2] and all Agricultural Development Divisions (ADDs).

The programme promoted Fertiliser trees, Fruit trees, Fuel wood trees and Fodder tress with an objective of positively impacting on the livelihoods of smallholder farmers and their families. The programme targeted 200 thousand farmers over a four year implementation time frame which was expected to have a positive impact on up to 1.3 million people in terms of food security.

The agro-forestry technologies that were being promoted included four components namely; fertilizer trees, fruit trees, fodder and fuel-wood options. The adoption of these technologies is expected to raise the productivity of land and labour, increase overall production of food, and income generation from fruit trees through the processing and marketing of tree products. The overall programme purpose is to combine proven science, effective partnership and informed policies that will help to increase food security and income, and improve livelihood[3] opportunities for rural communities in Malawi (ICRAF, 2011). It is against this background that the study was conducted through a survey to solicit primary data to assess the impact and factors that determine household decision to adopt agro-forestry technologies.

[2] Thyolo, Mulanje, Chikwawa, Zomba, Balaka, Ntcheu, Dedza, Lilongwe, Kasungu, Mzimba Shire Valley, Blantyre, Machinga, Lilongwe, Salima, Kasungu, Mzuzu, and Karonga

[3] A livelihood is a means of making a living which encompasses people's capabilities, assets, income and activities required to secure the necessities of life. A livelihood is sustainable when it enables people to cope with and recover from shocks and stresses (such as natural disasters and economic or social upheavals) and enhance their well-being and that of future generations without undermining the natural environment or resource base (Chambers and Conway, 1992)

1.1 Problem statement and justification

The Government of Malawi, non-governmental organisations and other donor agencies have and are attempting to attain national food security through implementation of programmes amongst others; targeted input programme, subsidized fertilizers, green belt irrigation programme and agro-forestry programmes to improve the rural livelihoods. In recent times Malawi has attained national food security but food insecurity still persists at household level among the poor resource farmers.

Among other factors, this persistence is attributed to lower land per capita, decline in soil fertility, increased fertiliser prices and limited diversification of income sources. While mineral fertilizer is still one of the best options for overcoming soil fertility depletion and increasing food production, the majority of the smallholder farmers are unable to afford and apply the fertilizers at the recommended rates and at the appropriate time because of high cost and delivery delays (Ajayi *et al.*, 2003; Akinnifesi *et al.*, 2006). For the past fifteen years, farmers and researchers from different national and international institutions led by the ICRAF have been combining their expertise and resources to develop agro-forestry technologies and options to address some of these challenges facing smallholder agricultural production and the environment.

These programme implementers and policy makers need feedback through vigorous research for informed decision making on how the programmes are performing in terms of impact on the rural livelihoods and adoption of these technologies. However there are a few studies especially in Malawi which have modelled the impact and adoption of agro-

forestry interventions on the rural livelihoods (Duvel, 1994; Thangata *et.al*, 1996 and 2002; Boateng, 2008).

In Malawi, the most recent programme underway is the one which was implemented in 2007 and was phased out in 2011.The study used the Heckman two step procedure and the Individual Household Modelling (IHM)[4] to assess the impact and adoption of the AFSP. Apart from examining the sources of income, the IHM was used to assess well being in terms of disposable income per adult equivalent (DI/AE)[5] of the individual households in the study area and food income measured in kilocalories per adult equivalent. Unlike other studies, the analysis in this study uses two approaches the Individual Household Model which analyses the individual household economy and in and the Heckman two step procedure for adoption and impact analysis.

1.2 Research questions of the study

This study is built on two research questions;

1.0 Who adopts Agro forestry Food Security Programmes or What are the factors that affect households' decision to participate in Agro forestry Food Security Programme?

2.0 What is the effect of Agro forestry Food Security Programmes on the rural livelihoods?

[4] The IHM is used to assess the wellbeing on rural livelihoods based on crop production, employment, livestock, remittance and wild foods which are the sources of livelihood.

[5] Disposable income per adult equivalent is defined as income that remains after a household has met all its food requirements based on its household size and composition. An adult demands 2100 kilocalories every day.

1.3 Objectives

The main objective of the study is to assess the overall impact of AFSP on the livelihood of the participants. The specific objectives are;

1.0 To determine the factors that influence household decision to adopt AFSP.

2.0 To assess the effect of Agro forestry Food Security Programmes on own food income

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter presents a summary of theoretical and empirical literature on adoption ad impact of Agro forestry technologies. This looks at the differing views that exist on the subject as regards to the factors that affect household decision to adopt agro forestry technologies. The chapter also reviews the studies that were conducted to analyse the impact of Agro forestry technologies. Since the study the analyses the impact of AFSP on the rural livelihoods, the chapter further discusses the sustainable livelihood framework and how it applies in the context of this study. The chapter first presents the theoretical literature and then the empirical literature.

2.1 Concepts of Agro-forestry

In the last past twenty five years Agro-forestry research and development has emerged as a new and vibrant discipline. It applies scientific principles to find practical solutions to Natural Resource Management (NRM) and agricultural production problems. The World Agro forestry Centre (ICRAF) was established in 1978 with global mandate of advancing the science and practice of agro forestry to address agricultural and environmental problems in the developing world. In its efforts to improve and support the traditional agro-forestry systems, ICRAF and its partners developed and documented various agro-forestry technologies over the past two decades. Agro-forestry research and development

innovations focus on increasing farm productivity, food security, and diversified incomes for improved livelihoods in the dry lands of Africa.

In its efforts to improve and support the traditional agro-forestry systems, ICRAF and its partners developed and documented various agro-forestry technologies over the past two decades. Agro-forestry research and development innovations focusing on increasing farm productivity, food security, and diversified incomes for improved livelihoods in the dry lands of Africa.

According to (Stoorvogel and Smaling, 1990), Soil fertility depletion is the fundamental cause of food insecurity and low income of farmers in Africa. The loss of nutrients due to continuous cropping gradually renders the soil less fertile, resulting in poor yields. The magnitude of nutrient losses from agricultural soils is huge with annual average loss of twenty two kilograms of Nitrogen, two and a half kilograms of phosphorus, and fifteen kilograms of potassium for the whole of Sub Saharan African region

Thus, ICRAF has been testing various agro-forestry options to enhance soil fertility, and prevent soil erosion while generating much needed income for resource poor farmers. Highlighted below are some. Some of the proven technologies and practices for soil fertility maintenance that have resulted in a potential increase in crop yields in many parts of Africa are discussed below:

Nitrogen production

Planted fallows can increase the amount of available nitrogen in the topsoil in the order of one hundred to two hundred kilograms of nitrogen per hectare within 0.5-2 years (ICRAF, 2003). Table 1 in appendix 1 presents a table for the three most popular species for improved fallows used by farmers in Western Kenya. Approximately two third of the nitrogen captured by the fallows come from biological nitrogen fixation and the rest from deep nitrate capture from the subsoil. Upon subsequent mineralization, these improved fallows provide sufficient nitrogen for one to three subsequent maize crops, doubling to quadrupling maize yields at the farm scale.

Improved crop yields

Maize yields following improved fallows averaged 4.1 tonnes per hectare in Western Kenya which is much higher than maize yield from non-fertilised plots continuously planted to maize 1.7 tonnes per hectare (Sanchez *et al.*, 1996, ICRAF, 2003). Similar experiments in Malawi showed that maize yields from third year onwards were markedly increased by *Gliricidia* incorporation to an average of 1800-2500 kilograms per hectare (Bohringer and Akinnifesi 2001).

Soil and water conservation

Fallows improve soil structure, making the soil easier to till, and facilitate conservation tillage (ICRAF, 2003). Fallows increase the soil's water infiltration capacity and are capable of deep root development as much as seven meters. Fallows decrease soil erosion, by maintaining a leaf canopy during dry seasons and more vigorous crop growth

during the rainy seasons. Better soil conservation results are achieved when fallows are combined with contour hedges planted to fodder species (Sanchez and Jama, 2000).

Fuel wood production

Fuel wood production is in the order fifteen tonnes per hectare in two years *sesbania sesban* fallows in Eastern Zambia. Sanchez and Jama (2000) estimated that on average a family consumes about 0.4 tonnes of fuel wood per year. Therefore a tree fallow as small as 0.5 hectare would provide the firewood needed for the family to cook for one year, saving women's time in collecting and carrying heavy loads. In addition, fallows help prevent encroachment of communities in nearby forests and woodlands, and conserve biodiversity.

Mixed intercropping with coppicing species

Coppicing tree species used for improved fallows include *Gliricidia sepium, Calliandra calothyrsus and Leucaena trichandra*. Maize/*Gliricidia* intercropping has been widely applied in densely populated areas such as Malawi and western Kenya where sizes of land holdings preclude fallows (Sanchez and Jama, 2000). The maize and *Gliricidia* are established concurrently on the same plot. Trees are managed through repeated cutting back so that they do not interfere with the crop. Large amounts of nitrogen rich tree biomass are left on the plot as green manure. The nitrogen equivalent that is added to the soil through the biomass ranges from 60 to 120 kilogram per hectare per year (Ikerra *et. al,* 1999).

Biomass transfers

The biomass transfer technology involves the growing of trees/shrubs along boundaries or contours on farms or the collection of the same from off-farm niches such as roadsides and applying the leaves on field at planting time. In western Kenya, Tithonia diversifolia became the preferred species used by farmers to grow maize, beans and kale. Tithonia accumulates high concentrations of nutrients in its leafy biomass, which mineralises very rapidly when incorporated in the soil. Green leaf biomass of Tithonia is high in nutrients, in the order of 3.5 – 4. Percent of nitrogen, 0.35 – 0.38 percent of phosphorus, 3.5 - 4.1 percent of potassium, 0.59 perecnt Calcium and 0.27 percent magnesium on a dry matter basis in Western Kenya (Rutunga *et. al*,1999).

2.2 Theoretical literature

2.1.1 Adoption of agro-forestry

Adoption is the acceptance of an idea or innovation and the willingness or intention to put it into practice (Adams, 1982). A farmer is considered to have adopted a technology if it is being used to any extent on his farm (Ahmed, 1991). Adoption of an innovation by an individual is grouped into five stages according to Adams (1982). The five stages are awareness, interest, evaluation, trial and the adoption stage. Awareness is a stage where the individual first hears about an innovation but not yet motivated to seek further information; the interest stage is where individuals feel that the innovation may be of relevance to their needs, as such, seek additional information about it; the third stage is evaluation, where the individual weighs up the advantages and disadvantages of the innovation; the fourth stage is the trial stage where the individual gives a try to an innovation if the evaluation is favourable; the final stage is the adoption where the

individual may decide to apply the innovation fully on a relatively large scale and continuous use of the idea and personal satisfaction based on the outcome of the trial version.

It is evident from Adams (1982) conceptual framework that adoption is not immediate and the final decision is usually as a result of a series of influences operating through time. This conforms to adoption theory. This process which is commonly called "innovation diffusion process" can occur in various ways (Rogers, 1983; Duval, 1994). Diffusion according to Agyemang (1991) begins at a point in time when technology is ready for use thus, how the technology is made available to the potential user is the main focus of diffusion. Agyemang (1991) considers adoption as the behaviour of individuals in relation to the use of the technology more particularly the reasons of adoption at a point in time are of primary interest.

