EFFECT OF VALUE ADDITION ON INCOME AMONG DEEPENING ENTERPRISE DEVELOPMENT GROUPS IN NTCHISI DISTRICT, MALAWI

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DECLARATION AND RECOMMENDATION

Declaration

I hereby declare that this is my original work and has not been submitted in this or any other university for award of any degree.

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Recommendation

This thesis has been presented to the Graduate School of Egerton University with our approval as university supervisors.

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DEDICATION

To my late dad Mr Robert Mkandawire.

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ABSTRACT

Agribusiness in Malawi is still in the early stages of development and is associated with insufficient value addition. Farmers' ability to produce outputs in quantities and quality forms that are marketable and commercially viable is limited by a number of factors. Lack of sufficient storage and processing facilities as well as inadequate skills are some of the notable constraints. As a way of enhancing the competitiveness of the rural agribusiness actors and ultimately raising their incomes, the government of Malawi with support from the African Development Bank (AfDB) implemented an initiative called Deepening Enterprise Development (DED) under the Local Economic Development (LED) project. The study was therefore carried out to better understand the impact of the project in solving the problem of low household income through value added agriculture. The aim was to assess the effect of value addition on income among DED farmer groups in Ntchisi District, Malawi. The study used a multi-stage sampling procedure to select 100 farmer groups comprising of 62 beneficiaries and 38 non-beneficiaries of the project. Data analysis was done using descriptive statistics, probit model and propensity score matching (PSM) model. Cleaning, grading, processing, packaging and labelling were the forms of value addition found to be practiced by the farmer groups. Beneficiaries of DED (23%) were more involved in packaging as compared to non-beneficiaries (3%). About 21% of the beneficiaries processed and labelled their products while none of the non-beneficiaries were involved in either of the two practices. Location and project participation were found to have significant positive influence on groups' decision to add value. On the contrary, type of farming, number of enterprises and belonging to a single gender group had a negative influence on the groups' decision to engage in value addition. Lastly, the difference in gross margins (ATT) between the two groups that came about due to value addition was MK251.08. The study therefore recommends that strategies be put in place to enhance the farmers' ability to engage in higher forms of value addition techniques. These may include creation of an enabling environment for credit access that can be used for investment in value addition equipment and facilities. Efforts should also be made by all stakeholders to advance the provision of agricultural extension services, which may lead to an increase in the adoption rate of value addition activities among the farmers. Value added agriculture should be promoted as one of the strategies for improving the socio-economic wellbeing of smallholder farmers through increased income.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS ABBREVIATIONS

AfDB	African Development Bank
ATT	Average Treatment Effect on the Treated
BSU	Business Support Unit
CGIAR	Consultative Group for International Agricultural Research
COMSIP	Community Savings and Investment Promotion
DED	Deepening Enterprise Development
DFID	Department for International Development
DID	Difference in Differences approach
EPA	Extension Planning Area
ESR	Endogenous Switching Regression
GDP	Gross Domestic Product
GoM	Government of Malawi
GTZ	German Organisation for Technical Cooperation
HIS	Integrated Household Survey
HIS	Household Integrated Survey
IFAD	International Fund for Agricultural Development
IMF	International Monetary Fund
IV	Instrumental Variable
LED	Local Economic Development
LLR	Local Linear Regression
LPM	Linear Probability Model
MDG	Millennium Development Goals
MDGS	Malawi Development and Growth Strategy
MEGS	Malawi Economic Growth Strategy
MLE	Maximum Likelihood Estimation
MPRS	Malawi Poverty Reduction Strategy
MSEs	Micro and Small-scale Enterprises
NGO	Non-Governmental Organisations
NNM	Nearest Neighbour Matching
PSM	Propensity Score Matching
RBCSP	Results-Based Country Strategy Paper
SACCO	Savings and Credit Cooperative

SSA	Sub-Saharan Africa

CHAPTER ONE
INTRODUCTION

1.1 Background Information

Malawi's economy relies greatly on agriculture. About 30 percent of the Gross Domestic Product (GDP) is contributed by the agricultural sector. The sector is characterised into estate agriculture sector and smallholder sector. The smallholder agriculture is a key source of living for most of the population residing in the rural area. It also represents more than three quarters of national exports and generates more than 80 percent of the export earnings. For the case in point, about 84 percent of value-added products from agriculture originates from 1.8 to 2 million smallholder farmers. These also contribute more than 70 percent of the agricultural Gross Domestic Product (GDP) despite owning not more than 2.5 hectares of land (GoM, 2016).

Agriculture in Malawi is rain-fed. Due to limited land holding size, the smallholder farmers prioritise the production of food crop to cash crop. Adoption of modern technology is mostly limited by lack of capital and credit hence their inability to increase production. Malawi's exports have for the most part been less competitive. This can be attributed to inadequate marketing institutions, poor road infrastructure and high transportation costs (Nankhumwa *et al*., 1999). Malawian products, such is the case for most African countries, have had difficulties penetrating the global market. Identifying new markets for alternative exports to replace the traditional exports has faced challenges and reluctance due to the fear of the repercussions such a shift may have on the economy in the short-run.

Poverty in Malawi is widespread. Based on the Integrated Household Survey (HIS), the estimates show that about 40 percent of the population earn or spend less than the threshold (GoM, 2012). The agricultural sector is the primary means of support for the poor majority which live in the rural areas (Benson *et al*., 2005). Market liberalisation, from 1987 onwards, resulted in the creation of new and better prospects for smallholder farmers to earn cash income. Due to liberalisation, rural trade fostered the growth of small and medium enterprises. On the other hand, liberalisation of smallholder crop production as well as marketing led to increased area of land dedicated to cash crops such as legumes. Cash crops provide smallholder farmers with limited land a way out of poverty. In essence, this implies that to combat poverty, policies should be market driven and place much emphasis to raising rural household incomes (Orr and Orr, 2002).

According to IFAD (2014), rural people in Malawi who are also less resource endowed lack the ability to diversify out of agriculture. Agribusiness is still in the early stages of development. Smallholder agriculture is associated with insufficient value addition and the farmers fail to meet the growing demands for both domestic and international market because they normally produce and sell primary commodities (GoM, 2009). Farmers' ability to produce outputs in quantities and quality, which are marketable and commercially viable, is inadequate due to limitations that they face.

The smallholder sector in Malawi faces a number of constraints that can be resolved through increased agricultural productivity, diversification of commodities to combat risk as well as production of high value outputs (Ellis and Ntengua, 2003). Lack of sufficient storage and processing facilities as well as inadequate skills are among the important constraints. This results in high post-harvest losses that in turn leads to inability of the farmers to capture premium prices during the off-season due to limited opportunities. Limited access to credit is another challenge to agricultural development in Malawi. Smallholder farmers lack access to formal lending institutions since they are perceived as bad risk (Aliou and Zeller, 2001). Information asymmetry also emerges as a challenge that comes about due to lack of information and poor access to commercial services. This causes farmers to earn relatively low profit margins for their products in agricultural markets. Participation of the farmers in agricultural value chain is affected by these constraints deterring them from satisfying both domestic and export markets (GoM, 2016). Reducing the challenges faced by the small-scale farmers would enhance their competitiveness and help to set up growth in the agricultural sector.

The policy environment has been dominated by agricultural development policies since 1964. This has been the case because Malawi has more than 80% of the population in the rural areas whose livelihood strategies are dependent on agriculture. The agricultural sector has for long driven the performance of Malawi's economy. The government has been focusing on developing the smallholder agriculture by devoting considerable amount of resources to the sector. A number of investments have been made including the founding of state-owned enterprises engaged directly in production and marketing of smallholder agricultural produce, provision of extension services by the state as well as subsidized credit and inputs. With all the effort however, the growth of the agricultural sector and the economy has been inconsistent and poverty has remained high (Chirwa *et al*., 2008).

It is recognised by the Malawi Growth and Development Strategy (MGDS) that advancement of local economic development would help to achieve broad based growth. The development should however be done based on the potentials that exist within the local areas. Several interventions have been put in place with the aim of protecting the poor from the risks of market reforms. The government has implemented a series of programmes with aid from bilateral donors since the late 1990s. The African Development Bank's mid-term review conducted in February 2008 emphasised the need for a multi-sector intervention that would enable local areas to develop by promoting value addition and building capabilities for entrepreneurship development as essential in maintaining pro-poor economic growth in the country (AfDB, 2008). It is to this effect that the Government of Malawi initiated the LED project with financial funding from the African Development Bank (AfDB).

The LED project supported a number of initiatives with the purpose of supporting the development of small and medium enterprises (SMEs). The household income and the socio economic wellbeing of these SMEs would be improved through their involvement in a series of economic activities. Among the supported components of the LED project was the Deepening Enterprise development (DED). The initiative focused on expanding already established businesses through a series of trainings on marketing, value addition, financial management and savings mobilisation. The farmer groups were involved in different types of enterprises. However, the study focus on tomato, groundnuts and honey. The value added products form the mentioned enterprises were tomato jam, cooking oil and honey. The project also supported the construction of basic economic development infrastructure such as processing and storage facilities and provided the beneficiaries with processing and other value addition equipment. The targeted beneficiaries were the economically active poor such as local business associations and cooperatives as well as small-scale entrepreneurs (AfDB, 2008).

1.2 Statement of the problem

Production and productivity has been the focus of Malawi's agricultural development strategies in the past. However, farmer groups remain less business oriented and weak. Because little has been done on value addition, majority of the smallholder farmers continue to trade their produce in raw form. This can be attributed to lack of capacity as well as processing equipment and facilities. Consequently, returns from their sales has remained low due to their inability to satisfy customer demands. The DED initiative was implemented to

increase household income and improve the socio-economic wellbeing of the SMEs through their involvement in a range of value addition activities. The study, therefore, intended to assess the effect of value addition on income among the DED project beneficiaries in Ntchisi District.

1.3 Objectives of the study

The overall objective of this study was to contribute towards the improvement of income through demonstrating the role of farmers' involvement in value addition activities.

1.3.1 Specific objectives

i. To establish the different types of value addition techniques practiced by the beneficiary and non-beneficiary groups of DED.
ii. To determine the factors influencing the groups' decision to engage in value addition.
iii. To determine the effect of value addition on gross margins between beneficiary and non-beneficiary groups of DED.

1.3.2 Research questions

i. What are the types of value addition techniques practiced by beneficiaries and non-beneficiaries of DED?
ii. What are the factors that influence the decision of the beneficiary and non-beneficiary groups to engage in value addition?
iii. Does value addition have any significant effect on gross margins between beneficiaries and non-beneficiaries of DED?

1.4 Justification of the study

Given the fact that poverty reduction is a critical issue in Malawi with agriculture as the driving force to the same, higher farm returns is one of the ways that ensures income availability at household level. Therefore, any research work that aims to better understand the strategies employed such as DED geared to solve the problem of low household income is essential. In order to formulate appropriate and effective agricultural and poverty reduction policies, there is need to be well informed of the impact of programs implemented by government and Non-Governmental Organizations (NGOs). Therefore, the study would assist policy makers in identifying appropriate rural development interventions hence improving the wellbeing of the rural poor. Additionally, the study would be helpful for the project in

providing the feedback information on its effectiveness and in validating the works done on its interventions.

1.5 Scope and limitations of the study

The study was limited to smallholder farmer groups in Malomo EPA of Ntchisi district. The aim was to analyse the effect of value addition on income of the beneficiary and non-beneficiary groups of DED. The study sorely relied on the farmer's ability to recall information due to poorly kept records. However, probing technique was used to enhance the accuracy of the information obtained.

1.6 Operational definition of terms

Famer groups: These are farmers who come together with a defined membership, purpose for assembling and organisational structure established to support members in pursuing their individual and collective interests.

Smallholder households: These households owning land and farm up to a maximum of 6 acres.

Income: These are earnings generated from farming and business activities accruing to an individual or group.

Effect: This is a change brought about by a cause.

Value addition: It is the transformation of raw agricultural commodities to consumer-ready food products. It includes local processing, packaging, or marketing, which improves the value of raw agriculture products.

Gross margin: This is the difference between total revenue and total variable cost

Agribusiness: This is the commercialisation of agriculture production.