According to Morris and Adelman (1988), there is no single theory of causation that can embrace all aspects of adoption and explain the traditional attitude of smallholder farmers in developing countries. However this study adopts the adoption behaviour model (Tolman, 1967) which was modified from a field theory proposed by Lewin (1951). This theory proposes that behaviour of an individual is a function of socioeconomic and environmental factors and the objective adoption is endogenous to the sum of the interacting forces of the individual's situation. As such the decision to adopt a new technology is assumed to be intentional in this model. A graphical model of agro-forestry adoption behaviour is presented in the Figure 1 below;

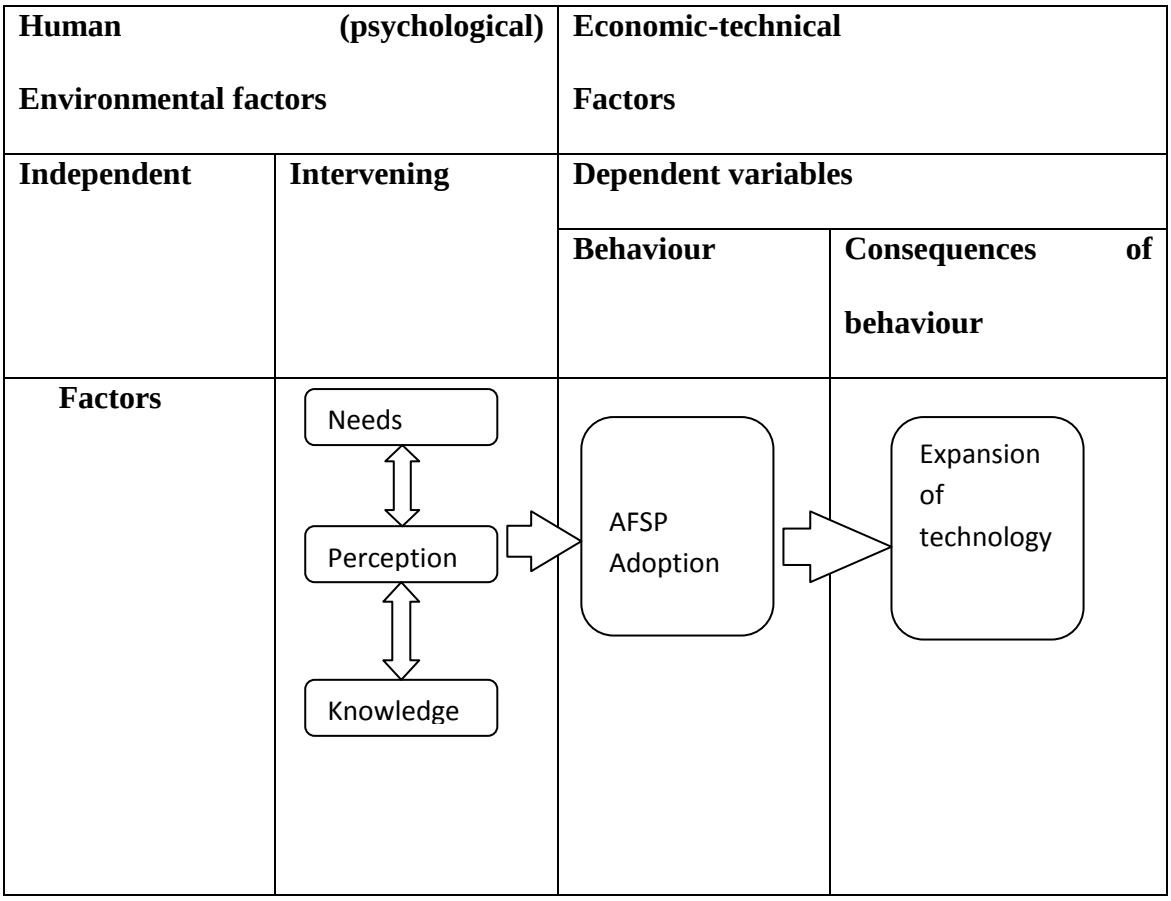


Figure 1: Theoretical framework for adoption

Source: Thangata (1996)

The model depicts that adoption behaviour is governed by a set of intervening variables such as individual needs, knowledge about the technology, and individual perceptions about methods used in meeting those needs in a specific environment. However, these intervening variables are shown to depend on a set of factors such as age of household head, Land holding size, level of awareness, extension contact, income, and the size of the family access to credit amongst other variables. In this model, it is assumed that agro-forestry is ecologically feasible, economically efficient, and socially compatible in the study area. The model clearly shows the distinction between adoption and expansion of

technology. Willingness to establish agro-forestry technologies may largely depends on the individual's risk taking behaviour. However, continuation or expansion of a technology largely depends on the realized net benefits of the new technology in meeting the individual's needs. Rodgers and Shoemaker (1971) also pointed out that the adoption rate and expansion of agro-forestry technologies is usually a function of the relative advantage of the innovation as perceived by the farmer, the compatibility of the innovation in the context of farming systems and complexity of the innovation. It is against this background that has stemmed the study on adoption technologies.

2.1.2 Livelihoods sustainability

A livelihood is a means of making a living which encompasses people's capabilities, assets, income and activities required to secure the necessities of life. A livelihood is sustainable when it enables people to be resilient or cope with and recover from shocks and stresses such as natural disasters and economic or social upheavals and enhances their well-being and that of future generations without undermining the natural environment or resource base.

Sustainability of livelihoods depends on the capital or resource base both at household and community level. The livelihood framework sustainability developed by Ashley and Carney (1999) discusses these capital assets in detail. The livelihood outcomes which this study will use to assess the impacts depend on these capital assets. The figure below is a livelihood framework which illustrates how capital assets link to vulnerability of households, transformation context, livelihood strategies and the livelihood outcomes.

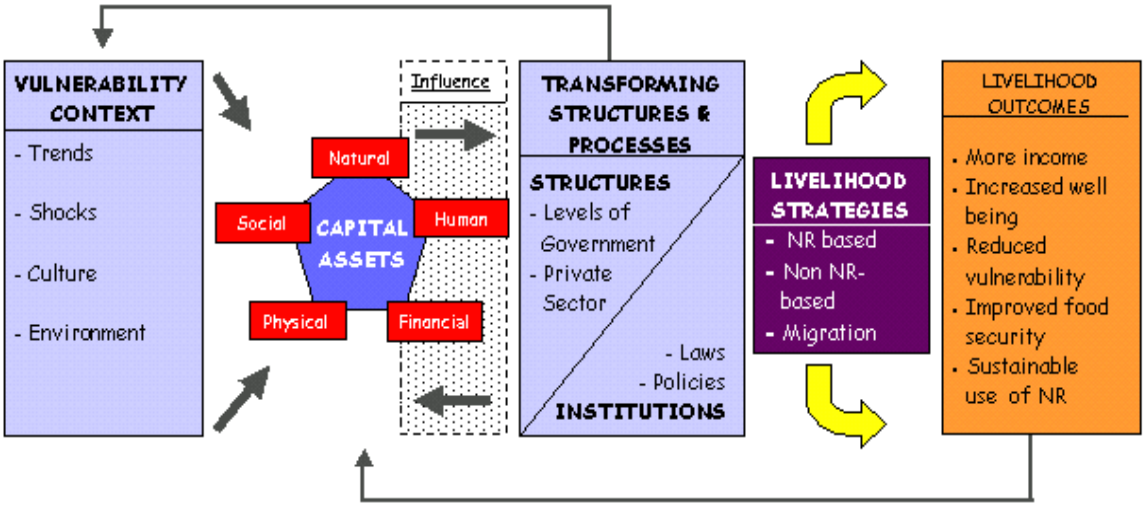


Figure 2: Sustainable livelihood framework

Source: Ashley and Carney (1999)

The components of the livelihood framework are discussed in turn below;

Vulnerability context

A household, community or village are vulnerable to trends, shocks, culture and environment. The livelihood assets will help the households to cope up or recover from these shocks

Capital assets

Social capital refers to the local institutions or organization in the communities. According to Ashley and Carney(1999) paper this is further explained as the networks and connectedness, either vertical (patron/client) or horizontal (between individuals with shared interests) that increase people's trust and ability to work together and expand their access to wider institutions, such as political or civic bodies; membership of more formalised groups which often entails adherence to mutually-agreed or commonly accepted rules, norms and sanctions; and relationships of trust, reciprocity and exchanges

that facilitate co-operation, reduce transaction costs and may provide the basis for informal safety nets amongst the poor. Lack of social capital may lead to poverty as people lack access to such amenities as loans or extension service to meet their needs.

Human capital represents the skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives (source). At a household level human capital is a factor of the amount and quality of labour available; this varies according to household size, skill levels, leadership potential and health status.

Natural capital is the term used for the natural resources stocks from which resources and services flow (Land, Nutrient cycling, erosion protection, and rivers). Natural assets are useful for rural livelihood. There is a wide variation in the resources that make up natural capital, from intangible public goods such as the atmosphere and biodiversity including divisible assets used directly for production.

Financial capital: This refers to the availability of cash or equivalent, which enables people to adopt different livelihood strategies. There are two main sources of financial capital namely available stocks and Regular inflows of money.

Available stocks refer to savings which are the preferred type of financial capital because they do not have liabilities attached and usually do not entail reliance on others. They can be held in several forms: cash, bank deposits or liquid assets such as livestock and jewellery. Financial resources can also be obtained through credit-providing institutions.

Apart from earned income Regular inflows of money play a crucial role to rural livelihoods. The most common types of inflows are pensions, or other transfers from the state, and remittances. In order to make a positive contribution to financial capital these inflows must be reliable (while complete reliability can never be guaranteed there is a difference between a one-off payment and a regular transfer on the basis of which people can plan investments).Access to finance to undertake economic activities are a major problem to a majority the households in rural areas.

Physical capital comprises the basic infrastructure and producer goods needed to support livelihood. Producer goods are the tools and equipment that people use to function more productively. The physical capital is categorised into household and community capital. The community capital comprises of affordable transport, secure shelter and buildings; adequate water supply and sanitation, affordable energy and access to information (communication). The household physical capitals are the household owned physical assets e.g. cell phones, bicycles, treadle pumps, televisions etc.

Transforming structures and processes

Transforming structure and processes are the institutions, organizations, policies and legislation that shape livelihoods. They operate at all levels, from the household to the international arena, and in all sectors, from the private to the most public. Structures are the organizations, both private and public, that set, implements policies and legislations, deliver services, purchase, trade and perform all manner of other functions that affect livelihoods. Processes determine the way in which structures and individuals operate and interact. They include macro, sectoral, redistributive and regulatory policies, international

agreements and domestic legislation, market culture, societal norms and beliefs, and power relations associated with age, gender, caste or class.

Livelihood strategies

Livelihood strategies are the range and combination of activities and choices that people undertake in order to achieve their livelihood goals which include productive activities, investment strategies and reproductive choices. This is a dynamic process in which people combine activities to meet their various needs at different times.

Livelihood outcomes

Livelihood outcomes are the achievements or output of livelihood strategies. We should not assume that people are entirely dedicated to maximizing their income. It is hard to weigh up the relative values of increased well being as opposed to increase in income, but this is the type of decision that people must make every time when deciding which strategies to adopt. There may also be conflict between livelihood outcomes. Examples are when increased incomes for a particular group is achieved through practice that are detrimental to the natural resources base or when different family members prioritize different livelihood objectives with some seeking to reduce vulnerability while others seek to maximize income streams.

In the context of this study adoption of agro forestry technologies is a strategy. However a household must at least be in possession of some of the discussed capital assets such as have land (a physical capital), must join a grouping or club (social capital) amongst others. The factors that may affect household's decision to participate in AFSP are accrued to the five capital assets discussed above in the Sustainable Livelihood Framework.

2.2 Empirical literature

2.2.1 Adoption

Studies have been conducted worldwide including in Africa on adoption and impact of agro-forestry programmes. However there are limited studies conducted in Malawi regarding the contribution of Agro-forestry programmes to the rural livelihoods. Literature on the factors that affect the adoption of Agro-forestry programmes is also limited. This section analyses the empirical studies conducted in Africa especially Sub-Saharan. Studies conducted in Malawi will also be analysed.

Socio-economic considerations are increasingly becoming important in technology diffusion and adoption processes. This is more so for agricultural, forestry, agro-forestry and related innovations, which are meant for the diverse environments and circumstances of rural people (Rocheleau and Raintree, 1986).

Hoskin (1987) also gives a partial list of factors that must be taken into consideration if farming families are to adopt agro-forestry technologies as: local uses and knowledge of trees, tenure, organization, conservation, landlessness, enterprises and marketing, labour, nutrition and gender and age.

Raintree (1991) asserted a need to examine socio-economic factors in the adoption of agro-forestry technologies. On closer examination of the issues, it appears that while most of the debate has been couched on ecological terms, many of the underlying issues are social and economic in nature. The analysis of Raintree (1991), further pointed out that factors that are relevant to consider under the broad heading of socioeconomics will

vary from place to place. Among the most important are: degree of local socio-economic stratification (by wealth, land holding size, gender, ethnic group etc.); access to resources (land and tenure); overall economic development strategy; general approach to tree planting programmes, opportunity for relocation of resources; access to credit; processing technology and marketing assistance among others.

Studies conducted by (Place and Dewees, 1999, Place, 1999) reported that access to information about agro-forestry, training opportunities, good quality seeds, property rights on land, size of available land, flexibility and compatibility of agro-forestry to existing farming systems among others are important factors affecting adoption of agro-forestry. Several empirical studies have been carried out to gain insights into the adoption of agro-forestry in southern Africa region. The specific studies investigated the types of farmers who adopt (do not adopt) agro-forestry practices (Kuntashula et al., 2002; Gladwin et al., 2002; Phiri et al, 2004; Ajayi et al 2006b). Other studies examined the factors that drive the adoption of agro-forestry (i.e. why do some farmers continue to adopt more than others) (Place et al., 2002; Franzel and Scherr, 2002; Ajayi et al, 2003; Thangata and Alavalapati, 2003; Ajayi and Kwesiga, 2003; Keil et al., 2005; Ajayi, 2006; Jera et al., 2006;).

Refer to a table1 in appendix 2 for a summary of these empirical studies conducted in Zambia. The table presents the empirical results of the factors that affect the adoption of agro-forestry technologies in Zambia. The summary of the results in the table show that some factors had positive influence on adoption of the technologies while other factors

had no influence. In all the studies being analysed in the figure above education registered no influence on the adoption of agro-forestry technologies. Wealth had a positive influence on adoption of the technologies.

The studies conducted in Zambia were omitting important variable to be tested. For example, Frazel (1999) only tested household head sex and household number. A study by Ayayi et al. (2006) indicated that only four variables (education, household size, farm size and uncultivated land) were analysed.

Studies conducted by Place and Dewees (1999) and Place (1999) revealed that access to information about agro-forestry, training opportunities, good quality seeds, property rights on land, size of available land, flexibility and compatibility of agro-forestry to existing farming systems among others are important factors affecting adoption of agro-forestry.

It could be seen from the above discourse that the socio-economic factors that affect the adoption of agro-forestry are many and varied and differ from place to place and it is time specific. In spite of these variations the major socio-economic factors that are necessary in the adoption of agro-forestry by individuals are land tenure and ownership issues, socio-economic stratification, labour requirements, capital, markets and institutions.

A study conducted in Malawi by Thangata and Alavalapati (1996) in Kanache and Mbelo (Malosa EPA) showed that age of household head, income generating activities and

extension contact are important variables in agro-foresrty adoption decision making. Another study conducted in Kasungu chipala EPA by Thangata et al (2002), established that households with access to land and a productive labor force adopted improved fallows, with or without the extra incentive. A study conducted in the southern part of Malawi by Rapando (2001) reported that farm size, household gender, non-farm activities and extension visits are important factors to consider in designing Agro-forestry technologies. The study further established technological characteristics are important factors in adoption of the technologies. It was found out that if the technology is used for soil conservation the farmers are likely to adopt the technology. An evaluation of agro-forestry technologies in Zomba by Mkandawire (2001) determined that livestock ownership, and marital status had a positive impact on adoption of agro-forestry technologies.

A synthesis of the studies on the adoption of agro-forestry in Zambia (Ajayi et al., 2003) revealed that the adoption of agro-forestry is not a direct relationship based on the technological advantages of an agro-forestry practice alone, but is influenced by several factors. The broad categories of the factors are technology-specific (e.g. soil type, management regime), household-specific (e.g. farmer perceptions, resource endowment, household size), policy and institutions context within which agro-forestry technologies is disseminated (input and output prices, land tenure and property rights), and geo-spatial such as tree species performance across bio-physical conditions, location of village (Ajayi et al., 2007).

3.2.2 Impact of Agro-forestry on the rural livelihoods

The impact of agro-forestry adoption on livelihoods of farmers in Malawi, Mozambique and Zambia includes increase in crop yields, increase in income, increased savings resulting in change of wealth and soil improvement (Kalaba *et. al*, 2010). An assessment conducted by Akinnifesi *et. al* (2008) in southern Africa indicated a number of impacts on the livelihood of the farmers. Table 1 of appendix 3 has a detailed summary of the findings.

Sileshi *et al*.(2008) reports that a fertilizer trees have been widely documented and known to substantially increase the yield of maize compared with continuous maize production without fertilizer, which is de facto farmers' practice. A recent meta-analysis conducted across several regions in Africa found that fertiliser trees doubled yields of maize relative to the control (maize without fertilizer) in most cases, especially in sites with low-to-medium potential and under good management.

On the other hand fertilizer trees improve soil physical properties through the addition of litter fall, root biomass, root activity, biological activities, and roots leaving macro pores in the soil following their decomposition. Chirwa *et al*., (2007) noted that the trees also improve soil aggregation thereby enhancing water filtration. This reduces water runoff and soil erosion relative to production systems where maize was continuously cultivated without planting trees (Phiri *et al*., 2003)

CHAPTER 3

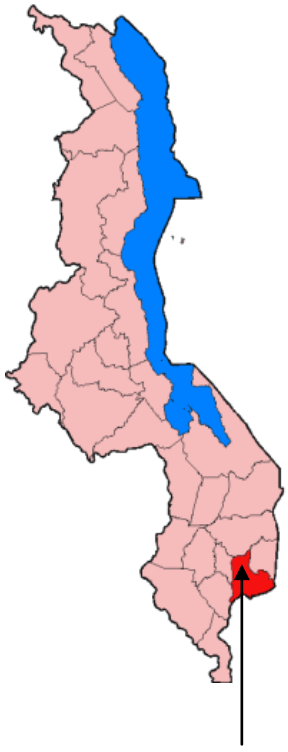
METHODOLOGY

3.0 Introduction

This chapter outlines the empirical approaches employed from data collection to analysis in order to meet the two objectives outlined in the study. The chapter first presents the study area, followed by data collection methods, sample and sampling technique, and concludes by discussing the analytical technique.

3.1 Study area

The study was conducted in Southern region of Malawi in Mulanje district Traditional Authority (T/A) Mkanda. The district lies between S 15° 56' 3" and E 35° 29' 59" and covers an area of 2,056 KM². It has a population of 432418 according to the 2008 population census. It is also known for its tea growing industry and Mount Mulanje which is one of the highest (3002metres) peaks in Southern Africa. Mulanje distitrict was selected because the programmes were extensively implemented in the district. Two villages namely Mlere and Mussa were also purposevely sampled out of the villages where AFSP projects are implemented in the district. Mlere village is 15 Kilometres West from the main road while Mussa Village is 10 Kilometres West from the main road. Mulere turn off is 20 Kilometres from Thuchila while Mussa is 5 Kilometres from Thuchila trading centre.



3.2 Data collection method

The study used primary data which was through household interviews in Mulanje district primary sources using the individual household interview form. The individual household approach[6] of data collection and specifically the method used to estimate household income has been developed over several years. The data collected included household demographic data which included household membership by age and sex, school attendance, marital status; household land type and area cultivated; household income by source; household assets; crop type and its production, split into amounts consumed, sold and given out as gifts and household participation in social programmes.Refer to box 1 of appendix 4 which provides a summary of data collection using the IHM approach. In addition to household survey, focus group discussion (FGDs) and key informant interviews were conducted to solicit information on the general perception of Agro-forestry Food Security Programme (AFSP), the impact or contribution (%) of the programme on income, crop productivity, improved food security and reduced vulnerability to shocks such as inadequate rains. The focus group discussions solicited contextual information on the crops, livestock, employment opportunities, remittance and wild products that households depend on for their livelihood in the two villages. In total 8 focus group discussions were conducted and 2 key informant interviews. The survey was conducted for a period of seven days from the 4th - 10th March 2012.

3.3 Sample and sampling technique

[6] A full description of the technique can be found in Seaman J and Petty C, 'The use of household economy approaches to provide information for the design of social protection policies and programmes', DfID/SC (UK) 2005

In obtaining the sample for the survey, a multistage sampling technique was used throughout. The first stage of sampling was a purposeful selection of the District, Extension Planning Area (EPA)[7] and villages to conduct the survey. The district was selected because it is one of the first beneficiaries of the project from time of inception of the programme in 2007. This is attributed to historical background about the agro-forestry trees in the southern region and Mulanje in particular. On the other hand the district was selected because it was logistically convenient to the author

The second stage involved sampling of the households to be interviewed. The study sampled and analysed 141 households from a sampling framework of 370 composed of 120 and 250 households from Mlere and Mussa villages respectively. The figure of 141 respondents was arrived at following the rules of thumb for determining sample size as proposed by Roscoe (1975), which states that sample sizes larger than 30 and less than 500 are appropriate for most research. Furthermore, in multiple regression analysis, the sample size should be several times (preferably 10 times or more) as larger as the number of variables in the study. Systematic sampling was used to sample 62 non adopters which composed of 20 households from Mlere village and 42 from Mussa village. The sampling had a total of 79 adopters with 46 households from Mlere village and 33 from Mussa village. All the adopters were interviewed in both villages.

[7] EPA is an agricultural area with the same agro-ecological characteristics subdivided into sections where extension agents do their work. Each section is subdivided into blocks that the extension agent visits (Thangata, 1996 as quoted in Benor et al., 1994)

3.4 Analytical technique

As mentioned above this study is based on data that was collected through household interviews. The data entry and preliminary analysis was conducted using Statistical Package for Social Scientists (SPSS). STATA package was used in estimating the Heckman two step procedure. Diagonistic tests were done STATA. The individual household model was used to compare the welfare of the adopters and non adopters in terms of disposable income per adult equivalent, food income measured in Kilocalories per adult equivalent (K/AE)[8], sources of income and their standards of living.

3.4.1 Adoption of Agro-forestry Food Security Programmes

The adoption of agro forestry technology was analyzed in the first stage of the Heckman two step procedure where the Probit model was estimated. The explanatory variables in the adoption model are age of household head, level of education of household head (junior primary, senior primary and junior secondary), household size, adult household members, dependency ratio, accessibility to extension services, gender of household head, The adoption model is estimated as follows

$$Y_i^* = \beta_0 + \sum_{i=1}^{n} \beta_n X_i + \mu_i \qquad (1)$$

Where Y_i^* is a latent variable not observed. What is observed is a dummy variable defined by

$$Y_i = \begin{cases} 1 \; if \; y_i^* > 0 \\ 0 \; otherwise \end{cases} \qquad (2)$$

[8] Food income (K/AE) consumed by the household which is a sum of Kilocalories consumed from its own production (crops and livestock), employment, wild foods and food aid.

Where Y = 1 if an individual/ household adopted agro-forestry programmes, otherwise y = 0. A household is expected to participate in AFSP if benefits are positive. If benefits are negative people will be unwilling to participate in AFSP.

β_o = intercept (constant)

β^*= coefficient for explanatory variables $\chi_{(1-k)}$

χ is a vector of explanatory variables

μ_i = stochastic error term

The coefficients that are estimated from the probit model above only give the direction of relationship between the explanatory variable and the independent variable. To interpret the relationship directly in terms of the probability of one adopting the programme or not the marginal effect are used. The marginal effects for the estimated coefficients are given by the expression below;

$$\frac{\partial \mathrm{pr}(y_i = 1 \mid x_i; \beta)}{\partial x_{ij}} = \frac{e^{x'\beta}}{[1+e^{x'\beta}]^2} \cdot \beta_j \qquad (3)$$

Having estimated the Marginal effects after probit estimation the next step is to estimate the mills ratio variable which will be incorporated into the outcome equation (own food income per adult equivalent per annum.

$$\lambda_i = \phi(\rho+\delta X_i) / \varphi(\rho+\delta X_i) \qquad (4)$$

Where λ_i is the mills ratio variable

X_i = the vector of the factors that affect household decision to adopt agro-forestry technologies

Φ = the density function of a standard normal variable

φ = the cumulative distribution function of a standard normal distribution

δ, ρ are parameters of explanatory variables

3.4.1.1 Description of variables

Age of household head (AGEHH)

Previous studies have shown that younger (18-35 years) households are more likely to adopt (Alavalapati et al., 1995; Boeteng I., 2008 and Thangata, 2003) agro-forestry technologies because they are labour intensive technologies. Therefore, it is expected that age of household head to have a negative relationship with adoption. Age of household head was a continuous variable.

Education of household head (EDUCHH)

Education is important in decision making, as well as in any development process, because people with some education are able to easily understand the benefits of adopting technologies as compared to those that are not educated. As such, it is expected that education should have a positive effect on farmers' decision to participate in agro-forestry technologies. Education was categorised into three categories (junior primary, senior primary and junior secondary) with each category measured as a dummy.

Active Household members (ACTIVEHHM)

The number of active household is expected to have a positive influence on household's decision to adopt AFSP with probability of adoption. This is because active household members are energetic enough to undertake the labour intensive agro-forestry technologies. An active household member includes those within the age group of 16-65

and was measured as a continuous variable and expected to have a positive influence on adoption of AFSP.

Household size (HHSIZE)

Household size affects workforce or labour availability at house hold level. Agro-forestry has been reported to be labour intensive, meaning that families with less labour cannot afford to take up the technology. As such, it is expected that household number will positive impact on adoption. Household size was measured as a continuous variable and expected to have a positive influence on adoption of AFSP.

Gender of household head (HHGENDER)

The adoption of technology by households headed women farmers may be quite different from that headed by men. The planning of an adoption survey may need to include a careful examination of how responsibilities for different agricultural activities are divided between men and women. Household gender was estimated as a dummy variable.

Formal employment (FORMEMPL)

Formal employment in this study includes salaried job and monthly income from rentals. Households that a generate income from such may have a positive influence or a negative influence on adoption of AFSP. Households that are formally employed have the financial muscle to invest in AFSP which may have a positive influence to adopt. On the hand this may discourage the households to adopt because they have alternative ways of generating income other than Agriculture.

Access to agro forestry extension (ACCESSEXT)

Extension contact is a key variable in developing a favourable attitude among farmers towards any technology. Therefore, it is hypothesized that extension contact will have a positive impact on agro-forestry adoption. Adsian and zinnah (1993) asserted that access to extension positively affects on adoption of agro-forestry technologies based on the innovation diffusion theory. Access to extension was measured as a dummy variable.

Dependency ratio (DEPRATIO)

Increase in the number of dependants as compared to the active group infers lower labour availability for productive economic activities. Dependants in this study are those that in the in active age group that is the young (below 15 years) and the old (above 70 years). It is expected that the higher the dependency ratio in a household the lesser the chances for to adopt agro-forestry technologies. Dependency ratio was estimated as a continuous variable.

Land holding size (LANDHH)

Land holding size (acres) is a one of the important factors of production. Farmers who have large farms are less likely to adopt agro-forestry technologies as compared to those who have small landholding size because they have capabilities of fallowing. Farmers with small land holding size might be obliged to adopt agro-forestry technologies to aggravate the soil fertility on their continuous cultivated land.