CHAPTER TWO
LITERATURE REVIEW

2.1 Rural development interventions

The changing aspects of African rural development can be connected with a rise in the level of commercialisation of production in different productive activities, branches, or sectors. Several organising principles for economic activities might be looked at in order to capture the unfolding rural dynamics. These may include the changes in and potential for increased levels of commercialisation of production among a number of non-state production agents, for instance private entrepreneurs and industries, individual smallholders, rural households and groups of various kinds including cooperatives and communities (Havnevik *et al*., 2003).

Although the process of elimination of government power and liberalisation provided new opportunities for rural population and entrepreneurs, problems resulting from this process such as market failure became internationally recognised Havnevik *et al*. (2003). A growing concern for poverty reduction, democratisation, and the inclusion and participation by rural people in civic life and productive activities led international institutions, donors, and non-governmental organisations (NGOs) to put much emphasis on the participation and empowerment of local people and communities. Development aid has responded to poverty, slow economic growth and poor governance in Sub Saharan Africa (SSA) in a variety of ways. The western aid policy has strongly focused on poverty, directly addressing the causes and consequences of it as well as the economic growth, as an indirect means of addressing poverty. Both of the focus areas are concerned with improving conditions for the poor.

Proctor (2014) argued that even with positive scenarios on job creation and accumulation effects, it would take time to complete economic transformation. Therefore, increasing productivity in agriculture continues to be a priority strategy for poverty reduction and a key contributor to growth. Nevertheless, the type of agriculture also matters. The IMF (2014) report on Sub-Saharan Africa fostering durable and inclusive growth illustrates growth paths followed by the six low-income countries sampled showed that where agricultural growth was driven by performance of cereal crops, for example in Ethiopia and Rwanda, growth proved more inclusive and rural poverty declined more significantly. This is in comparison with growth in agriculture for Burkina Faso and Mozambique, which was mainly driven by cash crops, such as cotton, sugar, and tobacco. Consequently, while growth in cash crops

brings surpluses from exports, growth in staples helps support domestic food supply hence lower poverty.

With agriculture making up the base of most African economies, economic transformation has to focus on the modernisation of agriculture, as well as increasing the agricultural and agricultural labour productivity of smallholders. Using agriculture as a foundation for manufacturing and services, particularly by increasing agro-processing and other agribusiness, will create jobs, especially for women and youth. Proctor (2014) further notes that it is necessary to address obstacles to smallholder agriculture, precisely those associated with scale and to seek incentives for off-farm enterprise job creation. This strengthens the need for strategies for agricultural and rural development to complement and be coherent with those allowing countries to industrialise and to diversify economically.

Rural transformation cannot be supported effectively using the prevailing sets of silo-based sectoral policies. Further sectoral interventions are often spatially blind and fail to deliver efficiently and effectively to the distinguished beneficiary groups in different locations, that is rural and urban areas, or in different territories or regions within a country. Future interventions need to have the capacity to plan and respond to the spatial reality and to work effectively across and between social and economic sectors at the national level and within more localised sub-national frameworks (Proctor, 2013).

2.2 Agricultural income and rural poverty

Poverty is not an easy term to define. A range of definitions exits the dominant being the Western definition since World War II that defines poverty in monetary terms, using levels of income or consumption to measure poverty. The poor are therefore defined by a headcount of those who fall below a given income or consumption level or poverty line (Grusky *et al.*, 2006). This has however been complemented with a multi-dimensional approach which includes low life expectancy and lack of a decent standard of living, lack of opportunities and access to basic services as well as the perceptions of the poor themselves. It is established by (Handley *et al*., 2009)that this holistic approach to defining poverty leads to a broader analysis of the causes of poverty. Socio-economic characteristics and politics are seen to be the drivers and maintainers of poverty in SSA.

Wiggins (2005) and Dorward *et al*. (2004) indicated that poor people are excessively concentrated in rural areas. (Bohne and Berlin, 2009) agrees with the same by alluding to the

fact that in SSA three quarter of all poverty is concentrated in rural areas. This means that agricultural growth and rural development are key to growth and poverty reduction. It is also noted that broad-based agricultural growth can increase the income of the less resource endowed farmers, as well as landless labourers reliant on agricultural employment. Agricultural growth can further have a strong impact on food prices and as the poor usually spend a high percentage of their incomes on staple foods, declines in food prices benefits the poor. Nevertheless, findings from case studies in Malawi and Zimbabwe by Dorward *et al*. (2004) suggest that only high-yielding and appropriate technologies, combined with extension services and improved access to markets will empower the increasing productivity necessary for pro-poor growth.

Rural poverty is said to be caused by a number of structural factors. The most significant factors are related to low labour productivity, a scarcity of capital and knowledge, high transaction costs and failing institutions. Because of high input costs, declining commodity prices and erratic rainfall, farmers are not motivated to invest in improved land use. Therefore, labour productivity remains low and purchasing power for fertilizers and seeds is limited. As indicated by Havnevik *et al*. (2003), economic actors in rural Africa have to a large extent diversified their income sources due to high risks, uncertainty, lack of access to assets, and in general the failing of a number of different markets.

Agriculture is about three times more effective in increasing income of the poor than is non-agriculture investments. Agriculture growth, as contrasted to growth in general, is found to be the primary source of poverty reduction (Cleaver, 2007). Spatial analyses of poverty and income are seen to be important for several reasons. Primarily, it can provide information on regions that fall behind in the process of economic development and reveal extents of disproportions. On the other hand, spatial information is the foundation for poverty alleviating programs and support complementary actions. This can cause efforts from governmental and non-governmental side to be targeted more specific. And lastly, relevant factors like geographic or economic conditions can be revealed (Bohne, 2008).

In Malawi, the agricultural sector is the most significant source of livelihoods to the majority of the poor people living in the rural areas. There are significant differences in agricultural household income and rural poverty among districts in Malawi. Mainly the central districts show the highest income and lowest poverty. Bohne (2008) indicated that in Malawi agricultural trade orientation through the involvement of districts households on cash or food

crops reveal a positive relationship on higher income and lesser poverty on district level. The study also found that within the rural employment and activities, agricultural income reveals a major positive relationship to decreasing poverty on a district level.

The historically there has been a close relationship between different rates of poverty reduction over the past 40 years (1964 to 2004) and differences in agricultural performance, particularly the rate of growth of agricultural productivity as emphasised in a paper produced by DFID (2004). The authors see links between agriculture and poverty reduction as being forged through direct impact of improved agricultural performance on rural incomes as one of the transmission mechanisms. Agriculture's fundamental role in stimulating and sustaining economic transition, as countries as well as poor people's livelihoods shift away from being primarily agricultural towards a broader base of manufacturing and services is also stated as another important transition. They also noted that the potential for future poverty reduction through these transmission mechanisms hinges on the extent to which agricultural productivity can be increased.

2.3 Agriculture and agribusiness development

Agribusiness if referred to as the commercialisation of agricultural production where production is not only meant for subsistence purposes but also supply to the market (Olwande and Mathenge, 2012). If the living standards and livelihoods of people are to be made better, then the agriculture sector needs to be the focus of development plans. The agricultural sector can be transformed through agribusiness. This has the ability of changing agricultural sector from a merely subsistence enterprise to a commercial venture which is also profitable. This is also the driving force behind increased development and sustainable growth in SSA (Mutemi and Sakwa, 2017). Agribusiness offers great potential for increased agriculture based investments and poverty alleviation.

As stated by World Bank (2013), agriculture and agribusiness are the largest economic sectors in Africa and also included among its fastest growing sectors since 1990's. In Africa, development and growth of the domestic market is stimulated by the increase in population, incomes and urban settlement. If Africa can attain competitiveness, agriculture and agribusiness this could achieve better things for the continent. However, the size of agribusiness sector in most African countries is small as compared to that of agriculture (Schaffnit-Chatterjee, 2014). Ehui *et al*. (2016) made mention of the fact that as countries

move from lower to higher levels of income, the share of agribusiness and agro-industries in GDP also tend to grow.

In the course of undergoing through structural changes, which saw a decline in GDP of agriculture's share did not in turn translate to the growth of a diversified manufacturing sector. Countries such as Ethiopia, Burundi and Malawi which are landlocked are still dependent on the export of agricultural commodities with very little or no processing (Schaffnit-Chatterjee, 2014). Investing in the agribusiness and agro-industries sectors is therefore of paramount importance since it contributes to value addition and enhances income. The development of these sectors paves way for market access, finance and technical assistance facilitated for the smallholder farmers which in turn promotes their inclusion into modern and efficient value chains (Ehui *et al*., 2016). This comes about through backward and forward linkages.

In SSA's, agricultural value chains mostly comprise of SMEs again posing a challenge of how they can be included in the value chain (Schaffnit-Chatterjee, 2014). Their inclusion in the value chain does not necessarily require transforming them into large-scale farmers. Organising them into cooperatives and linking them to large investors in form of mutual partnerships would go a long way. The fact that the success of agribusiness players is largely dependent on the success of smallholder farmers is leading the large investors into taking practical steps towards promoting the SMEs financially as well as integrating them into the global food supply chain.

The response to new market opportunities by private entrepreneurs leads to emergence of new agricultural activities and products (Larsen *et al*., 2009). Smallholder farmers also stand a chance of benefiting from such opportunities by engaging into higher value added products as a way of diversifying their production. Liberalisation of economies and globalisation of trade creates opportunities to which agribusiness responds. As much as the growth and development of agribusiness is dependent on initiatives done by the private sector, the public sector has a crucial role of creating and facilitating an enabling environment.

It is a common understanding that in order to attain rapid growth of incomes and to reduce poverty in the majority of African countries, agriculture and value adding agribusiness are key (UNIDO, 2004). In the global world, agriculture and agribusiness sectors in SSA have a dynamic comparative advantage (Wood and Mayer, 2001; Wood, 2002). And since

agriculture and agribusiness are the sectors in which majority of the poor are involved, the absence of growth in these sectors would limit the Millennium Development Goals (MDG) of poverty reduction from being met (Fafchamps *et al*., 2001).

Needless to say that the development impact from agribusiness investments cannot be achieved without interactions between the informal and formal forms of value chains (Temu and Temu, 2006). However, considering the size of the informal value chains progress cannot be made without first improving their performance. Such progress is vital to nurture inclusiveness and generate employment. In order for informal value chains to acquire vital capital, skills, technical expertise and market contacts they ought to be linked to the formal value chains. Without this, investment in agribusiness with brings new technologies and organisational innovations would threaten the existence of SMEs that are unable to adopt to the changing environment (Byerlee *et al*., 2013).

2.4 The role of collective action

Individual chain actors in developing countries are faced with several constraints in producing and marketing their products due to accelerated transaction costs along the value chain (Martey *et al*., 2014; Issa *et al*., 2015; Oluoch *et al*., 2016). Smallholders especially are victims to this. These challenges, *inter alia*, include restricted access to financial and physical resources that impede on their potential to increase their scale of production let alone achieve economies of scale. The other involves limited access to technical skills and information due to less or no access to training on production. Furthermore, individual farmers are wanting when it comes to bargaining power that marginalize actors since they receive little from the final value of their products because they do not benefit from economies of scale.

Over time, the role of collective action has evolved to bring a solution to the aforementioned challenges to enhance the value chain. Groups are seen as a vital instrument in transforming agriculture (Berem *et al*., 2010; Adong *et al*., 2012). Farmers have organised themselves into groups or associations which serve a common goal for all. Through these, farmers can market their products collectively which enhances their bargaining position and enhanced market access. Largely, collective action bears benefits of reduced transaction costs.

Following the adoption of structural adjustment programs, countries in sub-Saharan Africa have experienced a rise in the number of farmer groups. The state of economic liberalisation was birthed out of the programs which led to reduced control over farmer cooperatives by the

government in the region (Economic Commission for Africa, 2014). The absence of government regulatory powers in these cooperatives resulted into corruption and mismanagement of property. Consequently, farmers withdrew from the cooperatives and formed grass-root groups which were driven by the themselves (Temu, 2009).