However the opposite might also be true. Farmers with small land holding size might not adopt agro-forestry technologies depending on the type of agro-forestry trees being promoted. If the technologies demands a lot of land space then farmers with small acreage will have comparatively less probability to adopt agro-forestry technologies as

compared to their counterparts. The sign of land depends on circumstances such as type of agro-forestry technology being, land ownership status amongst others.

Piecework/casual labour (PIECEWORK)

Piecework is a livelihood strategy that provides cash and food income to rural households for their survival. Households that resort to piecework likely divert labour that is supposed to be invested on their fields. This may have a negative impact on households' decision to adopt agro-forestry technologies because they are labour intensive. Piecework was estimated as a dummy variable where 1 denoted for the households that had access to piecework while 0 for those that did not do any piecework.

3.4.2 Impact of Agro-forestry Food Security Programme on the welfare status of adopters

The IHM software was used to analyse the household income per adult equivalent. Households obtain this income as food which they consume (payments in kind, crops, livestock products, wild foods, gifts) and cash (crop sales, the sale of livestock and livestock products, wild foods, gifts and external assistance and employment). The disposable cash income per adult equivalent and disposable food income per adult equivalent for each of the household is the income or food left to a household after its food energy requirement has been met, standardised by the number of adult equivalents in the household[9]. This presentation allows the income of individual households to be

[9] This is virtually identical to the method used to calculate a 'food poverty line' by the GOM NSO/IFPRI in the 2004/05 Malawi IHS survey. Individual food energy requirement was calculated from World Health Organisation 'Energy and protein requirements' (WHO technical report series 724, Geneva 1985). An adult equivalent was taken as the average of the requirement of a young adult male and female using the same reference data and is approximately 2100kcal/ adult equivalent/day.

directly compared and household income to be set against a standard of living threshold i.e. the cost of a standard package of non-food goods e.g. salt, school fees, school uniform amongst others. The analysis will further disaggregate by individual households. This means that differences within sections of the population (for example the poor, middle and the better off) can be identified, and the impact of changes on specific demographic groups, for example, the elderly; female headed households amongst others can be analysed. The IHM analysis was also used to calculate the own food income that was generated by each individual household in the reference year of study. The own food income is then used in the second step of the Heckman procedure as an output variable.

The outcome equation in the second step of the Heckman procedure was estimated using a multivariate analysis. This analysis was undertaken to address the second objective of the study which is to determine the impact of AFSP on the rural livelihoods. Log of own food income (K/AE) which is regarded as a livelihood outcome in this study was used as a dependent in the outcome equation. The study used own food income because it is problematic to use households' own production because the proportion of household food obtained from a household's own production is not necessarily a guide to total availability or consumption. The other livelihood outcome indicators amongst others include income, food production, and improved welfare.

This study uses the own food income (K/AE) because the analysis reveals that the study areas' source of food income is solely from crops. On the other hand it reflects the direct production potential of adopters and non-adopters. Kumar (1989) outlines some of the

advantage of using the Kilocalories per capita for analysis. The information obtained is direct as such the data is reliable, secondly the collected data can be disaggregated by gender (head of the household), social class, and region. Thus, comparisons can be made across various categories depending on the needs of the impact assessments. In this study comparisons are made between the adopters and non adopters. Thirdly, investigators can target surveys to focus on specific groups that are most vulnerable to food scarcity. Such groups may include landless farmers, women, and other groups who constitute the poor majority.

On the whole economic analysis of Kilocalorie available to a household for consumption derives from the important role Kilocalories play in the definition of important welfare concepts such as health labour productivity and food consumption. Maxwell and Frankeberger (1992) asserted that enough food is mostly defined with emphasis on calorie and on requirements for an active, healthy life rather than simple survival. Food calorie intake has been found to have a strong empirical linkage with both human health and productivity.

Unlike other studies that have assessed food consumption based on food availability basing their estimates on per capita estimates, this study uses adult equivalents which takes into consideration the household composition. Rafael Claro (2010) noted that adult-equivalent scales are useful tools for narrowing the difference between such estimates and real food consumption and allowing the comparison of data for households with different compositions. The IHM tool calculates the adult equivalents for individual

households which allow identifying the contribution of various household members with different energy needs to the overall household food consumption pattern, unlike per capita measurement.

As mentioned above, the Heckman two step procedure was used to estimate the impact of AFSP on the livelihoods of household in the study area. To isolate the impact of AFSP adoption from other intervening factors, the establishment of a counterfactual outcome is required, as is the ability to overcome selection bias. According to Heckman and Smith (1999), the establishment of a counterfactual outcome represents what would have happened in the absence of project intervention. The adopters in the study area were self selected into the programme which intensifies these problems (Zaini, 2000). As a remedy to difficulties of establishing an effective counterfactual situation, a control group was used which comprised of AFSP non- adopters.

Another problem with this type of analysis is selection bias which relates to the unobservable factors that may bias the outcome on the own food income due to AFSP adoption. In taking care of selection bias in assessing the impact of AFSP adoption, the study used the instrumental variable method following the Heckman two staged procedure to analyse the data. The Instrumental variable selected has to influence adoption but not Kilocalorie consumption per adult equivalent. Zaman (2000) asserts that the selection of the instrumental variable has a limitation therefore the results from the procedure should be checked for robustness. Access to agro forestry extension services was used as an instrumental variable in this study. The motivation of selecting this

variable is that an increase in the number of extension visits increases farmer households knowledge about the AFSP and helps farmers make an informed decision to adopt or not. The impact of extension visit on household on own food income will depend access to extension, number of extension visits per year but also on the quality of extension services rendered to the farmer households. The impact of this variable was tested in the adoption and poverty models to verify its choice as an identification variable.

The outcome equation in is the second step of the Heckman two step procedure is estimated using the multivariate analysis to examine the determinants of own food income of the households that adopted the agro-forestry technologies. The welfare equation is estimated as follows;

$$\ln FI = \beta_0 + \beta_1 Z_i + \beta_2 Y_i + \beta_3 \lambda_i + \upsilon_i \quad (5)$$

where ln *FI* = Log of food income(K/AE)

β_{0-3} = Parameters to be estimated

Z_i = Vector of explanatory variables

Y_i = a dummy variable which is 1 for adopters and 0 for non-adopters

λ_i = mills ration term

υ_i = error term for household *i*

CHAPTER 4

RESULTS AND DISCUSSION

4.0 INTRODUCTION

This chapter presents the results of the analysis and their interpretation following the methodology of the study. The chapter is presented in four sections. Descriptive statistics is presented first in section 4.1 followed by the first step of the Heckman model which is adoption model results section 4.2. Section 4.3 presents the Individual Household Method analysis. The chapter concludes by presenting the Second step of the Heckman model results which analyses the impact of the AFSP programme.

4.1 Descriptive statistics

4.1.1 Population pyramid of the sample population

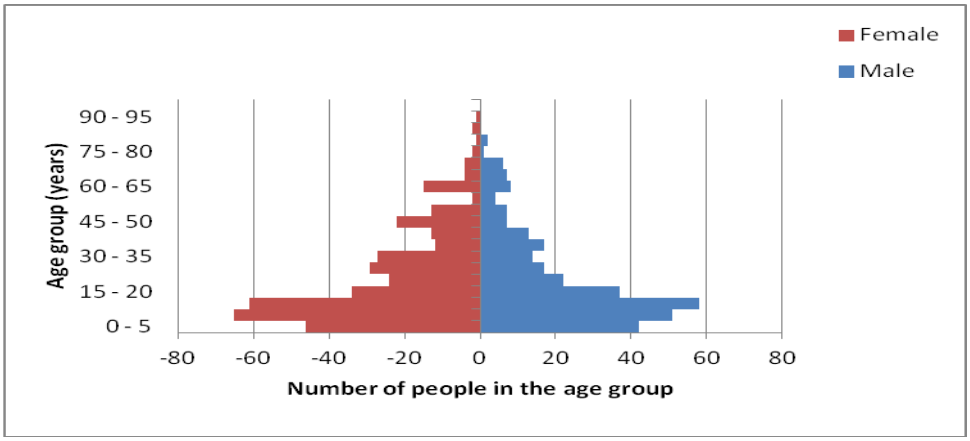


Figure 3: Population pyramid

Figure 3 above indicates the population distribution by age sex of the sampled 141 household in the two villages. The population has 690 persons with 45 percent of the population representing males. The figure illustrates that the young population is dominating in the area of study with an average age of 25 within the range of 1-92. The figure further reveals that about 57 percent of the population are below the mean age. The dependency ratio of the population in the study area is 1.3 which is significantly higher than the national ratio pegged at 1.1. The average household size is 4.7 with a minimum of one member and maximum of nine members in the household which is relatively above the national figure 4.5

4.1.2 Summary statistics

The summary statistics in the table below compares the means of AFSP adopters and non adopters for the variables that are used for analysis in the subsequent chapters. T-test was used to determine if there is significance difference of these variables.

Table 1: Summary statistics for variables used for analysis

Characteristics	**Adopter**	**Non adopter**	**p-value**
Age of household head	46	46	0.990
Household size	5.0	4.4**	0.043
Active household members	2.7	2.0	0.174
Dependency ratio	0.25	0.73	0.23
Member of farmer organisation	0.7	0.1***	0.000
Upland own(acres)	2.1	1.7**	0.030
Upland cultivated(acres)	2.5	2.1	0.132
Total land holding size(acres)	3.3	2.9	0.810
Tropical Livestock Unit(TLU)	0.6	0.4*	0.070
Amount of maize produce(Kg)	949	526***	0.000
Sorghum produced(Kg)	98.9	85.3	0.396
Access to extensions	0.8	0.3***	0.000
Income from formal employment	10546	2295	0.198
Off-farm income(Mk)	65400	32797*	0.057
Access to peace work (ganyu)	0.5	0.7**	0.001
DI/AE/year	31123	17903**	0.019
Crops Kilocalories/AE/year	1290600	1171400	0.645
Disposable income adult equivalent	118040	51708***	0.003
Maize productivity(Yield)	389.69	235.41**	0.010
Adult equivalents	4.0	3.44***	0.009

Notes: *p=0Notes: *p=0.1 **p = 0.05, ***p = 0.01

The descriptive statistics in the table above show that some variables are homogenous between adopters and non-adopters while others significantly differ. The age of the household heads were the same for the two groups. Apart from the upland cultivated the other categories of land and the total land holding size are not different between the adopter and non adopters. In terms of production, there is a significance difference of maize production (one percent) and productivity (five percent). It is also interesting to note that most of the adopters were members of farmer organisations (one percent) and had access to extension services which is also significant at one percent Non adopters significantly (five percent) generated their income from agricultural labour (ganyu) as compared to adopters. On the other hand much as it is observed the DI/AE is higher for the adopters at 1 percent significance level, the Kilocalories consumed from crops per adult equivalent per annum is not statistically different between the adopters and non adopters.

4.2 Estimation results of the first step (adoption model) of the Heckman two step procedure

The table 3 presents the marginal effects of adoption which were computed after estimating the participation model in the first stage of the Heckman two step procedure. The participation model was estimated by the Probit model.

Table 2: Determinants of household decision to participate in AFSP

Variable	Coefficient	Std. Err.	P-value	Mean
Access to extension*	0.657***	0.101	0.00	0.61
Active household members (16-65)	-0.183	0.158	0.247	2.20
Age	-0.003	0.005	0.546	45.39
Age squared	0.000	0.000	0.959	2387.67
Dependency ratio	-0.911	0.602	0.131	0.48
Piece work(Ganyu)*	-0.525***	0.106	0.00	0.57
Formal employment*	0.372**	0.078	0.012	0.16
Household size	0.199*	0.088	0.025	4.78
Sex of household head*	-0.003	0.127	0.979	0.57
Upland owned	0.077	0.048	0.109	1.98
Old household members	-0.035	0.187	0.851	0.14
Proportion of crops Kilocalories	-0.036	0.097	0.71	1.07
Education variables				
Primary senior*	0.076	0.139	0.592	0.35
Primary junior*	0.160	0.527	0.749	0.04
Secondary junior*	-0.053	0.157	0.736	0.37
LR $chi^2(15)$	74.74			
Pseudo R^2	0.49			
Prob.(chi^2)	0.0000			
Log likelihood	-38.087			

Notes: *p=0.10, **p = 0.05, ***p = 0.01. The asterisks on the variables names show the variables that were measured as dummy variables.

There are four factors that determined farmer household decision to participate in the programme. The factors are household size, formal employment, piecework and access to extension.

The model has shown that household size influences the decision to participate in AFSP programme. Household size was significant at 5 percent and had a positive sign as was expected. This implies that the higher the number of household members the higher the probability of participating in the AFSP. In this study a unit increase in the household size increased the probability of a household to participate in AFSP by 0.2. In contrast to the caution by Adesina (1999) that large families may have a negative influence on the adoption of agro-forestry technologies as they often have lower land per capita the study findings conform to Carter (1995) and Maghembe (1996, pers. Comm.), who noted that practicing agro-forestry technologies require more labour and households with more people have an advantage over households with fewer people.

Formal employment also positively influenced the decision to adopt AFSP and was significant 5 percent. Those that were formally employed had a 40% probability of adopting AFSP compared to their counterparts. This attributed to the fact that those with formal employment may atleats have some formal education.

The dominating piece work in the study area is agricultural labour. This includes agricultural activities ranging from land preparation to harvesting in the agricultural reference year. The households that generated income from piecework had 60%

probability of not adopting AFSP at 1% significance level. Therefore households that are involved piece works have slim chances of adopting AFSP as compared to those that do not do piece works.

Extension contact is a key variable in developing a favourable attitude among farmers towards the technology. As hypothesized extension contact had positive impact on AFSP adoption. Household that had extension contact had a 60 percent chance of adopting AFSP as compared to those that did not access extension services at one percent significance level difference. The findings confirms to the assertion by Adesina and zinnah (1993), that access to extension positively affects adoption of agro-forestry technologies based on the innovation diffusion theory.

Dependency ratio, old age, household head age squared, household head's sex, primary school junior, secondary school junior and active household members were not significant. Dependency ratio, number of old aged household members, primary school junior, secondary school junior and household age squared had a negative relationship with the probability of adoption. Household gender and active household members had a positive relationship with probability of adoption.

On the whole, the results revealed that household size, formal employment, access to extension services will increase the probability of adoption whilst engaging in piece works reduces the probability of adopting the AFSP.

4.3 Household income

An overview of the households' income and the sources is presented in this subsection. It is important to have an in depth understanding of the individual households' welfare. The econometric estimation of the adoption model presented in the above gives a general picture of the factors that affect households' decision to adopt AFSP. In this context the factors that affect adoption are household size, access to extension, formal employment and piece works (ganyu). However it doesn't give an insight of the individual households' economy in the study area. For example what type of employment are the individual households engaged in? Knowledge of the performance of the individual household welfare in terms of disposable income, sources of income, Kilocalories per adult equivalent generated by the households is of great importance in conducting such evaluations if policy makers have to make objectively informed decisions. As discussed in chapter 3 the individual Household method(IHM) designed by E*f*D is used to fill this gap The analysis includes food and cash income, sources of income, disposable income per adult equivalent and then concludes by comparing the welfare of the AFSP adopters and non-adopters.

4.3.1 Food and cash income

The individual household model recognises the fact that an individual household obtains income as cash or food. Cash income is obtained from the sale of crops; livestock and livestock products; wild foods and gifts; from employment; and cash gifts whilst food income obtained as food from crop and livestock production; wild foods and hunting, gifts and payment in food. At most all the households obtain food income from crop production. Sources of cash income and their respective percentage contribution by

quintile are presented in the figure 4 below. Figure 4 is a presentation of the contribution of the sources to overall cash income in the study area for adopter and non adopters.

Panel A: Non- adopters Panel B: Adopters

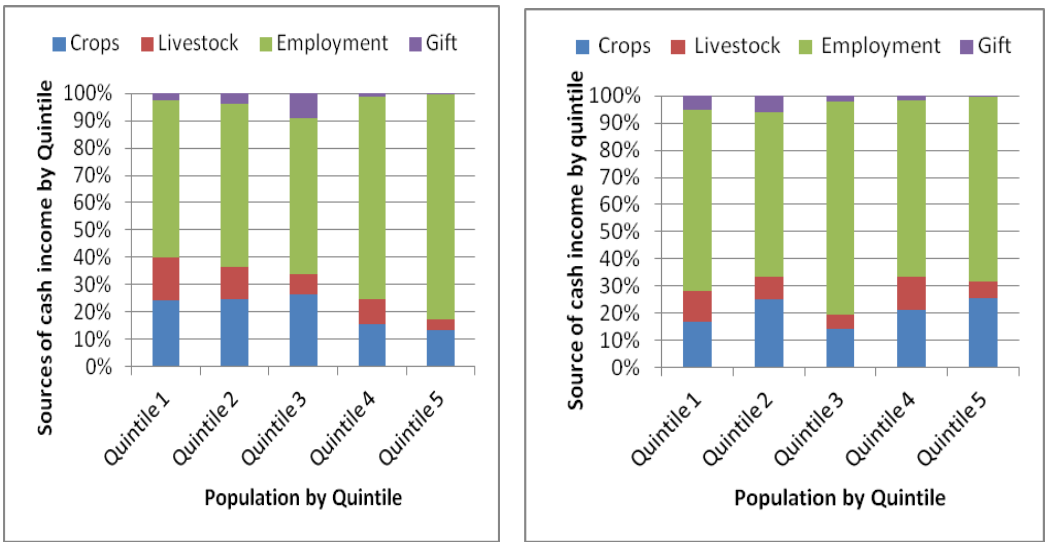


Figure 4: Percentage contribution of different sources to total cash income by quintile

Notes: * No household that obtain cash income from aid and wild foods.

*Quitile1 is the poorest while Quintile 5 is the richest

The results from the figure 4 above show that employment contributes significantly to the household cash income in all the quintiles with quintile for both adopters and non-adopters. However there are horizontal differences in terms of the type of employment amongst the income quintiles. For example the richest income quintile 5 is dominated by trading of agricultural commodities and selling of groceries amongst others while quintile 1 which is the poorest leaves on garden peace works (ganyu) such as ridging weeding and harvesting. The figure further reveals that the selling of crops from own production is not common in the study area. The low figures for cash income realised from crops is attributed to the culture of storing food for home consumption purposes.

Another interesting analysis is presented in Figure 5 which illustrates the contribution of the income sources to gross money income for the interviewed households in the study area. Employment is on the lead followed by crops whilst gifts least contributes to cash income.

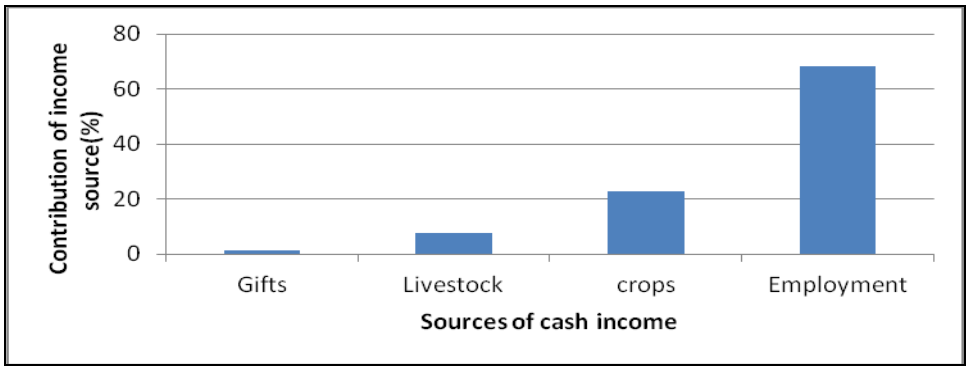


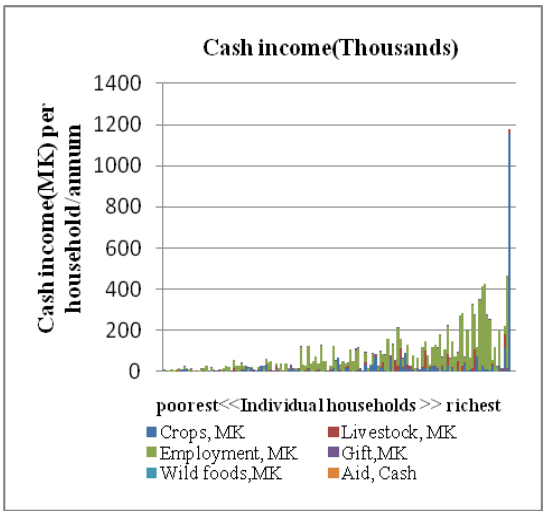
Figure 5: The contribution of different sources of income to gross money income

4.3.2 Income sources at household level

An analysis of cash and food income sources for individual households and wealth groups[10] are presented in figures 6 and 7 below respectively.

[10] Wealth groups are composed of households with similar types and levels of assets and which have similar income sources or groups of households according to their ability to exploit the local food and income options in a particular area. The wealth group categorization is similar to the one that was used by Malawi Vulnerability Assessment Committee (MVAC) in the baseline profile in the year 2005.

Panel A: Cash income



Panel B: Food income

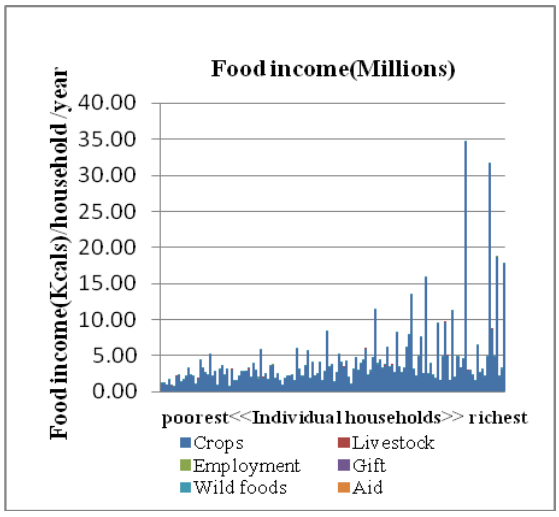
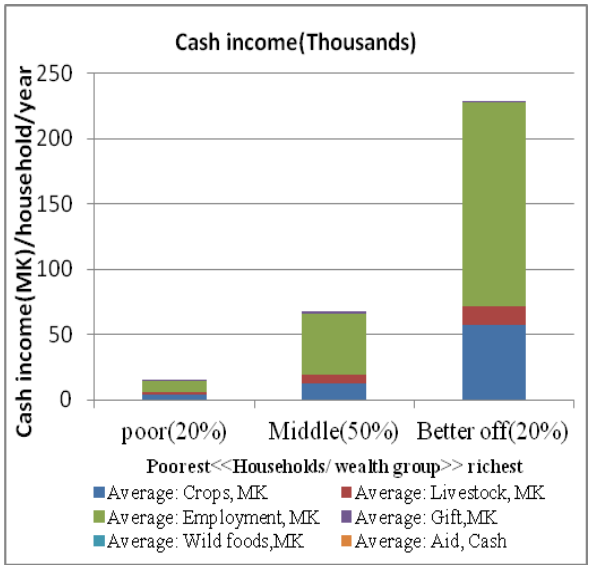


Figure 6: Cash and food income sources per individual households

Panel A: Cash income



Panel B: Food income

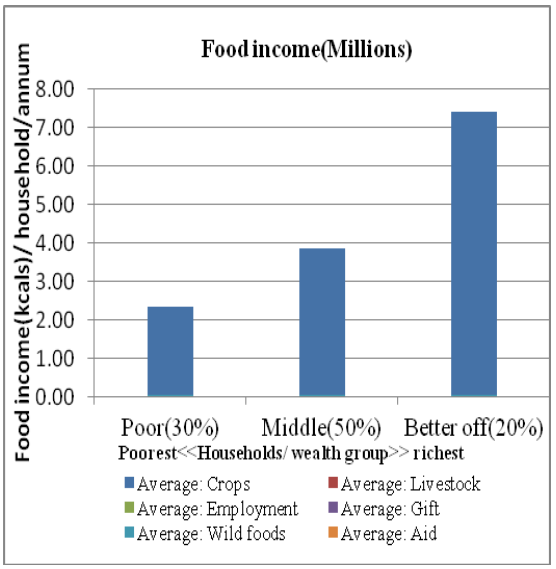


Figure 7: Cash and food income sources for households per wealth group

This study adapts the wealth group categories that were used for analysis in a baseline profile survey that was conducted in 2005 by the Malawi Vulnerability Assessment Committee. On average results of the baseline profile showed that 37 percent of the households were in the poor wealth group, 45 percent in the middle and 18 percent were

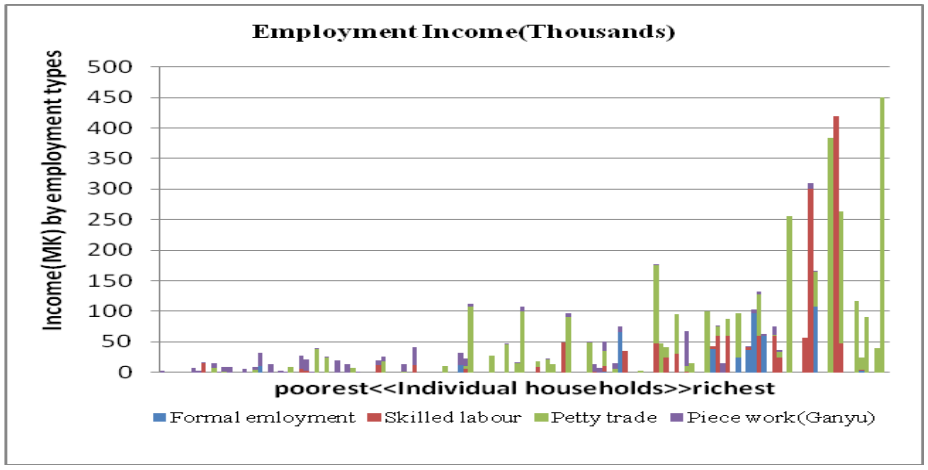
in the better off club (MVAC, 2005). This study has used the ratio of 30:50:20 to take account of the relative economic improvements from 2005 to the time this study was conducted. At the time of study the country

Sources of income for the individual household analysis show that the majority of the households depend on employment to generate cash income followed by sale of crops. The analysis reveals that households' food income is fully generated from crop production. The analysis is also conducted for the three wealth groups in the study area. The results, as expected, are showing the same trend with the individual household analysis in that employment is significantly contributing to cash income as compared to other income. Analysis by wealth groups show that 60-70 percent of cash income is generated from employment while crop sales contribute about 20-24 percent of the households' cash income.