Nevertheless, the farmer-driven groups are not left without challenges in this liberalised economy (Shiferaw *et al*., 2011). This may be attributed to lack of managerial capacity due to their unpreparedness to take over after the governments pulled out (Abaru *et al*., 2006). Additionally, the farmer groups have been less competitive when faced with large market forces. This has emanated largely from the market instability which has affected the performance of the farmer groups in a negative way (Onumah *et al*., 2010; Markelova *et al*., 2009). Poor organisation of farmer groups has contributed to their failure to excel. Nonetheless, some among them have managed to survive and continued to perform well.

In order to benefit from the supermarket revolution, there is a need to build the capacity of smallholder farmers. Supermarkets have benefits such as broader supply of products, safer foods, more streamlined supply chains and economies of scale which leads to lower consumer prices (Byerlee *et al*., 2013). Smallholder farmers often tend to have challenges in dealing with supermarkets due to their procurement systems. As stated by Neven *et al*. (2009), majority of supermarket suppliers are educated commercial farmers, who own sizable pieces of land hence have an advantage in terms of quantity and consistency of supply. For effective market access, the ability of the smallholder farmers to fill the gaps in bulking and quality is intrinsic, therefore, their participation in collective action is essential (Muthini *et al*., 2017). Farmers who are well organised and supported through technical assistance stand a better chance to benefit from such new opportunities.

2.5 Value added agriculture

According to Temu and Temu (2006), agriculture's contribution to the east and southern Africa is more than double to the average contribution it makes to SSA as well as East Asia and Pacific regions. Due to a fall in world prices, returns to traditional exports have declined over the years. With the emergence of new markets on the international arena, there is need to overcome barriers for smallholder farmers in order to have them included and benefit from these emerging markets. Despite such developments, people within the African countries especially in the rural areas continue to depend on agricultural production as a source of their livelihoods. However, production is mostly done in form of agricultural raw materials as well

as intermediate products with less value addition. Agribusiness chain with limited value addition translates to low returns to the agricultural sector (KIPPRA, 2017).

Many African countries have succeeded to sell in international markets even without making further enhancements of their business environment and competitiveness of their export commodities. However, majority of these countries in the SSA faces the risk of producing products that are of low skill and low value thereby impinging them from gaining a significant share in the area of value added agriculture on the international market (Webber and Labaste, 2010). Global integration has been ignited by important changes in international finance and commerce. These include reduced transport costs, lower trade barriers and technology advancement. Globalisation presents new opportunities for African countries to increase economic growth and reduce poverty through having access to new markets and provision of a wide range of choices to consumers. Nevertheless, this comes with its own challenges including the requirement to boost the quality and complexity of African products and making regulatory reforms in order to benefit fully from global markets (Bolnick, 2005).

Value-added agriculture is an imperative strategy to both agricultural entrepreneurship and rural development (Lu and Dudensing, 2015). The concept of value addition in agriculture in the developing economies is widely becoming an acceptable strategy adopted by both government and non-governmental organisations towards improving the income generation of the rural communities (Ja 'afar-Furo *et al*., 2011). On the other hand, current definitions of value-added agriculture lack a framework founding economic linkages between consumers' preferences and farm practices. Inputs for various sectors of light manufacturing such as food processing which also dominates this agro-industry, is provided by the agricultural sector (Schaffnit-Chatterjee, 2014). Majority of these values added activities require skills, scale and financing. Nevertheless, simpler changes fruit drying and milk cooling can also capture higher value.

Value-added producers need to focus on products that satisfy consumer desires or market niches. Producers can identify the desires of consumers and target markets by utilizing value-added principles for business development unlike taking the commodity to the market and hoping that consumers will like it and put it to use (Boland, 2009). Target markets are tightening as retailers and consumers pay more for a narrower variety of eating experience. Penetrating these target markets means that value-added businesses must know their customers' requirements.

According to Boland (2009), producers need to search for ways to be economically viable through incentive-based solutions. Producers' greatest opportunities are hinged on activities that add value to their products. Adding value to bulk raw commodities is a means by which producers keep a larger share of the margins associated with further processing and market development. Advanced producers respond to market developments, determine what factors will drive the future of their businesses.

Adding value to products marked for sale on domestic markets can be a step towards accessing higher value markets by smallholder farmers in Africa. According to (Byerlee *et al*., 2013), for smallholder farmers to progress along the value chain it becomes much easier for them to move from one level of the standards spectrum to the next rather than jumping directly to the most demanding markets. It is therefore important that interventions aimed at enhancing smallholder farmers' competiveness should initially put their focus on domestic market in which smallholders stand a better chance to succeed. The domestic markets, provides farmers and agribusiness with new opportunities to sell their products and ultimately raise their incomes. This in a way supplements production for export markets which are hardly participated by the smallholder farmers due to high transaction, investment and compliance costs (Larsen *et al*., 2009).

2.5.1 Forms of value addition

Value addition is defined as any act that takes a raw product a step closer to the form in which it can conveniently meet the needs of the user (Sarma *et al*., 2016). The original form of the product is transformed to satisfy consumer preferences. In the quest of finding ways of increasing farm income, much interest has been shifted towards adding value to raw agricultural products. Most of the agricultural raw commodities have an inherent value embedded within them. Ways in which value can be added to agricultural products include sorting, cleaning, cooling, packaging, processing, distributing, cooking, combining, churning, culturing, grinding, hulling, extracting, drying and smoking (Born and Bachmann, 2006). This is in other terms referred to as food processing.

With value addition, the business mentality of producing and then selling the commodity directly to the market is gradually being substituted by an approach of firstly looking into what attributes are needed by the cosumers as part of the product and then the product is created accordingly (Coltrain *et al*., 2000). With the emergence of a global economy there is growth in the demand for value added products. Market forces have created greater

opportunities for product differentiation. This is attributed to the increase in consumer demands regarding health, nutrition, and convenience, efforts to improve productivity by processors as well as advancement in technology, which makes it possible for production to be in response to customers' demands (Royer, 1995).

Food processing is said to be the changing of agricultural commodities into different forms in preparation for human consumption (Gulati *et al*., 2005). Food processing is an important aspect as far as rural development is concerned. With it comes the provision of new outlets for agricultural products, increased income, creation of employment and reduction of wastage. As consumption evolves so does the food processing industry. Low income countries tend to have low levels food processing because the diet mainly consists of staples. Generally, industrial production linkages where agriculture is involved are weak in the SSA (Ehui *et al*., 2016). Investing in agro-processing therefore plays a crucial role in the small commercializing economies of African countries. Apart from adding value to agricultural commodities, processing also makes the products more tradable than they would be otherwise. Therefore, there is need to make more investments in processing in order to transform African's non-tradable rural economies into market-based economies (Goletti and Wolf, 1999).

Recently, demand for standards and certification by consumers have been growing due to health concerns that have driven the need for traceability systems. Consumers want to know how the animal or crop was raised, the environment it was raised in, all the way until it reaches their tables (from farm to fork). Certification in Africa is still obscure and limited due to costs involved in training, standards compliance and other logistics. However, producers could fetch premium prices for value added products, attract external investment from donors and possess enhanced bargaining power due to transparent price determination that certification bring along (Latynskiy and Berger, 2017). The provision of public services through institutions that deal with food safety can play a significant role in enabling smallholder agribusinesses to have better access to markets. Investing in reference laboratories as well as certification bodies would help producers to comply with standards (Byerlee *et al*., 2013).

2.5.2 Worldwide evidence of value addition

Evaluation of value addition benefits to value chain actors has documented positive effects accrued. Adding value is believed to be a wealth creator for chain actors and the economy at large (Roy *et al*., 2013; Ntale *et al*., 2014) A satisfying number of studies have explored the effects, however with main focus on benefit derived at smallholder level. Interestingly value addition at this level is relatively low and leaves more room to explore and proper policies in place to promote adoption of value addition.

Value addition has been evaluated enough in East African Community (EAC). A study by Latynskiy and Berger (2017) conducted in Uganda, assessed the income effects of group certification for smallholder coffee farmers. The study found that positive impact, though small, were observed on participating households. However, certification as a form of value addition was observed to be low due to costs involved. Recommendations thereto were made to increase group membership of farmers as well as adoption of the value addition form to enhance rewards that come with packaging and certification.

In Kenya, Oluoch *et al*. (2016) found that the more value a farmer added to raw tubers of sweet potatoes, the better the incomes they received as value for their products. Further, marketing groups were found with strengthened bargaining power than individual farmers. Likewise, vertical and horizontal integration among smallholder dairy farmers was found to result in high gross margins (Mutura *et al*., 2016). Thus, Ntale *et al*. (2014) recommended that farmers should create alliances in Savings and Credit Cooperatives (SACCOs) which can help achieve economies of scale in production and value addition through the role of collective action.

Value addition was reported to have yielded fruits for farmer cooperatives in Rwanda. Farmers who engaged in cleaning of coffee (depulping, washing and drying cherries) obtained high quality coffee (Issa *et al*., 2015). This provided cooperatives with opportunities to accrue lucrative prices for their fully washed coffee. However, low production of fully washed coffee coupled with low participation rates by farmers in cooperatives is still a challenge to achieving this. Thus, governments continued efforts are on encouraging farmers to belong to cooperatives and as well strengthens the same through access to farm inputs, credit, markets and extension service access.

In a study by Agbarevo *et al*. (2015), it was found that the adoption of cassava value added technologies increased the production of cassava which led to an increase in income of the farmers involved. This was also in line with the findings by Nwosu (2005) who reported that there was an increase in farmers' yield leading to increased income as a result of adoption of improved agricultural innovations. The study further recommended that more effort should be geared towards increasing the adoption rate and level of the various value added technologies by farmers to increase not only the production of the crop but also income of the people.

2.6 The Evaluation Approach

Given the fundamental role that project interventions play in the rural development process, it is vital to assess both the specific and overall impacts of implemented projects. Several approaches to evaluate rural development projects have progressed over time. Kirkpatric (1994), indicated that various appraisals of most projects have focused on cost-benefit or cost-effectiveness approaches by assessing project costs, in particular, their relation to alternative uses of the same resources and to the benefits being produced by the projects. Certainly, the critical issue of a measure of project success is not whether the planned results have been achieved, but what impact the activities of the project has delivered and if they satisfy all the stakeholders (Yabi and Afari-sefa, 2009).

As a result, project evaluations in recent times have focused on the impact evaluation approach. In this approach, project success puts emphasis on whether the project had the desired effects on individuals, households and institutions and whether those effects are attributable to the project intervention (Koth, 2008). In project evaluation, the central problem is how to isolate and to estimate their impacts on target groups. Since many other exogenous factors that are not related to project execution such as government policy, market conditions and former experiences also have an effect on the beneficiaries' evolution, assessment approaches of projects seem to be difficult.

The literature suggests two core approaches with different concepts of measurement: the before-after and with-without approaches. The before versus after is sufficient to establish impact in cases where no other factor could reasonably have caused any observed change in outcomes. The most common counterfactual is to use a comparison group. The difference in outcomes between the beneficiaries of the intervention (the treatment group) and the comparison group is a single difference measure of impact. Kerr and Kolavalli (1999) argued that if the 'with-without' approach is designed in such a way to ensure that the exogenous

influences are isolated and to carry out the project impact only, it may provide more reliable results.

The main concern in selecting the evaluation approach is the way in which the problem of selection bias would be addressed. How this would be done depends on an understanding of how such biases may be generated, which entails a good understanding of how the beneficiaries were identified by the program. In theory, evaluators could follow two main quantitative methods in establishing control and treatment groups which are randomised experiments and quasi-experiments (MLE, 2013).

Randomised design also named as experimental design, are the most rigorous evaluation methodologies, often referred to as the "gold standard". Quasi-experimental (non-random) methods are used to carry out an evaluation when it is not possible to construct treatment and comparison groups through experimental design. For projects that are often setup purposefully, it is common to only have access to a single cross-sectional survey done after the project is introduced (Jalani and Ravallion, 2003). These techniques produce control groups that resemble the treatment group, at least in observed characteristics. This is done through econometric methodologies that include matching methods, double difference methods, and reflexive comparisons. The crucial methodological challenge in non-experimental evaluation method is that examining outcome response of an intervention involves extracting the effect of intervention from that of the other factors that affect individuals (Foster, 2003). Different econometric approaches have therefore been used to avoid or reduce this problem.