Crop production is solely the source of food income for all the three wealth groups. The other sources of income for food income are almost negligible. For example, the second highest of kilocalories source from crops production is employment which contributed 0.2 percent gained by the poor wealth group.

This is a clear indication that the farmer households in the study area did not sell crops from their produce for cash but rather store for home consumption in the study's reference year. Employment is a source of cash income in the area of study. The most important question to address is what type of employment are the individual household engaged in? Are the types of employment the same for all the individual households? Is there variation between poor, the better-off and the rich as regards to the type of employment? The IHM modelling answers these question in figure 8 below.

Panel A: Analysis by Individual households



Pane B:Analysis by wealth groups for the whole sample

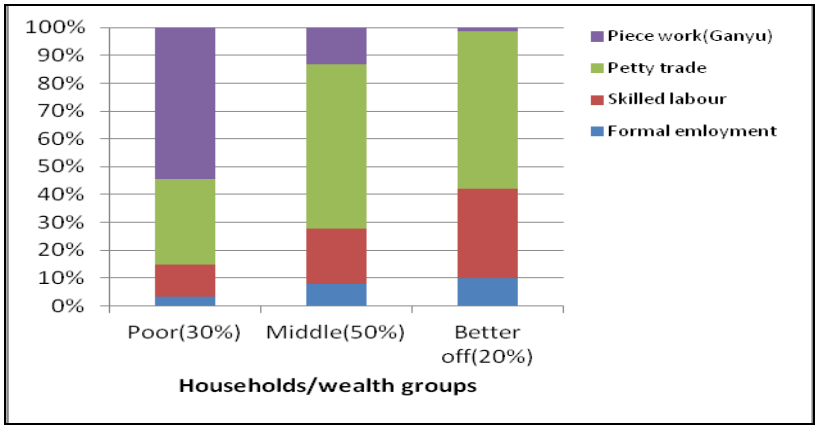


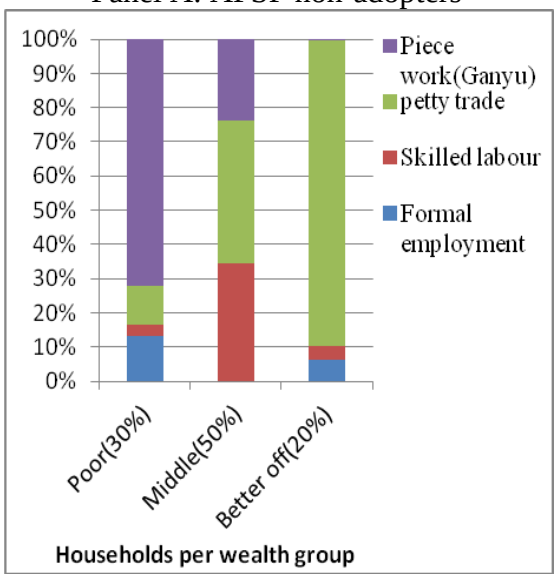
Figure 8: Income by employment type

Panel A of figure 8 shows the types of employment per individual household. Apparently the poorest households depend on piecework (ganyu) while the richest depend on petty trade and skilled labour. Panel B analyses the same but in the wealth groups. It is clear that the poorest 30% in the study area depend on ganyu while the richest 20 percent generate most of their cash income from petty trade followed by skilled labour. It is also interesting to note that that formal employment contributes about 2 percent to cash

income generated from employment to the poorest while the richest registered double as much.

A horizontal analysis was also undertaken to compare the employment types between the AFSP adopters and non adopters. The results are presented in figure 9 below and are intuitively appealing. Panel A presents analysis for non- adopters while panel B for adopters.

Panel A: AFSP non-adopters



Panel B: AFSP adopters

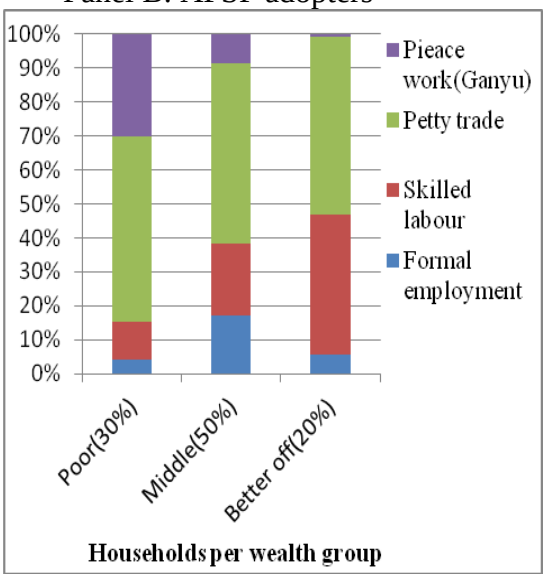


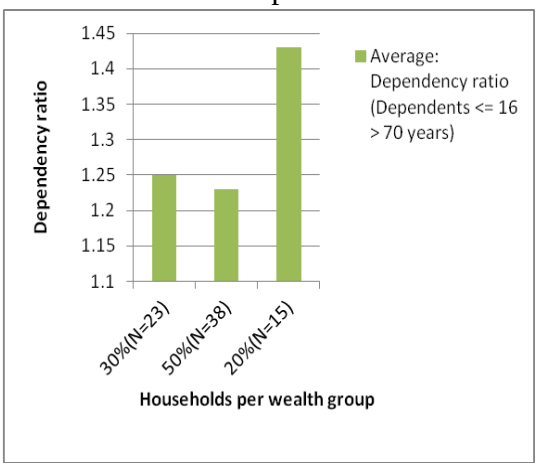
Figure 9: Income by employment type for non adopters and adopters

The poor wealth group of the households that did not adopt generated about 70 percent of their cash income from piece work while the poor wealth group for adopters generated only 30 percent of cash income from piece work employment category. Petty trade contributed significantly (58 percent) for the adopters poor wealth group. It is noted that the rich 20 percent of non adopters diversified their sources of income from employment i.e. they practiced all the four types of employment however petty trade was leading. The

adopters' rich club only practiced petty trade and skilled labour which carried at most the same weights of about 50 percent each.

The probit estimation showed that households that indulged in piece works reduced the probability of adopting AFSP. The IHM analysis provides an in depth analysis to have an understanding of which households are involved in piece works. The results show that those households that did not adopt depend on piece works as noted in panel A of figure 9. Piecework featured in all the wealth groups of the non- adopters. In panel B of figure 9 reveals that only thirty percent of the poor and 10 percent of the middle class (better off) were involved in piece work while the rich class of the adopters did not practice any piece work.

Panel A: Adopters



Panel B: Non-adopters

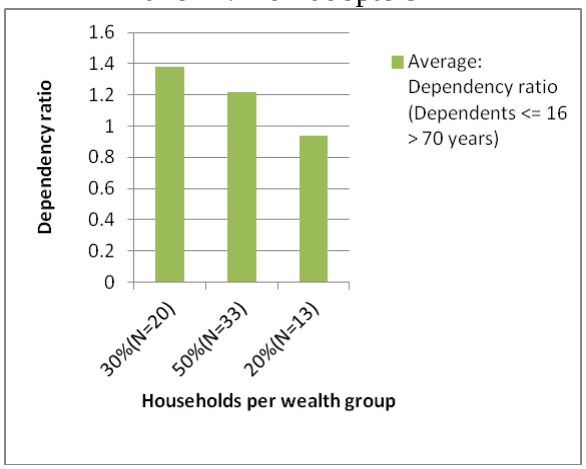


Figure 10: Dependency ratio for adopters and non adopters

The Figure 10 above compares the dependency ratio of adopters and non- adopters by wealth groups. Except for the poor wealth group where non adopters have a higher dependency ratio than the adopters, Figure 10 shows that the middle (1.23) and the better off (1.43) wealth groups for the adopters have a higher dependency ratio as compared to

the middle (1.2) and better off (1.28) of non adopters. It is interesting to note that the results are in contrast to theory that the higher the dependency ratio the lesser the probability of adopting AFSP for the middle and the wealth groups in figure 10 above. The theory expectation is in congruence to the findings of the adoption model in Table 3 above but not the IHM analysis. The IHM analysis shows that the adopters had a higher dependency ratio as compared to non adopters for the middle and better off wealth groups which is an in depth analysis to take care for some of the issues that may be overlooked by the econometric analysis in table 2. This is important for policy and programme implementation guidance.

5.3.3 Disposable Income

This section discusses the results for disposable income per adult equivalent for individual households. The first presentation is the disposable income for all the households that were sampled followed by the agro-forestry adopters and non- adopters. In the Individual Household Method, disposable income is defined as the amount of income a household has after meeting all its food energy requirements from its own production or where this is insufficient by purchase where the food purchased and the price are standardised. The values below the zero line or food poverty line shows that a household was unable to meet its food energy requirements while values above zero shows that a household was able to meet its food energy requirements and had a surplus, the disposable income. About seventeen percent were not able to meet there food energy requirements in the study area.

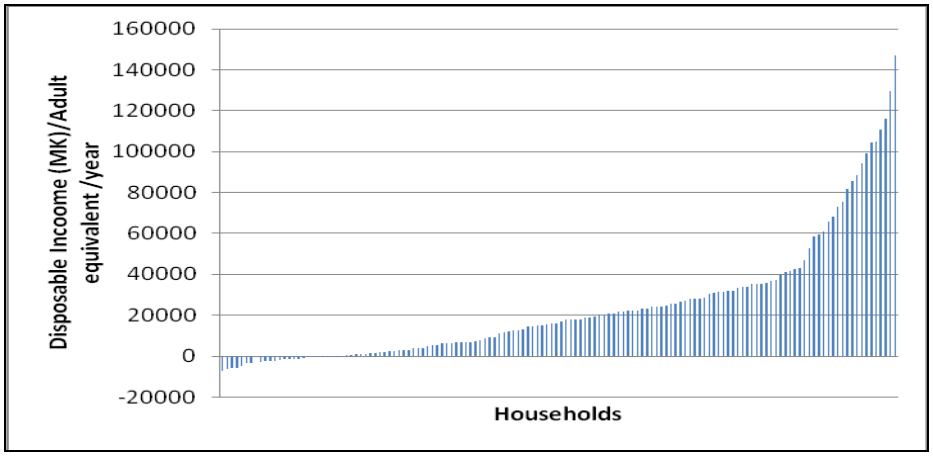


Figure 11: Disposable income adult equivalent for all individual households

The households in the figure are shown in ascending order of households' disposable income per adult equivalent per annum from the poorest to the richest households. In this paper the disposable income is used as a proxy for household welfare. The IHM analysis enables a horizontal and vertical analysis of households. The assumption being that a household with a higher disposable income per adult equivalent is better off than one with a lower disposable adult equivalent.

Having estimated the disposable income adult equivalent and established those above and below the food poverty line, the IHM estimates the individual households that are able to meet non-food needs in addition to food energy requirements by establishing the standard of living threshold (SOLT). The SOLT estimates a household's non-food needs per annum while taking into account the household composition. In addition to household size the IHM software allocates costs according to the age and sex composition of the household e.g. school costs are allocated only when the household has school age children. A minimum standard of living has been defined as the ability of a household to obtain sufficient food to meet its needs and basic household expenses (paraffin, matches

and utensils.); personal expenses (clothing and soap) and primary school costs (school dues, uniforms and books). Refer to the Figure 13 below is a presentation of the households that are above the standard of living threshold and those below.

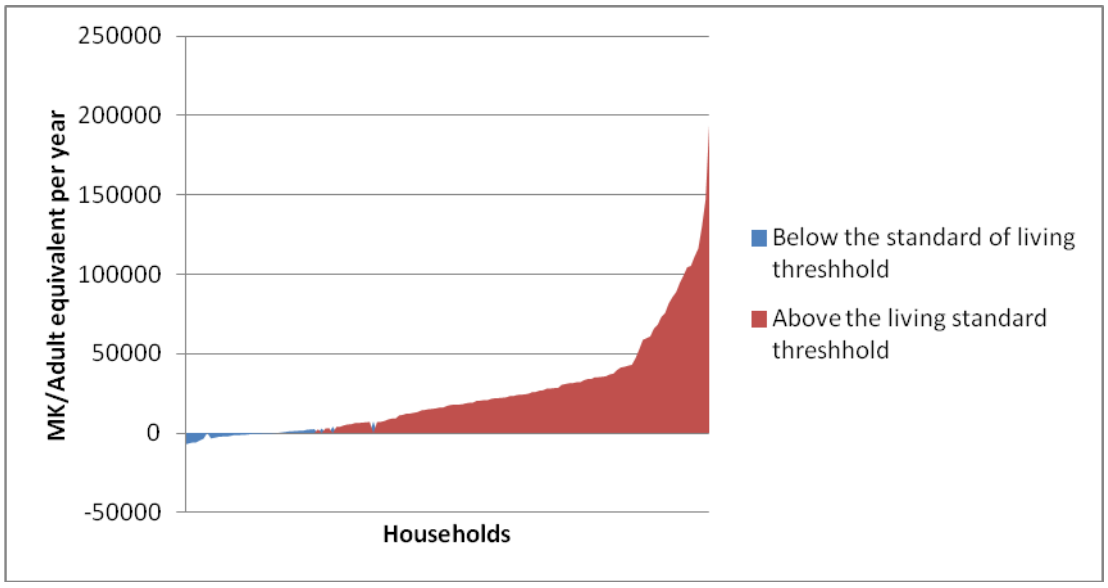


Figure 12: Disposable income adult equivalent for all individual households

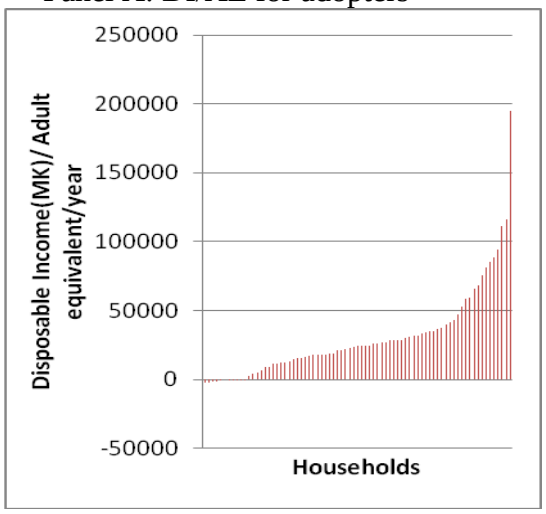
About 27% of the households failed to meet their food energy requirements and non food needs simultaneously. Some households (about 4) are living below the standard of living threshold but however met their food requirement levels and had more disposable income than some of the households that are living above the standard of living. This is attributed to different household compositions amongst the household which in turn differ in terms of expenditure

4.3.4 Comparison of AFSP adopters and non-adopters

One of the objectives of the study is to compare the welfare of the adopters and non-adopters in terms of their welfare. In this paper the disposable income per adult

equivalent and Kilocalories/adult equivalent per year are used. Below are graphs which compare the disposable income per adult equivalent per annum and kilocalories per adult equivalent per year for the adopters and non- adopter.

Panel A: DI/AE for adopters



Panel B: DI/AE for non-adopters

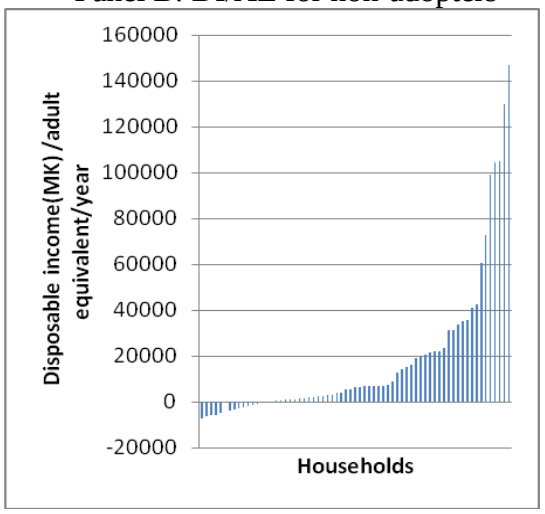
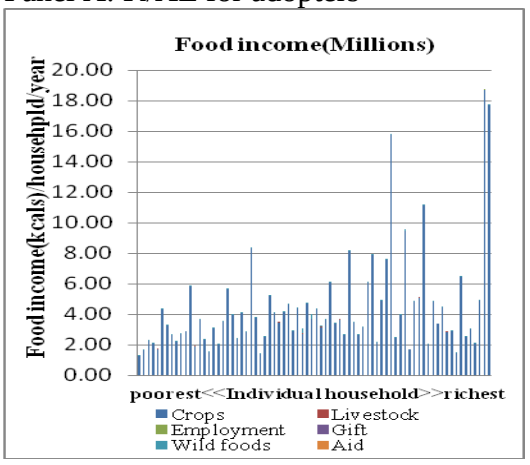


Figure 13: Disposable income adult equivalent for all individual households

Panel A: K/AE for adopters



Panel B: K/AE non-adopters

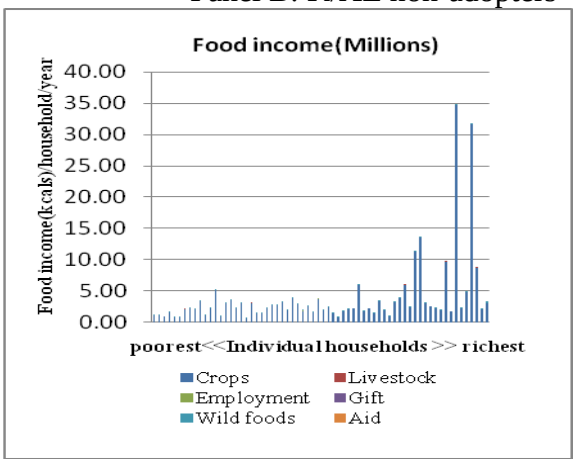


Figure 14: Comparison of food income (K/AE) for adopters and non adopters

Panel A of Figure 13 shows that disposable income is higher and the income inequality amongst the households is lower as compared to non adopters in panel B who have lower disposable income but comparably higher levels of income disparities. The sample of adopters has 12 percent of the households that failed to meet the food energy

requirement. The counterparts registered 24 percent of the households below the food poverty line. The t-test computed in table 2 shows that average DI/AE for adopters (31123) is statistically different from that of non adopters (17903) at 5 percent significance level. A comparison of food income in terms of Kilocalories between the adopters and non- adopters is presented in figure 15 in panels A and B respectively. This confirms the uniform pattern of distribution of the kilocalories between the adopters and non adopters which conforms to the descriptive statistics presented in table 2 which showed that there is no significance difference in terms of food income.

5.4 Impact of the AFSP on the rural livelihoods

5.4.1 Determinants of food income (K/AE)

A multivariate analysis was undertaken to assess the impact of AFSP adoption on the rural livelihoods using the Heckman two-step procedure. Essentially, the explanatory variables include the same household and community characteristics, as well as institutional factors, as in the adoption model. The second step of the Heckman two-step procedure estimates the determinants of food income from own production is measured by crops and livestock kilocalories per adult equivalent available for household consumption. The selectivity bias is tested for by incorporating the Lambda into a linear regression. The Lambda is the inverse Mills ratio saved from the probit equation describing adoption.

The decision arrived at about the insignificance of the mills ratio is supported by an assertion by Wooldridge (2003) that the usual t-test on Lambda can be used. If lambda is not significantly different from zero as the result in there is no selection bias which

means that there is no correlation between the error terms of adoption and food income in this paper.

Table 4 below presents the results for the coefficients in the food consumption indicator model from both the second step of the Heckman two step and the Ordinary Least Squares (OLS) estimation procedures. Results for testing selection bias showed that there is no selection bias in the sample. This is because Lambda coefficient is not significantly different from zero.

Table 3: Determinants of own food income (Kilocalories per adult equivalent)

Variables	X	Y	Z
Constant	14.02(0.00)	14.63(0.00)	14.123(0.00)
Access to extension(yes=1)		-0.28(0.217)	-0.051(0.667)
Active household members(16-65)	0.363(0.002)***	-0.37(0.002)***	0.356(0.002)**
Age of household head	-0.001((0.679)	0.00(0.769)	0.000(0.926)
Household head age squared	0.000(0.754)	0.00(0.734)	0.000(0.797)
Proportion of ckals	0.198(0.082)	0.182(0.087)*	0.173(0.092)*
Dependency ratio	-1.527(0.001)***	-1.55(0.001)***	-1.516(0.001)***
Piece work	0.066(0.45)	0.21(0.177)	0.067(0.544)
Formal employment	-0.112(0.393)	-0.11(0.385)	-0.108(0.409)
Household size	0.113(0.069)*	0.09(0.136)	0.110(0.069)**
Adoption (yes=1)	0.158(0.336)	0.15(0.249)	0.187(0.141)
Old aged household members(>65)	0.102(0.37)	-0.14(0.329)	-0.129(0.352)
Primary School junior (yes=1)	0.162(0.158)	0.06(0.632)	0.105(0.367)
Primary school senior (yes=1)	0.582(0.02)**	0.18(0.132)	0.168(0.148)
Secondary school junior(Yes=1)	-0.089(0.346)	0.59(0.02)**	0.580(0.02)
Sex of Household head	-0.014(0.679)	-0.10(0.312)	-0.086(0.369)
Upland owned (acres)	-0.363	-0.02(0.529)	-0.015(0.666)
Lamda	-0.134(0.64)	-0.25(0.196)	
Wald chi^2	236	216	
Prob chi^2	0.000	0.000	0.000
Adjusted R-squared			68
R- squared			62

Notes: X=Heckman second step with access to extension as an instrumental variable, Y= Heckman second step and identifying on functional form Z= Ordinary least square (OLS) estimation

*p=0.10, **p = 0.05, ***p = 0.01

The selection of the identification variable was tested by estimating the determinants food income (K/AE) and number of extension visits per year was used as an identification variable in column X of Table 4. Column Y of table 4 presents the results for tests of

robustness of the identification variable using the identification on functional form method. This involves including the identification variable in the model. Again, the Lambda coefficient was not significant. The identification variable was also not significant, which implies that it does not influence the food income (K/AE) in the study area. Therefore, it is possible to judge that access to extension is suitable for an identification variable. Since the results from the estimation can, however, be sensitive to the choice of the identification variable and in the two models the Lambda is not significant, the model can be estimated using an OLS (Z). Adoption is included as explanatory variable in the OLS model to account for the impact on own food income.

The OLS results in column Z of table 5 show that five factors affected the food income (K/AE) for consumption at household level. The factors that are significant in the OLS model include secondary school junior, household size, active household members, old household members and crops kilocalories.

There is a positive relationship between junior secondary school attainment of the household head and Kilocalories adult equivalent consumed. The relationship is significant at 5 percent. This means attaining secondary education will have a positive impact or will increase the own food income (K/AE) to the households by 58 percent. According to Adeoti (2007) this is not surprising because literacy can enhance the capacity to adapt to change, understand new practices technologies, and improve a household' productivity and income. The other levels of education attained by household heads had the expected positive sign but were not significant.

Household size was significant at 10 percent significance level but surprisingly had a positive sign meaning that a unit increase in the household number will increase the food income (K/AE) at household level. This can be argued along the lines that a unit addition of household size increases the labour available for production activities more than the demand for the kilocalories requirements. Apparently this holds while keeping the other factors constant.

Number of active household members had a positive influence on food income and was significant at 1 percent. A unit increase in an active household member increased the household food income (K/AE) by 35 percent. The positive relationship of the active household members and food income (K/AE) are involved in can also be viewed as the active age group was more of consuming than contributing to kilocalories production.

Another interesting factor is dependency ratio which has expected results and conforms to theory. Dependency ratio had a negative sign which implies that a unit increase in the number of dependants reduces own food income (K/AE) of a household. An increase in a unit of dependency ratio reduced about 1.47 of the households' food income (K/AE at 1 percent level of significance. Proportion of crops Kilocalories was significant at 1 percent and is positively related to the food income (K/AE).

4.4.2 The contribution AFSP to food income (K/AE)

One of the variables that were not significant in the multivariate analysis above was adoption of AFSP. Despite the insignificance of AFSP adoption, the study has established that there is a positive relationship between adoption of AFSP and food income (K/AE). This means that adopting AFSP has a positive impact on own food income (K/AE) only

that the impact is not significant between the adopters and non- adopters. The insignificance of the AFSP adoption to food income may be attributed to a number of factors. The reference year that the study based its assessment was in April 2010/March 2011 agricultural calendar which was a phasing out year for the AFSP. The FDGs conducted in the study area revealed that a significant number of the fertiliser trees did not survive at the time of study which may have affect the potential output of own food income. Secondly the adult equivalents for the adopters is significantly (1 percent) greater than the non-adopters, refer to table 2. On the other hand in 2010/2011 agricultural year the study areas were hit by a dry spell which would have affected the households' food income.

The project idea of AFSP is very important and if the rural livelihoods are to be transformed then AFSP is one of the livelihood strategies to go by especially in Malawi where Agriculture is the mainstay of the economy. However the impact of the programme is likely to be undermined if the implementation process is not closely monitored. The study established through the FDGs that the farmers were not fully guided on how to plant the fertiliser trees. This would negatively affect the potential outputs likely to be realised if the right agronomic practices are disseminated and internalised by the farmers. Significance difference is noted for Maize productivity (5 percent) and Maize production (1 percent) where adopters produced more than the non adopters in table 2.