Among quasi-experimental design techniques, matched evaluation techniques are largely considered a second-best alternative to experimental design (Baker, 2000). Instinctively, propensity score matching (PSM) tries to create the observational equivalent of an experiment in which everyone has the same probability of participation. The variation is that in PSM it is the conditional probability (P(X)) that is intended to be uniform between participants and matched comparators, whereas randomization guarantees that the participant and comparison groups are identical in terms of the distribution of all characteristics whether observed or not. Therefore there are always concerns about remaining selection bias in PSM estimates (Ravallion, 2005).

2.6.1 Empirical studies

Regardless of its shortcomings, PSM is widely used in the recent literature on economic impact evaluation (Jalani and Ravallion, 2003). It is very attractive to evaluators with time constraints and working without the benefit of baseline data given that it can be used with a single cross-section of data, where this study envisions to employ. A number of researchers have applied this semi parametric model to evaluate various programs implemented particularly in less developed countries. Below are some of the studies that have applied PSM in their evaluations.

Nicoletti (2011) used PSM in order to analyse the effects of a comprehensive micro-irrigation program on income and crop production in Zambia. The results show that there were no significant effects on total family earnings, but there were positive significant total crop income and total crop revenues.

Singh *et al*. (2015) applied the model to assess the impact of micro-projects programme on rural household's income in Swaziland. According to the results, Micro-projects has a positive impact on rural households on income due to income sources attributable to Micro-projects. The findings also showed that the intervention plays a role in alleviating poverty of the rural households. Even though a gap exists among all, the necessary resources for the beneficiaries to maximise income gain that would significantly improve their standard of living were provided. In assessing the adoption and impact of improved groundnut variety on rural poverty in Uganda Kassie *et al*. (2010) used MPS model. The researchers found out that improved groundnut varieties is associated with increased crop income and contributed to moving farm households out of poverty.

Josephat and Likangaga (2015) also applied PSM in analysing of effects of agriculture intervention. Basing on the findings, welfare of farmers participating in the program was almost same with that of the non-participants. This was attributed to the fact that majority of the groups did not put into practice what they acquired from the intervention. It was also observes that groups had a tendency of changing group activities often.

In a study by Simtowe *et al*. (2012), PSM was used to find out the welfare effects of agricultural technology adoption. The results showed that growers of improved groundnuts had their production levels increased by 30 percent compared to non-adopters. The study

further found out that adopting improved groundnuts varieties increased income for the farmers who owned small land hence helped them to overcome the poverty line as well.

2.7 Deepening Enterprise development (DED)

The Government of Malawi (GoM) established the Local Development Fund (LDF) in the Ministry of Finance as an Inter-Governmental Fiscal Transfer mechanism through which Local Authorities access financial resources for their local development. The design of the Local Development Fund is guided by the MGDS that identify the Integrated Rural Development Strategy as one of the priority areas to stimulate local economic growth and reduce rural poverty. To this effect, the Government of Malawi through the LDF initiated the promotion of local economic development through the LED Project. The goal of the project was to contribute to pro – poor growth and poverty reduction with the objective of improving the social economic wellbeing and strengthening economic growth in four growth centres located in four districts across the country. The Project has four components namely Deepening Enterprise Development, Growth Centres Development, Local Authorities Capacity Enhancement and Program Support and Knowledge Management (GoM, 2011).

The primary target group for DED were the economically active rural poor who have the potential to embark on business ventures that would bring value addition to their on-farm and off-farm commercial activities. The selection of beneficiaries included at least 40% women. Existing groups organized by other programs were targeted to benefit from savings mobilisation, enterprise/business development skills training and market linkage support. The DED initiative expected outcomes were to strengthen business associations and cooperatives, to have groups which are participating in savings mobilization, to impart new technological and business skills to local entrepreneurs and to strengthen market linkages through the development of market information systems linked to agricultural resource centres (GoM, 2011).

2.8 Theoretical framework

The theoretical framework for this study was centred on the random utility theory. This theory is based on the idea which states that an individual derives utility by choosing an alternative (Walker and Ben-Akiva, 2002). Following these, the decision to add value to agricultural products is denoted by $\tau = 1$ and $\tau = 0$ for value adders and non-value adders respectively. The utility is given by $\mathrm{U}(Z_{\tau i}, F_{\tau i})$ informing the preference of the i^{th} individual.

The utility is assumed to be a function of $Z_{\tau i}$ a vector for farmer group characteristics (for instance gender composition, number of members, type of farm enterprise) and $F_{\tau i}$ a vector for institutional factors (for example access to credit, access to market, access to extension services) which describe the farmer group as a decision-maker *n* and the alternative i. The resulting utility equation can be written as:

$U_{\tau i} = \gamma_t \, V(Z_{\tau i}, F_{\tau i}) + \varepsilon_{ti} \; \tau = 1{,}0; i = 1 \ldots \ldots n$………………………………..…………..(1)

The relation in (1) does not restrict the function to be linear. The utilities $U_{\tau i}$ are random, and the i^{th} farmer group opts to add value to derive more utility from adding value than otherwise.

$U_{1i} \geq U_{0n}$ ………………………………………..…………………………………… (2)

The choice probability equation is then:

$P(i|Z_{\tau i}, F_{\tau i};\; \beta, \theta_{\varepsilon}) = \text{Prob}[U_{1i} \geq U_{0n}, \forall\, j \in C_n$ ……………..……………..………… (3)

Employing classical techniques, estimation involves maximizing the likelihood of the preference indicators (y_t). The likelihood is derived from the structural equation, in this case the utility equation (1), and the measurement equation, which defines y_t as a function of n the utilities via the utility maximization equation (2). For example, the measurement equation for choice data is: $y_{it} = 1$ for the chosen alternative and 0 otherwise for all $i \in C_n$, which leads to the following likelihood:

$P(y_t|F_n, Z_n;\; \beta, \theta_{\varepsilon}) = \prod_{i \in C_n} P(i|F_n, Z_n;\; \beta, \theta_{\varepsilon})^{y_{in}}$ ……...………...……………………… (4)

As established by (Deininger *et al*., 2008) this study is built on the assumption that the small scale farmer's decision to participate in the DED initiative is based on the question of whether they will maximize their utility (farm income) or not by optimally engaging their endowed resources through this initiative.

Participation then takes place if U*(R)>U*(NR). It is not possible to predict with certainty the alternative that the farmer group as a decision-maker will select. However, it is possible to express the probability that the farmer group will select alternative τ conditional on her choice set i; this is the probability that the perceived utility of alternative τ is greater than that of all the other available alternatives:

The perceived utility $U_{\tau i}$ can be expressed as the sum of two terms; a systematic utility and a random residual. The random residual ε_{ij} is the (unknown) deviation of the utility perceived by user i from this mean value it captures the combined effects of the various factors that introduce uncertainty into choice modelling.

2.9 Conceptual framework

Figure 1 shows a diagrammatic representation of the conceptual framework of the utility theory to this study. The theory was used to model farmer group's decision making on whether to add value or not and its consequences thereof. The choice of variables was based on author's conceptualisation as well as insights gained from literature review. The diagram provides a link between participation in DED and income. Farmer group characteristics and institutional factors are determining factors to a group's participation in DED initiative which also extends to their involvement in value addition activities. The value addition activities were being promoted by the project as part of their activities in trying to improve the competitiveness of the farmers' products on the market. In this case, income is the dependent variable. Being involved in value addition is ultimately perceived to have an effect on the farmer group's income.

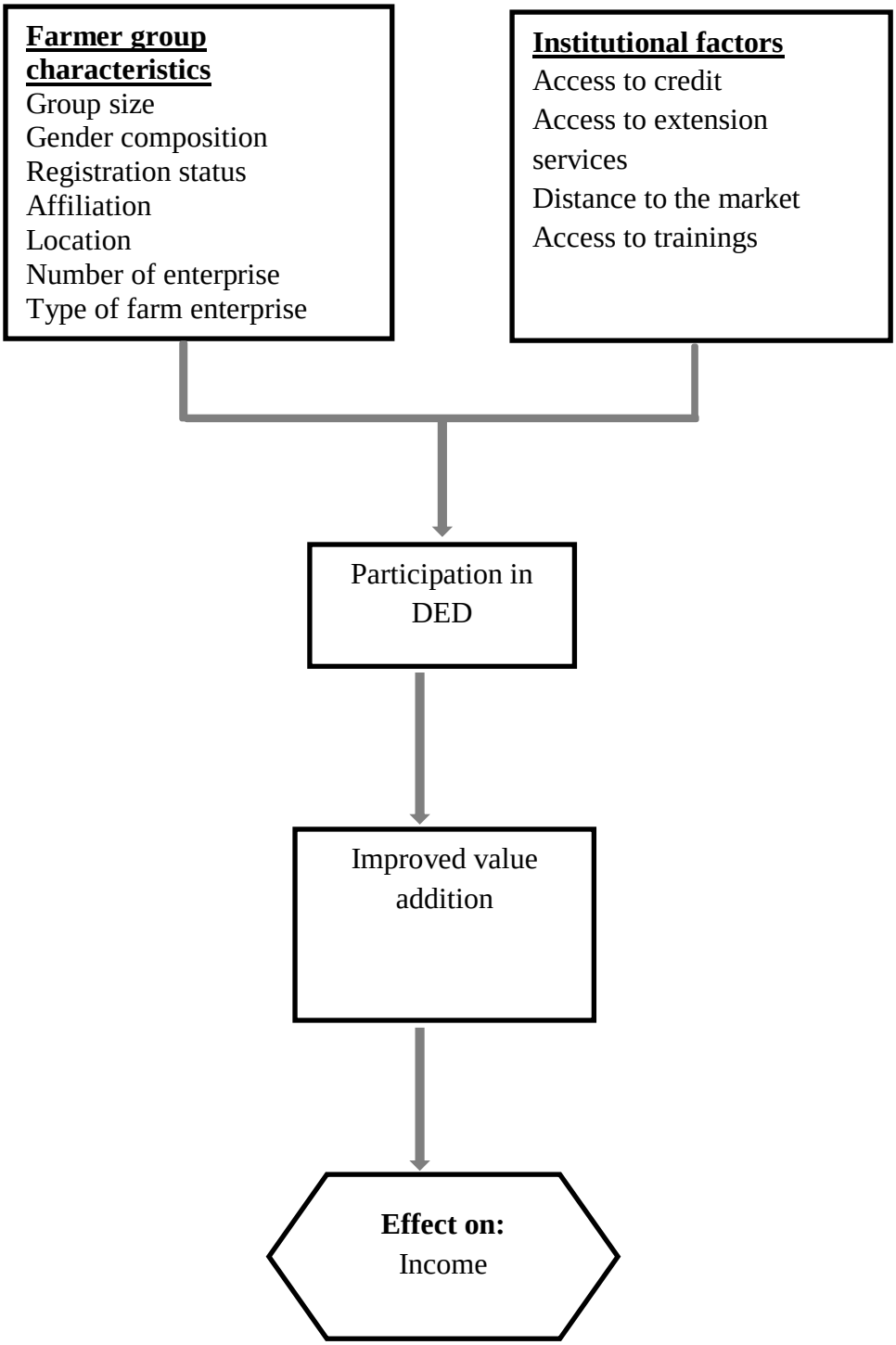

Figure 1: Conceptual Framework

Source: Author's conceptualisation

METHODOLOGY

3.1 Study area

The study was conducted in Ntchisi district located in the Central Region of Malawi (Figure 2). Ntchisi is situated 90 km North East of Lilongwe City and located at the approximate latitude of 13°22′S and 34°0′E. Total land area of the district is 1,655 square kilometres with a population of 212,000 giving a density of 128 persons per square kilometre. Ntchisi lies at an altitude between 1,300 to 1,700 meters above the sea level. The mean annual temperature varies between 22°C in low altitude areas and 18°C in high altitude areas. Annual rainfall ranges from 900mm to 1500 mm (Andreski *et al*., 2005).

The district has 4 major Extension Planning Areas (EPAs) namely Malomo, Chipuka, Chikwatula and Kalira. The study covered specifically Malomo EPA, the area where the project was implemented. The major part of the population in Ntchisi live on subsistence agriculture. The sector forms around 80% of the district economy where 15% of cultivable land are estates producing mostly tobacco with the remainder small holder farms producing a range of crops such as maize, soybeans, beans, groundnuts, potatoes, tomatoes and cassava. Livestock, forestry and irrigation are also important activities in the district. There is little private industry in the District and Government is by far the largest employer (GoM, 2015).