4.4.3 The contribution of AFSP to disposable income per adult equivalents

They were five indicators that were set for household income according to Programme Implementation Plan (PIP) of the AFSP. The indicators include amount of annual income,

income from selling raw and processed fruits, fuel wood sales (from own production) and fodder. Through the FGDs conducted it was established that in the study area at most 100% adopted the component of fertiliser trees and only 50% planted fruit trees out which a significant number of the trees did not survive due to drought in the study area. In addition to food income, sources of income and disposable income per adult equivalent per year were also used to compare the welfare of the adopters and non-adopters. However it is evident from the analysis that the source of income are from employment which constitutes different types of off-farm activities as presented in figures 6 (Panel A), 7 and 8 from the IHM analysis. The disposable income for the adopters is significantly higher than the non- adopter the difference cannot be attributed to AFSP because the cash income predominantly generated from employment rather than the PIP indicators.

CHAPTER 5

CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Summary and conclusions

The overall objective of the study was to determine the impact of the AFSP on the rural livelihoods of the participants. Using primary data that was collected in two villages in Mulanje district the study address two specific objectives to achieve the overall objective. These were to determine the factors that influence household decision to participate in AFSP and ascertain the effect of AFSP on the adopters' rural livelihoods (Food and disposable income in this study). A total of 141 households were sampled for the study which comprised of 79 adopters and 62 non-adopters. The Heckman two step procedure and the IHM were used to assess the two specific objectives.

The empirical results show that household size, access to extension services, formal employment positively influenced the households' decision to AFSP adoption while piecework involvement had a negative influence on the households' adoption decision. The IHM analysis showed that non- adopters' source of cash income was predominantly from piecework. This is an indication that much of their time is spent on piece works rather than investing on their own farms. The study established that the AFSP has a there is a positive correlation between AFSP and household food income however the programme did not have a positive impact on the rural livelihoods. In terms of disposable income there is a significance difference between the adopters and non adopters but it is

difficult to attribute the difference to AFSP. The adopters were well to do in terms of disposable income adult equivalent.

5.2 Policy recommendations

The findings from Focus Group Discussions (FGDs) show that the demand for the programme is high as such there is need for the programme implementation to continue. The study based on the research findings suggest a number of recommendations to be incorporated in the future programmes.

From the finding that the AFSP has a positive impact on the adopters though not significant, the study recommends that AFSP should integrated the capacity building component in the programme to ensure that farmers, lead farmers and extension agents are fully capacitated to ensure sustainability of the programme. The FGDs revealed that no exit strategies were initiated in the study area. To ensure sustainability of the programme exit strategies should be amongst the priorities of the programme. For example farmers should have sustainably functioning seed banks so that the trees that do not survive in their fields should be replaced immediately so that the expected yields should not be undermined.

The study has established that extension contact is very important in influencing the farmer's decision to adopt AFSP therefore there would be a significant impact if the farmers are frequently visited by the extension agents and directed on how to plant and take care of the trees to increases the survival rate. This can be achieve by reducing the channels of resources flow to ensure that front line staff are reasonably supported logistically to reach out to farmers; establishing a well linked communication channels

for example mass media to disseminate information on agro-forestry practices; and promotion of exchange visits for the adopters as an incentive to the farmers.

The study found out that the households that practiced piecework (ganyu) do not adopt AFSP. Such types of households do not invest much resource on their farms. This is why it is important that the grass root staff should at least regulate the self selection approach into the programme so that the beneficiaries are seasoned and dedicated farmers if the programme is to have an impact on the rural livelihoods.

5.3 Limitations of the study

There is limited literature on the topic of study especially on the empirical literature. As such the study reviewed

The study didn't have a yardstick to compare the study findings to. The results were going to be more intuitively appealing if there was a baseline for the individual households' livelihoods before the programme was implemented. The study only used the Heckmans two step procedure to estimate the impact of the AFSP. The results were going to be more intuitively appealing if the IHM was also used to assess the impact so that the results for the Heckman and IHM were comparable. The IHM was not used to measure impact due to lack of the baseline data for the individual households. Despite that the study was conducted in one district, the results give a true reflection of the programmes impact on the adopters and the factors influencing the farmers' decision to participate in the AFSP.

5.4 Direction for future research

No single study can encompass all what is needed in the area of research. While this study has made outstanding contributions, further research is a requirement in Agro-forestry technologies. A panel or cross section analysis should be under taken to track the impact AFSP on the rural livelihoods over time. In addition, there should be effort to capture a baseline scenario in order to facilitate the creation of a counterfactual for each household.

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APPENDICES

Appendix 1

Table 5: On farm trial of Nitrogen yield of biomass of six month old improved fallows in Kenya

Species	**Nitrogen Yield(Kg per hectare)**
Tephrosia vogelii	121.3
Crotalaria grahamiana	152.6
Sesbania sesban	85.7
SED	11.5

Source: Sanchez and Jama, 2000

Appendix 2

Table 6: Factors affecting farmers' decision to adopt fertiliser trees continuation

Study (sample)	**Wealth**	**Age**	**Sex**	**Education**	**House hold size**	**Land**	**Uncultivated land**	**Use of fertiliser**	**Off -farm income**	**Oxen ownership**	**Village exposure to improved fallows**
Factors affecting farmers decision to plant fertiliser tree fallows for the first time											
Franzel,S. 1999(157)			N		N						
Phiri *et al.*2004(218)	+		N								+
Kuntashula *et al.* 2002(218)	+	N		N		+	N		N	+	
Ajayi *et al.* 2006(305)			N		+,N	N		+			
Peterson *et al.*, 1999(320)	+					+				+	
Factors affecting farmers' decision to continue to plant fertiliser trees											
Keil 2001(100)	+/-	N	N	N	+	+					
Place *et al.*, 2002		+	N	N	N	N					+

Key: +: Positive association; - : Negative association; +/-: positive or negative depending on the value; N: No influence; Blank space indicate: Variable not included in the study

Source: Ayayi *et al.*,(2003)

Appendix 3

Table 7: Qualitative assessment of the impact of agro forestry adoption on livelihoods of farmers in southern Africa.

Impact indicator	**Malawi (n=184)**	**Zambia (n=57)**	**Mozambique (n=34)**	**Regional range**
		% of respondents		
1.Increase in are under agro forestry	55	87	65	83-100
2.Yield increase(> quarter to triple)	70	90	71	83-100
3. Significant food security(2 months of hunger reduction)	94	84	54	66-100
	58	68	53	33-83
4.Increase in income	90	nd*	59	nd*
	87	94	71	nd*
5.Firewood availability	77	84	77	77-100
	84	82	59	71-100
6. Increased savings				
7. Change in wealth				
8.Soil improvement				

Source: Ayayi *et. al.* (2003)

Appendix 4

Box 1: Summary of the IHM data collection method

It is difficult to collect income data especially to poor countries due to the nature of the economic activity. For example, food produced by a household may be consumed or sold for cash; employment may be paid in kind rather than in cash; many income sources are seasonal or intermittent; and local measures such as sacks, ox carts or tins, rather than metric measures may be used.

To fill this gap, Evidence for Development (E*f*D) has developed a reliable, standardised method of collecting and using household income data suitable for operational use. This approach, known as the 'Individual Household Method' (IHM), has two parts. The first is a method of data collection which aims to systematically minimise known sources of error and specifically those errors which arise from the more usual questionnaire based approach. The second part is specialised software designed for data checking and an alysis; this is needed as household data can be difficult to manage, and decision making requires current information.

IHM field work involves a preliminary survey to establish an overview of the local economy. This ensures that interviewers have a good working understanding of the economy before they start the household interviews. The preliminary survey also provides contextual information which is required for the analysis.

Household interviews are conducted in a way that: (i) Minimises the risk of omitting income sources. Interviews are tailored to the economy of the area and an income classification is used to ensure that all sources of income are included; (ii) Avoids leading questions. Income questions are approached in relation to each productive asset. Apparent anomalies are explored and an explanation sought (e.g. why a household obtained a lower return on a crop than its neighbours); (iii) Makes accurate recall easy for the interviewee. Employment income is often seasonal and intermittent and requires working through the year month by month; (iv) Minimises recording errors. Local units of measurement are used during the interview (e.g. sacks, buckets, ox carts) and interviewer/ interviewee fatigue is avoided by keeping interviews short.

Source: Seaman J. and Petty C. (2010)

Appendix 5: Individual Household interview form

INDIVIDUAL HOUSEHOLD ECONOMY

Agricultural year:

Date: **Household #:**

Place:

Interviewer: **Interviewee:** **Status (adopter=1/non adopter=0):**

1. Name of current household head: Record the name they would use for 'official' purposes

2. Details of all household members: Include everyone who eats and sleeps here; also include 'part time' resident's i.e. family members who work away for part of the year but contribute to household income. Record each person's relationship to household head. Ask if any of the adults in the household are not able to work. Ask why? (e.g. too old, blind, chronically sick etc). Finally, ask if any household members died during the study period.

Name	**School** (Educ. Level)	**Sex**	**Age**	**Full time or p/time resident**	**If part time, approx how many weeks present per year?**	**Note any adult in the household who is not able to work**	**Did any household member die during this period? If yes, note their age, sex and month in which they died [e.g. 65 yrs, Male, March 2008]**

Name	**School**	**Sex**	**Age**	**Full time or p/time resident**	**If part time, approx how many weeks present per year?**	**Note any adult in the household who is not able to work**	**Did any household member die during this period? If yes, note their age, sex and month in which they died [e.g. 65 yrs, Male, March 2008]**

3. Land: Include information for each plot

Type of land (e.g. upland, dimba)	**Area of each plot**	**Area cultivated**	**What inputs were used? e.g. fertiliser, fertiliser trees, seed,**	**Is this plot inherited/bought(1) or rented in/matrilineal(0)**	**Area rented from others last year**	**Area rented out to others last year**
1.						
2.						
3.						

4. List major assets i.e. items that can contribute to household income (e.g. bicycle, plough, house for rental, brick mould, sewing machine, land for rental, mobile phone, radio, crop processing machine, ox cart, brewing utensils etc)

Asset	**Number**

5. What type of agro-forestry technology did you adopt? (Circle and specify type of trees)

i) Fertiliser tree: specify which type(s)_____
ii) Fruit tree: Specify which type(s)_____
iii) Fuel wood trees: Specify which type(s)_____
iv) Fodder trees: Specify which type(s)_____

6. Production: With the interviewee, make a sketch of their plot/s and indicate the size of plot/s, crops grown and quantity produced in the last full agricultural year. Use the back of this sheet and indicate Season 1/ Season 2 where relevant. Indicate crops grown and quantity produced. Fill in the following table, indicating total production, amount sold, other uses and amount consumed by the household. Do not attempt to convert local measures to kg during the interview. Check if 'sacks' are 90kg or 50kg.

Crop	**Total Production local measure.**	**Total Production (Kg)**	**Amount sold**	**Sale price/unit**	**Month sold**	**Other uses e..g given away, saved for seeds etc**	**Amount consumed by household(Kg)**

7. Did you have access to agro-forestry extension services? 1=Yes, 0=No

8. Livestock and livestock products. Include all livestock and poultry

Animal	**Number**	**Milk consumed**	**Milk sold- when & price?**	**Meat consumed**	**Live sales- when**	**Price/unit**	**Eggs consumed**	**Eggs sold/when?**	**Other e.g. animals given away; kg sold: when & price**

9. Employment: List all sources of employment from month 1 to 12, for each household member (e.g. Ridging, weeding, petty trade,)

Month	**Work**	**Who?**	**How many days/month?**	**Total value of work/month**
1 April 2010				
12th month (march 2011)				

10. Wild foods Is any wild food collected? Include total quantity consumed and sold (meat from game, wild fruits and vegetables)

Food: name and if necessary describe type of food e.g. dark green leaves	**Kg sold per year**	**Month/s sold & price**	**Total kg consumed per year**	**Other comments**

11. Transfers: Include all sources including relief, support from relatives who are not part of the household, neighbours etc

Source of assistance: NGO, neighbour, church, relative, government relief	**Type of assistance. If food, record food type e.g. maize, cassava etc**	**Quantity: if food, total kg. If cash, total per year**	**If food, quantity sold**	**If food quantity kept for own consumption**	**Other information e.g. when assistance was received**

12. Other food transfers: check if any food is gained by children or others e.g. gleaning after the harvest; begging etc

Food	**Total kg consumed per year**	**Other comments – e.g. when the food is given to the family**

13. Other sources of income not yet recorded e.g. from property rental, hire of oxen/ox plough, company pensions, other employment benefits etc. **Cross check for any remittances from 'part time' members of the household. These should be noted in the employment section of the form.**

Source of income/benefit	Value per year	Other information e.g. when income was received

14. Credit and loans

Source of credit	Purpose of loan	Value of loan	Repayment per month	Total repayment

15. Inputs

Fertiliser Type	Total kg	Used for (crop type)	% used on each crop type	Where? (eg upland; dimba)
Seeds Certified				
Type	Total(Kg)	Source	Type	Quantity harvested

Seeds Uncertified				
Type	**Total Kg**	**Source**	**Type**	**Quantity harvested**

16. Membership of Farmer organisation

Name of farm.org.	Reason for joining	Membership fee	Notes