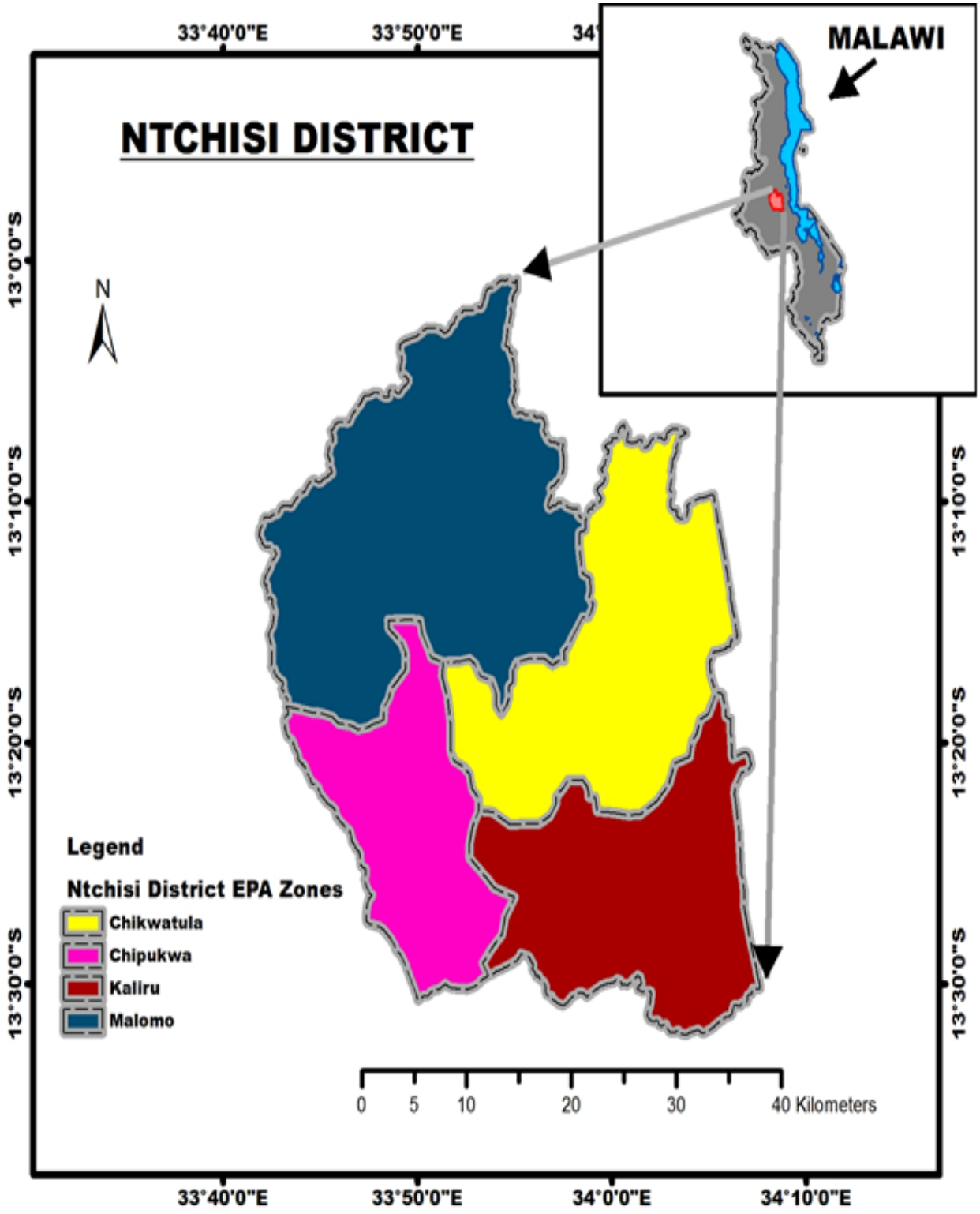

Figure 2: Map of Malawi showing location of the study Area

Source: (Kundhlande *et al*., 2014)

3.2 Sampling procedure

The study used a multistage sampling technique to obtain the required sample size. The first stage was to purposively select Ntchisi District because of its development in terms of production of agricultural commodities as compared to the other 3 districts. The second stage involved purposive selection of Malomo Extension Planning Area (EPA) among the 4 EPAs because it the area where the project was implemented. The EPA has 133 farmer groups out of which 83 are the beneficiaries of DED and 50 are the non-beneficiaries. From the 133 farmer groups, a sample size of 100 was generated. This was then divided proportionately between the beneficiary and non-beneficiary groups. Lastly, the respondents from the two categories were selected from a list of smallholder farmer groups provided by the District Agriculture Office using a systematic sampling procedure.

3.3 Sample size determination

The sample size determination followed a sampling methodology as specified by Yamane (1973) and adopted by Israel (1992) and Polonia (2013) . The sample size was calculated as follows:

$$n = \frac{N}{1 + N(e)^2} \quad \text{.....(1)}$$

Where:

n = sample size; N = number of groups; e = the level of significance at 0.05.

Therefore;

$$n = \frac{133}{1 + 133(0.05)^2} = 100$$

The sample size was therefore 100. The proportions for the beneficiaries and non-beneficiaries were thus calculated as below:

$$n = \frac{83 + 100}{133} = 62.40 \approx 62 \text{ Beneficiary groups}$$

$$n = \frac{50 + 100}{133} = 37.59 \approx 38 \text{ Non-beneficiary groups}$$

3.4 Data collection and analysis

Primary data was collected from 100 respondents using semi-structured questionnaires which were administered by trained enumerators. All selected beneficiary and non – beneficiary groups of DED initiative were visited. About 3 to 4 of the executive committee members were interviewed per framer group depending on their availability. A pilot test of the questionnaire was first carried out to determine its suitability and validity for the study. The data collected included the farmer group characteristics, institutional characteristics, information on value addition, marketing, product prices, output and cost of product sales. For the purposes of analysis, collected data was cleaned and coded to ensure consistency, uniformity and accuracy. The data was used to generate descriptive, inferential and econometric results and it was managed using STATA software.

3.4.1 Analytical framework

3.4.1.1 Specific objective one

Descriptive statistics on means, frequencies, and tables were used to achieve this objective. The study evaluated engagement of farmer groups in value addition activities. Further, the types of value addition were characterised and described. Information was collected from the farmer groups on the different types of value addition done on their commodities such as grading, cleaning, processing, packaging, labelling, branding and specifications.

3.4.1.2 Specific objective two

A probit model was used to determine the factors influencing the decision to engage in value addition among the beneficiaries and non-beneficiaries of DED. A satisfying number of past literature used the probit model (Martey *et al*., 2014; Ntale *et al*., 2014; Issa *et al*., 2015). Other studies have employed the logit and linear probability models (LPM) to analyse the objective. However probit is usually preferred due to its ability to constrain the utility value of the decision to engage in value addition to lie within 0 and 1 and more importantly resolves the heteroskedasticity problem (Asante *et al*., 2011); Wiboonpongse *et al*., 2012). Furthermore, logit analyses data that have a logistic cumulative distribution function. Shortcomings of LPM are that it can generate probabilities that lie below or above zero but also leads to questionable values of the measure of goodness of fit (Gujarati and Porter, 2009). The probit model was chosen because adding value is mutually exclusive, discrete and dichotomous (binary) response, that is to say a group opts either to add value or not. The aim was to explain the effects of the x_i (factors in this case) on the response probability

$P(y = 1\backslash x)$ on farmers groups' decision to add value. However prior to running the probit model a test for multicollinearity was conducted using the Variance Inflation Factor (VIF). For this method, a VIF value of less than 4 indicates that the problem of multicollinearity does not exist among the explanatory variables.

The dependent variable was value addition, represented by the letter Y. The dependent variable assumed only two variables (1 if the group engages in value addition and 0 otherwise). The supposed utility Y^*_{i1} from engagement in value addition activities which is unobservable was dependent on a vector of explanatory variables x_i. Having the underlying variable $y^*_{i1} > 0$ results into the binary outcome $y_{i1} = 1$. The regression equation representing the dependent variable, which is value addition and the independent variables influencing decision to engage in value addition, is thus written as:

$$Y = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_k X_{ki} + \mu \quad \text{..... (2)}$$

Where Y= Value addition

X= Factors determining the decision to engage in value addition

β= Coefficient

μ= Error term

The probit model is represented as below according to Greene (2012):

$$P(Y = 1 \mid X) = F(X\beta) = \frac{1}{\sqrt{2\Pi}} \int_{-\infty}^{X\beta} e \frac{-(X\beta)^2}{2} dx \quad \text{.....} \quad (3)$$

Where: X= $(1, x_{1i}, x_{2i}, \ldots . x_{ki})$

β'= $(\beta_0, \beta_1, \ldots . \beta_k)$

The relationship between a specific variable and the outcome of the probability is interpreted by means of the marginal effect, which accounts for the partial change in the probability. The marginal effect associated with continuous explanatory variables Xk on the probability $P(Y_i = 1|X)$, holding the other variables constant, was derived as follows:

$$\frac{\partial p_i}{\partial x_{ik}} = \emptyset\ (x_i\beta)\beta_k \quad \text{..... (4)}$$

where $\emptyset$ represents the probability density function of a standard normal variable.

The marginal effect on dummy variables was estimated differently from continuous variables. Discrete changes in the predicted probabilities constitute an alternative to the marginal effect when evaluating the influence of a dummy variable. Such an effect was derived from the following:

$$\Delta = \Phi(\tilde{x}\beta, d = 0) \quad \text{..... (5)}$$

A set of explanatory variables used in the probit model and their priori signs are presented in Table 1.

Table 1: Specification of variables used in a probit model

Variable	Description	Measurement	Expected sign
Dependent variable			
ValueAdd	Value addition (1= adds value, 0= does not add value)	Dummy	
Independent variables			
CredACC	Access to credit (1=yes , 0=no)	Dummy	+
ExtACC	Access to extension services (Number of contacts)	Continuous	+
MarACC	Access to the market (Distance to the market in km)	Continuous	+/-
TrainACC	Access to trainings (1=yes, 0=no)	Dummy	+
TrainProd	Training on production of tomatoes, groundnuts or honey (1=yes, 0=no)	Dummy	+
TrainVA	Training on value addition of tomatoes, groundnuts or honey (1=yes, 0=no)	Dummy	+
Memb	Number of members	Continuous	+/-
GendComp	Gender composition (Percentage of males and females)	Dummy	+/-
Regstatus	Registration status (1=registered, 0= not registered)	Dummy	+/-
Affil	Affiliation to an organisation (1=yes, 0=no)	Dummy	+/-
NumberEnter	Number of enterprises	Continuous	+/-
TypeEnter	Type of farm enterprise (1=crop, 0=animal)	Dummy	+/-

3.4.1.3 Specific objective three

A propensity score matching (PSM) method was employed to achieve this objective. Past literature also employed PSM to evaluate the effect of adopting a technology (value addition) on incomes and gross margins ((Wu *et al*., 2010; Piabuo *et al.*, 2015; Julian *et al*., 2014). The most commonly used methods of impact evaluation are the differences in differences approach (DID), endogenous switching regression (ESR), propensity score matching and instrumental variables approach (IV) (Julian *et al*., 2014). The DID is bestowed with an advantage of removing biases introduced through both observable and unobservable factors. However, it requires pre and post project panel data generated through well designed experimental approaches. The limitation of IV was finding an appropriate instrument, which is challenging since the data for the current study was only a one shot survey on the program while ESR allows for the presence of endogeneity.

PSM is a non-experimental method used to estimate the difference in outcomes between beneficiaries and non-beneficiaries that is attributable to a specific program. PSM reduces the selection bias that may exist in non-experimental data. Selection bias exists when participants have not been randomly allocated to a particular program, and those units that are eligible to participate are systematically different from those who are not. It is essential to draw a counterfactual scenario about the outcome in absence of the intervention for one to infer the impact of an intervention on individual outcome. The challenge lies in the formation of a proper comparison group amid a large group of non-participants (Caliendo and Kopeinig, 2005).

Rosenbaum and Rubin (1983) suggest matching on the probability of participation, given all observable treatment-independent covariates X. The propensity score of vector X can be defined as:

$$P(X) = \Pr(Z = 1 \mid X) \quad \text{.....} \quad (5)$$

Where, Z represents the participation indicator equalling one if the group participates, and zero otherwise. Since propensity score is a balancing score, the probability of participation conditional on X was balanced such that the distribution of observables X was equal for participants and non-participants. The differences between both groups were therefore reduced to the only attribute of the assigned treatment and unbiased impact estimates were

obtained. The counterfactual group can be known if potential outcomes Y_1 (Y_0) of participants (non-participants) are independent of participation, conditional on observables X:

$$Y_0, Y_1, \perp Z \mid X, \forall X \quad \text{..... (6)}$$

This conditional independence assumption shows that the selection is entirely based on the vector of observables X that determines the propensity score, thus it rules out perfect predictability. In addition, in order to guarantee randomised selection the common support condition needs to be applied:

$$0 < P(X) < 1 \quad \text{..... (7)}$$

It ensures that with identical observable characteristics groups have a positive probability to belong both to the participation and to control group. The assumptions together ensure that participation is ignorable and imply that:

$$Y_0, Y_1, \perp Z \mid P(X) \quad \text{..... (8)}$$

If outcomes are independent of participation given X, then they also do not depend on participation given P(X). As a result, the multidimensional matching problem is left to a one-dimensional problem. The distribution of possible outcomes was balanced among participants and counterfactuals.

The probit and logit are standard approaches for estimating models with limited dependent variables (Wu *et al.*, 2010). Both yield similar results when estimating the probability of a group participating or not participating in value addition. The study adopted a logit model to estimate propensity scores. The probability of participation, given vector X containing all observable characteristics, can be defined as:

$$P(X) = \Pr(Z = 1 \mid X) = F(\beta_1 x_1 + ... + \beta_i x_i) = F(X\beta) = e^{X\beta} \quad \text{..... (9)}$$

Where F (·) produces response probabilities between zero and one. After the set-up of the core assumptions and the prediction of the probability of participation, one parameter that measures the differences in outcome between participants and non-participants is introduced in the next step. Generally, the difference in potential outcomes can be captured in the treatment effect for an individual i, expressed as follows:

$$TE_i = Y_{i1} - Y_{i0} \quad (10)$$

Where i = 1,…, N and N represents the total population. One parameter of interest is the average treatment effect on the treated (ATT). Applying the merged assumption of strongly ignorable treatment assignment involving both the independence of the outcome variable from treatment conditional on observable covariates and the common support assumption as introduced above, the real ATT based on PSM, can be presented as:

$$ATT_{PSM} = E_{p(x)}\{E(Y_1|Z=1, P(X) - E(Y_0|Z=0, P(X))\} \quad (11)$$

In thought of the non-randomised selection of groups in the project, it might be possible that other unobservable factors had affected the participation decision. Rosenbaum (2002) suggests solving the problem of unknown bias by a bounding approach. Thus, within the logit model to estimate propensity score (equation 5) the probability of participation F(·) needs to be completed by a vector U containing all unobservable variables and their effects on the probability of participation captured by γ:

$$P(X) = \Pr(Z=1|X) = F(X\beta + U\gamma) = e^{X\beta + U\gamma} \quad (12)$$

Rearranging the likelihoods ratio of two groups (m and n) who are identical in observable characteristics, the resulting relative likelihoods of participation is given by question 13.

$$\left(\frac{P(X_m)}{1-P(X_m)} * \frac{1-P(X_n)}{P_{(X_n)}}\right) = \frac{e^{\beta_n x_n + \gamma_n u_n}}{e^{\beta_m x_m + \gamma_m u_m}} = e^{[\gamma(u_m - u_n]} \quad (13)$$

As long as the U between the two groups is similar or if the unobserved variables got no effect on the probability of participation, the relative odds ratio becomes one and the selection procedure is random.

Matching algorithms

After calculation of propensity scores, there is need for an algorithm to match farmer groups who have engaged in value addition and those who have not. This is normally based on the closeness of their propensity scores (Wu *et al*., 2010). Heckman *et al*. (1998) suggested matching algorithms such as nearest neighbour (NN) matching, kernel matching, local linear (LL) matching, radius (caliper) matching and weighting. NN matching is the most straightforward matching estimator. Each individual from the control group is selected as a

matching partner for a treated individual. The choice of individuals from a comparison group is based on closeness in terms of propensity scores. The NN matching faces a risk of bad matching if the closest neighbour is far away since its role is to match each farmer group from the participators with the farmer group from non-participants with the closest propensity score

Radius matching is used to reduce the NN matching risk, which imposes a maximum tolerance on the difference in propensity scores. Allowing for replacement in NN matching works in the same way as imposing a caliper (propensity score distance) in radius matching. This method helps to avoid bad matches hence increasing the quality of matching. For this matching method, apart from choosing individuals from a comparison group based on propensity scores, the selection is also done in terms of the caliper (propensity range). As noted by Smith and Todd (2005) a possible shortcoming with this method is the inability to have a foreknowledge on the choice of a tolerance level which is reasonable. In contrast to caliper matching an alternative to this technique called radius matching is suggested by Dehejia and Wahba (2002). Rather than just using the nearest neighbour in each caliper for comparison, radius matching uses all the comparison individuals within the caliper. The advantage with this method is that as many units as are available in the caliper are used for comparison hence allowing the usage of fewer units when good matches are not available and vice versa.

For stratification (interval) matching, the common support of the propensity score is divided into strata. The mean difference in outcomes between participants and non-participants is obtained through the calculated impact within each strata. The choice of the number of strata is dependent on the balance of propensity score within each stratum (Aakvik, 2001).
The kernel and LL matching are non-parametric matching estimators that use a weighted average of all individuals in the control observations to come up with a counterfactual. Since more information is used, a lower variance is achieved in turn. The highest weight is placed on those control units with scores closest to the treated thus assigns a weight which is inversely proportional to the distance between the propensity score and the corresponding treated unit. The merits associated with this method is that it produces average treatment effect estimates with lower variance due to use of much information. However the method has its own weakness in that observations which are bad matches are possibly used (Caliendo and Kopeinig, 2005).

The current study used NN matching, stratification matching and radius matching to estimate the effect of value addition on income.

Gross margins

Income is a key dependent variable for objective three. This was estimated using gross margins which were calculated as the difference between gross revenue and total variable costs. The value of output was determined by measuring the actual output produced by each farmer group in the 2015/2016 cropping season and multiplied by the market price. The variable costs were captured as variable inputs used for each enterprise. These included seeds, chemicals, fertiliser, packaging material, transport and labour among others.

CHAPTER FOUR
RESULTS AND DISCUSSION

This chapter is divided into four sections. Descriptive results comprising of group and institutional characteristics are discussed in section one. The second section discusses descriptive results of the type of value addition techniques practiced by the beneficiaries and non-beneficiaries of DED. Empirical results of probit and propensity score matching models are discussed in the third and fourth section, respectively.

4.1 Descriptive statistics

4.1.1 Group characteristics

Table 2 presents results on the number of members, gender composition, affiliation to organisation and registration status of the farmer groups in percentages. The mean number of members was 31.21 and 51.6 for the beneficiaries and non-beneficiaries respectively. The sense in the results is that having a large number of group members increased the probability of benefiting from the program. A study by Poteete and Ostrom (2004) showed that there is no straightforward relationship between group size and prospects of collective action. However, the DED project did not consider the number of members in recruiting its beneficiaries. The economic activeness of the groups regardless of their group size in terms of members was of paramount importance. The number of members was statistically different ($p<0.05$), with benefiting from the program bearing a positive relationship. A large number of both the beneficiaries and non-beneficiaries (74% and 79% respectively) were located within Malomo. This was the project site.

The variable gender composition was statistically related with benefiting from the program at 10% significance level. Gender was made up of three categories, males only, females only and a combination. For the male only category 19% benefited from the program and 13% did not. More of the female-based groups (31%) also benefited from the program as compared to 13% who were non-beneficiaries. The majority of the groups were found under the mixed-gender category, with the beneficiaries having 50% and the non-beneficiaries, 74%. The results indicate that the preferred option to the majority of the farmers is to belong to mixed-gender groups as opposed to male only or female only gender groups. This is in agreement with the findings by Tallam *et al.* (2016) whose results indicated that farmers would choose to form mixed-gender groups as opposed to single gender groups. Gender is currently a focus point in most development projects including agricultural and rural development. Women are

being incorporated into development projects because they make vital contributions to agriculture both in developing and developed countries (Lambrecht *et al*., 2014).

Table 2: Number of members, gender, affiliation and registration

	Program beneficiary			
Variable	**Beneficiary**	**Non-beneficiary**	**t-value**	**p-value**
Number of members (mean)	31.21	51.63	2.339	0.021**
			χ^2 **value**	
Location (%)			0.292	0.589
Malomo	74	79		
Outside Malomo	26	21		
Gender composition (%)			5.774	0.056*
Males only	19	13		
Females only	31	13		
Mixed-gender	50	74		
Affiliation to organisation (%)			3.330	0.068*
Yes	100	95		
No	0	5		
Formal registration (%)			0.422	0.516
Yes	11	16		
No	89	84		

Note: ***, **** indicate significant at 10% and 5%.

All the beneficiary groups were affiliated to at least one organisation representing 100% affiliation while 5% of the non-beneficiaries indicated no affiliation. Affiliation to an organisation was found to be significantly related to participating in the program at 10%. Being beneficiaries of the project, the farmer group were automatically connected to this organisation. According to Tallam *et al*. (2016) farmer groups with affiliation have access to more services and enhanced social network as compared to those with no affiliation. This is because these partners play different roles such as capacity building in the form of trainings, in-kind support such as provision of inputs and financial support provided as credit or grants.

The non-beneficiaries had a greater percentage (16%) of the groups that were formally registered by the government as compared to the beneficiary groups (11%). Registration status was found not to have any relationship with joining the program. The expectation is that benefiting from the group should enhance registration of the groups. However, in Ntchisi district, the DED project did not facilitate the registration of groups into either cooperatives or associations. The project focused on strengthening the groups that already existed. The registration of the existing groups was done mainly with the help of government extension officers. In the rural areas, informal farmer organisations, also termed as traditional organisations have a function of self-reliance to build social capital and facilitate collective action. This is done with the aim of dealing with uncertainties that go with agricultural production as well as building relationships within the groups (Thompson *et al*., 2009). Formal farmer organisations on the other hand bridges relationship gap between the famers and other stakeholders.

4.1.2 Institutional characteristics

Table 3 illustrates results on institutional traits being market distance, number of contact with extension officer, credit and training access. The mean market distance in kilometres for the beneficiary groups was less (3.12) than that of the non-beneficiaries (4.64). According to the results, positive relationship indicated that farmers who travelled longer distances to the market were more likely to benefit from the program with intention to benefit from enhanced market access thus reduced market distances. This implies that participating in the program improved the group's ability to have access to the market. One of the LED project component was Growth Centres Development. Under this component, market structures were constructed within the rural growth centres. Mujeri (2002) further concurs with this finding and states that this type of infrastructure reduces the costs of marketing of products from the rural areas due to ease of access and increases farm gate prices. In essence, infrastructure development is an important way of raising rural incomes.

The mean number of contact with extension officers for groups that benefited from the program was 6.56 while that of the non-beneficiaries was 3.00. The results were statistically significant at 10% indicating a negative relationship. The direction of the sign here bears meaningless interpretation. However, the logic is that participating in a program should increase with the frequency of farmers' contact with extension agents who are usually the carriers of the information let alone the project. Agricultural extension creates links between

available technology and farmer's practices through the provision of technical advice, information and training. In the absence of this, farmers would be limited in their ability to adopt new technologies (Oladele and Mabe, 2010).

Table 3: Market distance, number of contact, access to credit and access to training

		Program beneficiary			
Variables		**Beneficiary (62)**	**Non-beneficiary (38)**	**t-value**	**P-value**
Market distance (mean)		3.12	4.64	1.894	0.061*
Number of contact with extension (mean)		6.56	3.00	-6.974	0.000***
				χ^2 value	
Access to credit (%)				0.874	0.350
	Yes	84.00	76.00		
	No	16.00	24.00		
Access to trainings (%)				28.793	0.000***
	Yes	100.00	61.00		
	No	0.00	39.00		

Note: ***, ***** indicate significant at 10% and 1%.

About 84% of the beneficiary groups had access to credit in comparison to the 76% of the non-beneficiaries. Both the groups indicated rotating savings and loans as their source of credit. The project facilitated trainings on savings mobilisation for the beneficiary groups resulting in most of them resolving into sourcing credit through rotating savings and loans. This informal source of credit entails the revolution of social capital into economic capital. A framework is created enabling the farmer groups to mobilise savings from within themselves. The saved income is then invested into agricultural production or other business ventures. Farmers in the rural areas opt for informal financial mechanisms due to the absence of formal financial institutions within their localities. Mostly importantly, informal institutions do not require collateral and uses group membership as the requirement for access. As indicated by Ksoll (2016), the role of collective action as an institution has over time played an integral role in accelerating access to some institutions. Savings groups act as a substitute to existing informal financial networks, which provide more flexibility, transparency, and security.

Training enhances the adoption of new technologies. According to the study results, all the beneficiary groups had access to training as compared to only 61% non-beneficiary groups. The results indicated a positive relationship between training access and program participation at 1% significance level. According to Nhundu *et al.* (2015) farmers who received regular training had a higher probability of participating in a program. Mostly, farmer groups rely on services from government extension agents who are usually not sufficient due to limited resources. Agricultural extension is the most important means of reaching out to farmers in the rural areas most of which are hard to reach. The role of Non-governmental Organisations (NGOs) in complementing governments' efforts in delivery of agricultural extension services cannot be overemphasised. So is the case with the program under study, which was funded by NGOs but implemented by the government. Sustainable agricultural growth is dependent on effective agricultural extension services (Masangano *et al*., 2016).

4.2 Types of value addition techniques practiced by farmer groups

Value addition is a process of increasing economic value and consumer appeal of agricultural commodities with exceeded benefits of increasing farmer profits (Anderson and Hanselka, 2009; Lu and Dudensing, 2015). This is done through a diverse range of techniques designed to enhance quality and improve shelf life. Results in Table 4 show the value addition techniques practiced by the beneficiaries and non-beneficiaries of DED. The techniques included cleaning, grading, processing, packaging, and labelling.

A considerable number of the farmers were involved in cleaning as a value addition technique. For the beneficiaries 39% cleaned their product as compared to 16% of the non-beneficiaries. Majority of these had tomato production as their type of enterprise. Cleaning of products in the form of washing is considered as value addition since it enhances the quality of the produce. High quality products translate to value received for produce and lucrative marker access (Issa and Chrysostome, 2015). Cleaning involves the removal of unwanted substances such as soil and other impurities from the fresh commodities. This is done with a purpose of getting rid of harmful substances present in the soil or water during the growing phase. Water is commonly used as a cleaning agent and it is done soon after the commodity is harvested. Research has shown that majority of the farmers from developing countries rarely practice this technique (Arah *et al*., 2016). This may be attributed to the scarcity of water at

the production sites, less incentive to add the value due to competition and complete ignorance of the practice.

Table 4: Types of value addition techniques

Type of value addition		Beneficiaries (%)	Non-beneficiaries (%)
Cleaning			
	Yes	39	16
	No	61	84
Grading			
	Yes	63	47
	No	37	53
Processing			
	Yes	21	0
	No	79	100
Packaging			
	Yes	23	3
	No	77	97
Labelling			
	Yes	21	0
	No	79	100

A considerable number of the farmer groups practiced grading as another value addition practise. About 63% of the beneficiaries and 47% of the non-beneficiaries graded their commodities. This practice cuts across the various types of enterprises in which the farmers were involved. Grading involves sorting the commodities based on physical characteristics such as colour, size and bruises. Grades and standards have immerged as important characteristics in a quest to meet consumers demand for quality and safety (Reardon *et al.*, 2001)

Cleaning and grading are seen to be the lower forms of value addition techniques since they require less inputs and low levels of technical competency. Processing, packaging and labelling on the other hand are considered to be advanced levels of value addition in the sense that they demand more inputs and a much higher level of technical know-how. This is evidenced by low levels of participation in these value addition techniques by both beneficiaries and non-beneficiaries. One of the objectives of the DED project was to boost the businesses of the beneficiaries through value addition. This was achieved through the provision of value addition trainings, equipment and construction of processing facilities.

About 21% of the beneficiaries were involved in processing while none of the non-beneficiary groups was engaged in either in this value addition technique. Processing of agricultural commodities is a process of transforming the raw ingredients into other forms. Raw ingredients are changed into marketable food products that can easily be used by the consumer. The processed products were cooking oil, tomato jam and honey. Cooking oil is a valued commodity for cooking in that it provides energy and flavour (Mhazo *et al*., 2012). Oil expression was done using motorised systems which is considered to be a medium-scale level as opposed to manual ram presses. In cases where oil was being extracted from sunflower, the oil machines also produced cake as a by-product used to produce animal feed.

Tomato is one of the commonly produced vegetable crop in Malomo. It has a limited shelf life due to its level of perishability. The product tends to be plenty with a lot of wastage during its production season and becomes very scarce and expensive during its off-season. As is the case with most small scale tomato producers, smallholder farmers in Malomo experienced losses due its short shelf life (Adegbola *et al*., 2012). This can be attributed to the farmers' incapability to process and preserve the product due to lack of expertise and processing equipment. Preparation of tomato jam involved sorting, boiling, mashing, and pasteurisation.

Beekeeping is also among the traditional economic activity being practised among the farmer groups in Malomo. Most of the honey produced by the small-scale farmers was sold either in crude or semi-refined form. With the initiative from the DED project through the provision of superior hives efficient in honey production, the beneficiary groups involved in this enterprise had better quality honey. Through trainings, the farmers processed and packaged the honey by themselves.

Packaging was also among the techniques being practiced by the farmer groups. For the beneficiaries, 23% did packaging and Only 3% of the non-beneficiary groups were involved in this technique. In order to ensure safe handling and delivery of fresh and processed products, packaging becomes an essential component within the food system (Opara and Mditshwa, 2013). Initially, packaging was done to prevent the food from being in contact with foreign substances. Recently, packaging of products is being driven by consumer demand for food quality. For the beneficiaries of DED, packaging of the processed products was done using plastic bottles. Plastic materials enable consumers to assess the product

before purchase due to its transparency. However, glass containers are preferred due to their odourless and chemically inert property (Marsh and Bugusu, 2007).

Packaging goes hand in hand with labelling. Again, only 21% of the beneficiaries labelled their products while none of the non-beneficiaries were involved in this practice. Labelling is a way of displaying information about a product on its container, packaging or the product itself. A label performs promotional and informational functions and is designed to offer adequate information about the content in the package (Santini *et al*., 2013). However, in most cases, farmers in the rural areas, only manage to come up with a basic label with no information on nutritional content, open freshness or product's use. This reduces their competitiveness on the global market due to low acceptability of the products by the consumers.

4.3 Factors influencing the decision to engage in value addition

Table 5 presents maximum likelihood estimates of probit model regression results used to determine factors influencing the decision to engage in value addition among beneficiary and non-beneficiary groups of DED. The enterprises considered were groundnuts, honey and tomato. The log likelihood for the fitted model of -34.341 and p-value of 0.000 indicted that at least one of the regression coefficients was not equal to zero. Variables; location, animal farming, program participation, number of enterprises and gender categories were statistically significant in influencing the decision to engage in value addition.

Location was statistically significant at 10% significance level. Being located in Malomo rural growth centre increased the likelihood of the group to engage in value addition by 35%. This could be because Malomo was a project site, which provided the groups located within it a chance to benefit from the value addition activities promoted by the project. Furthermore, the rural growth centre provided the groups located in Malomo access to a reliable market. Being located outside Malomo might have hampered the non-beneficiaries from participating in value addition activities. Transaction costs would be relatively higher as compared to their counterparts due to increased transportation costs hence lowering their product competitiveness. Selling within their localities would lead to low profits owing to insufficient markets. Kaguongo *et al.* (2012) found out that location had an effect on adoption and intensity of adoption of an intervention.

Table 5: Factors influencing the decision to engage in value addition

Variable	dy/dx	Std. Error	P-value
Access to credit	-0.033	0.155	0.831
Access to extension (number of contact)	-0.002	0.026	0.953
Distance to the market	0.004	0.013	0.751
Location	0.346	0.183	0.059*
Crop farming dummy	0.252	0.279	0.367
Animal farming dummy	-0.77	0.095	0.000***
Program participation	0.605	0.15	0.000***
Number of enterprises	-0.146	0.046	0.002***
Training in value addition	0.193	0.126	0.126
Training in production	0.118	0.108	0.274
Male only dummy	-0.466	0.155	0.003***
Female only dummy	-0.428	0.172	0.013**
Number of observations = 100			
Wald $chi^2_{(12)} = 48.15$			
Pseudo $R^2 = 0.464$			
Log likelihood = -34.340801			
Prob > $chi^2 = 0.000$			

Note: *, **, *** indicate significant at 10%, 5% and 1% level.

Practicing animal farming reduced the probability of engaging in value addition activities by 77%. This was significant at 1% significance level. In the livestock value chain, local farmers transact at farm level with minimal volumes. Terminal markets have been left to big traders and butchers who process the live animals into meat products as demanded by the consumers. Livestock farmers face a number of market related constraints that prevent them from participating in terminal markets. These include poor infrastructure, high transaction costs and lack of information (Musemwa *et al*., 2008). Changes in the supply chain of the agricultural products pose challenges to smallholder farmers since high-value agricultural products attract increased cost of production coupled with greater production and marketing risk (Gulati *et al*., 2005). In the quest to enhance market participation level of the smallholder livestock farmers, infrastructure as well as institutional arrangements needs to be improved in order to guarantee wide-ranging, competitive and functional markets. This would be achieved

through improving the famers' capacity in terms of cooperation (Zuwarimwe and Mbaai, 2015).

Participating in the DED program increased the probability of a group to engage in value addition activities by 61%. The influence of being a beneficiary on the choice of adding value was statistically significant at 1% significance level. Being a project beneficiary entails getting assistance inform of capacity enhancement required to address the problems faced by the rural community. Mbavai *et al*. (2015) argued that participating in agricultural activities organized by organisations aimed at promoting agricultural activities is fundamental to the adoption of new technologies. Findings by Kaguongo *et al*. (2012) indicated that programme beneficiaries were three time likely to adopt an intervention as opposed to the non-beneficiaries.

Increased number of enterprises reduced the group's probability of doing value addition by 15% at 1% significance level. An enterprise in this case is defined as a component of business that a group is undertaking. These results imply that as the number of enterprises increases, the group's likelihood to engage in value addition lessens. In agriculture, diversification strategy calls for complex management capacity and increases the cost of management per unit of output limiting local farmers from getting its benefits. Although enterprise diversification is seen as a risk management strategy, an increased number of enterprises have implications on specialisation. Specialization strategy is an accepted economic theory having widely held origins, particularly in agriculture (Edwin *et al*., 2013). Although it can be argued that specialisation leads to instability of cash flow, this can be cushioned through full exploitation of technologies and savings generation to be used during occurrences of uncertainties. Findings by Chaplin *et al*. (2003) indicated that adding value to raw agricultural commodities was poorly developed among the diversified activities. In most cases, farmers prefer to diversify into other farm activities rather than value added processing which is regarded as a high value commodity mix.

For the gender composition categories, the results showed that male only and female only groups reduced the probability of doing value addition by approximately 47% and 43% respectively. This was in reference to mixed-gender categories and was significant at 1% significance level for male only groups and 5% significance level for female only groups. The outcome can be explained with the reasoning that organisations with a greater gender equality in membership and participation contribute positively to organisation performance

due to improved member's collaboration as well as increased collective benefits and knowledge within the group (Kaaria *et al*., 2016). Gender is a social concept in reference to relations between and among sexes, based on their relative roles. For decades, men have been perceived as the real farmers as compared to women hence being qualified to receive a better share of both technical assistance and extension services. However, a critical view reveals that women are greatly involved in the production and handling of crops (Manfre *et al*., 2013). Women tend to be side lined as agricultural value chains become more formalised. Eliminating either of the two gender categories from the picture endangers the proper functionality of the agricultural value chain since both make significant contributions to its success

4.4 Estimation of propensity scores

The logistic regression model was applied to estimate the propensity score matching for participant and non-participant farmer groups. The participation propensity equation estimated by this model is presented in Table 6. The model portrays some of the factors behind the farmer groups' decision to engage in value addition. The dependent variable takes the value one if the group adds value to their commodities and zero otherwise. The results from the logit model are according to the chosen characteristics that capture all observable relevant differences between groups which added value and those who did not. These were used to generate propensity scores for matching. The statistics summary in this table shows that the model was statistically significant. The test for goodness of fit achieves a Pearson Chi-square with a high probability value. This then indicates that the probability of participation was adequately explained by the chosen observable characteristics.

Number of contact with extension agent was found to have a positive effect on participation and was significant at 5% significance level. This implies that participating in value addition increases the probability of having an increased level of contact with extension agents by about 5%. A similar study by (Wanyama *et al*., 2013) found out that number of contact with extension officers had a positive effect on adoption of peanut value addition in Kenya. In extension, farmer groups who accessed training on value addition had a high probability of participating in vale addition. The coefficient of training in value addition was positive and significant at 1% significant level. This indicates the importance of increased knowledge in influencing the decision to add value.

Table 6: Logit model predicting probability of participation

Variable	dy/dx	Std. Err.	P>z
Access to credit	0.091	0.182	0.616
Access to market (market distance)	-0.001	0.018	0.937
Access to extension (number of contact)	0.045	0.020	0.022**
Training in value addition	0.338	0.119	0.004***
Location	0.302	0.214	0.158
Training in production	0.120	0.131	0.358
Crop farming dummy	0.0763	0.287	0.791
Animal farming dummy	-0.766	0.086	0.000***
Number of enterprise	-0.129	0.049	0.008***
Male-only dummy	-0.342	0.186	0.066*
Female-only dummy	-0.239	0.172	0.164
Number observations = 100			
LR $chi^2_{(12)}$ = 27.57			
Pseudo R^2 = 0.3724			
Log likelihood = -40.233697			
Prob > chi^2 = 0.0038			

Note:*, **, *** = significant at 10%, 5% and 1% level respectively

On the other hand, owning solely an animal enterprise reduced the probability of engaging in value addition by 77% at 1% significant level. Livestock farmer groups in rural areas are unable to sell directly to wholesalers and retailers even in the local markets. Smallholder livestock producers normally sell live animals due to transaction costs associated with processing and transportation (IFAD, 2010). This is attributed to a number of challenges that include; lack of investment capital that would improve quality, lack of infrastructure, limited access to market-related information and lack of business management skills among others.

Each increase in number of enterprises owned by a group lessened the probability of adding value by 12%. Number of enterprise was significant at 1% significant level. The idea of diversification for SMEs has more to do with survival than profitability. With most smallholder farmers, owning a business has a significant contribution on social and economic identities of its owners (Amanor-Boadu, 2013). These then prefer to diversify into different

unrelated businesses (horizontal diversification) rather than venture into value addition activities of a product as an alternative business enterprise (vertical diversification).

Belonging to a group that comprised of a single gender category also reduced the probability of adding value by 35%. This can be associated with increased collaboration in gender specific responsibilities and tasks. Mixed gender groups benefit from the idea of working through cooperation rather than isolation with the aim of achieving equality. Having the two gender categories to work together allows them to address shared issues collectively in a creative manner (Heilman and Mayers, 2016).

4.4.1 Matching participants and comparison groups

Figure 4 depicts the resulting probability of participation and non-participation. The propensity cores ranged between 0.15 and 0.99 with the mean of 0.83 for the treated groups. For the control groups the propensity scores ranged between 0.00 and 0.93 with the mean of 0.29. Consequently, the application of the common support condition was necessary for impact estimations. From the results, the common support region lied between 0.15 and 0.99. Therefore, groups whose propensity scores were less than 0.15 and greater than 0.99 were not considered for the matching exercise.

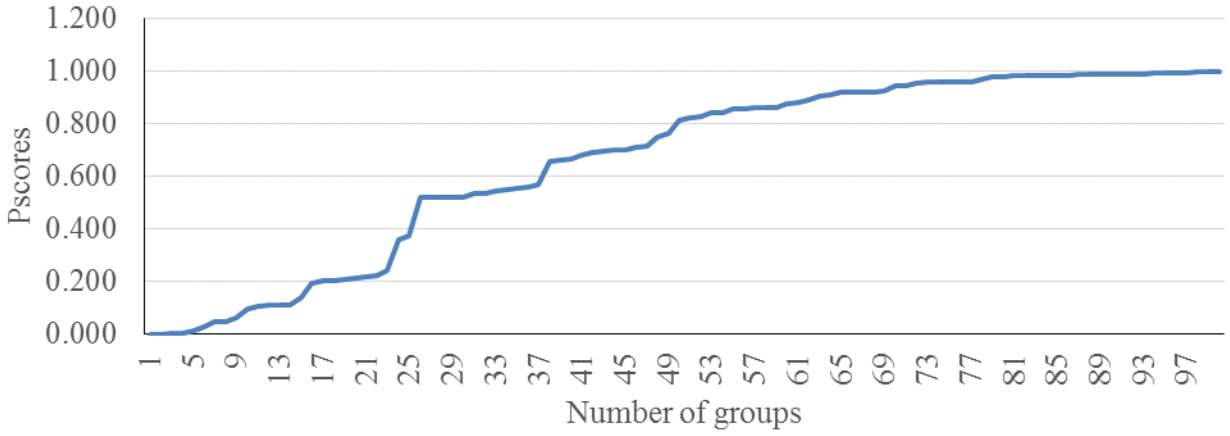

Figure 3: Propensity scores line graph for all groups

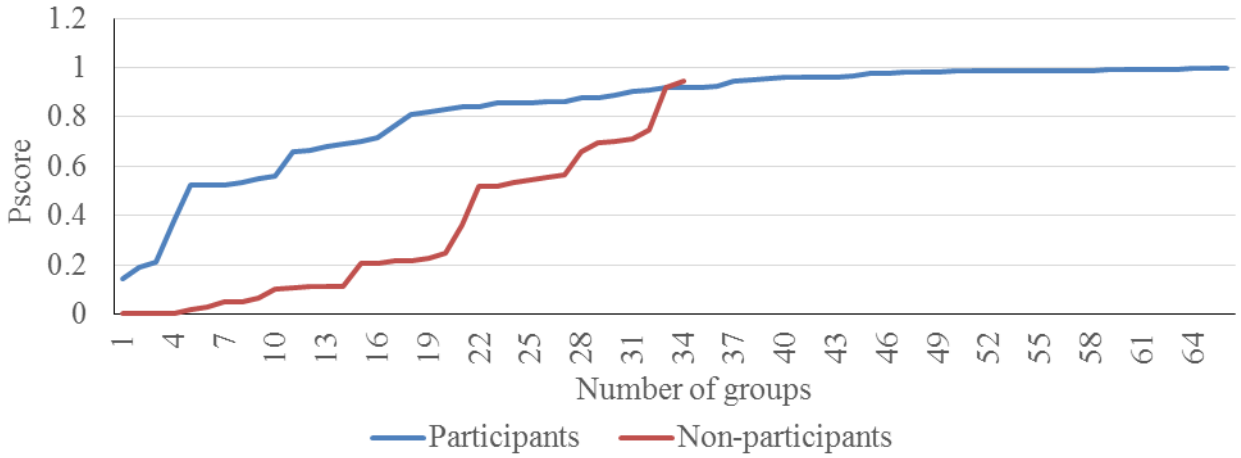

Figure 4: Propensity score line graph for participants and non-participants

4.4.2 Testing the balance of propensity score and covariates

The core purpose of the propensity score estimation is to balance the observed distribution of covariates across the groups of participants and non-participants. The quality of matching is assessed by performing tests that check whether the propensity score adequately balances characteristics between the treatment and control group units. A balance test for the balancing of the distribution of relevant covariates between participants and no-participants before and after matching was conducted. As recommended by Rosenbaum and Rubin (1985) a standardized difference of 20% or more should be viewed as large. The standardize mean difference for overall covariates used in the propensity score is reduced from about 36 before matching to 13 after matching. Table 7 shows the mean absolute standard bias as well as the t-tests before and after matching. The results indicate that there were statistically significant differences between the t-tests of the chosen variables before matching. The balancing of all observable variables between value adders and non-value adders was achieved after matching.

Table 7: Test for balance of propensity score and covariates

	Before matching (N=100)			After matching (N=92)		
		Mean			Mean	
Variable	**Treated**	**Control**	**T-test**	**Treated**	**Control**	**T-test**
Access to credit	0.833	0.765	0.82	0.833	0.800	0.25
Distance to the market	3.788	3.521	0.32	4.375	3.985	0.25
No of contact	5.470	4.706	0.26	4.778	4.550	0.80
Training in value addition	0.333	0.147	2.01**	0.139	0.150	-0.09
Location	1.288	1.147	1.57	1.167	1.150	0.13
Train in production	0.439	0.294	1.41	0.389	0.250	0.84
Crop farming dummy	0.803	0.647	1.71*	0.889	0.800	0.76
Animal farming dummy	0.015	0.324	-4.98***	0.028	0.150	-1.55
Number of enterprise	2.076	2.794	-2.70***	2.194	-0.360	2.35
Male-only dummy	0.152	0.206	-0.68	0.139	0.100	0.33
Female-only dummy	0.212	0.294	0.90	0.333	0.300	0.20

Note: *, **, *** indicate significant at 10%, 5% and 1% level respectively

The similarity in distribution of covariates X after matching was evidenced by a low pseudo R^2 that dropped from 46% to 11% after matching (Table 8). Furthermore, the p-values of the likelihood ratio tests indicate that the joint significance of the covariates was rejected after matching where as it was not the case before matching. The low pseudo R^2, low standardized bias and the insignificant p-values of the likelihood ratio test after matching shows that the specification of the propensity was effective in terms of balancing the distribution of covariates between the two groups.

Table 8: Chi-square test for joint significance of variables

Sample	Ps R2	LR chi2	P>chi2	Mean bias
Unmatched	0.464	59.53	0.000	36.4
Matched	0.112	5.79	0.926	13.5

4.4.3 Matching Algorithm: Estimation of Average Participation Effect (ATT)

Average treatment on treated (ATT) was calculated using the nearest neighbour, kernel and radius matching techniques. The control group for this analysis were the small-scale farmer groups who did not participate in value addition. The results obtained using the radius

matching were considered since it gave the largest treatment effect on the treated and produced balanced propensity score and covariates after matching. The results of the estimation of ATT are presented in Table 9.

Table 9: Estimation of Average Participation Effect (ATT): Matching Algorithms

Matching algorithm	Treated	Control	ATT	S.E.	t-value
Nearest neighbour matching	66	17	244.97	29.68	8.25
Stratification matching	64	22	244.27	21.82	11.20
Radius Matching	66	26	251.08	25.13	10.00

After controlling for all observables, the results indicate that there was a statistically significant difference on gross margin per unit between groups that participated in value addition and those which did not. Groups who were engaged in value addition activities had higher gross income compared to those who did not add value. The difference in gross margins between the two groups that came about due to value addition was MK251.08. The increase in gross income for groups which added value can be attributed to the extra effort the farmers applied on their produce. In a similar study by Umeh (2013) the results revealed that cassava value addition had a positive influence on the farm household income. Likewise Lawal *et al*. (2011) reported that there were significant differences in terms of income between farmers who added value to their cashew nuts and apples and those who did not. Other previous studies also came up with results which indicate positive impact of adoption of agricultural technologies (De Janvry and Sadoulet, 2002; Diagne *et al*., 2009; Wanyama *et al*., 2013; Winters *et al*., 1998; Umeh, 2013)

Value added products fetch a higher price as compared to those that are sold in raw form. This could explain why groups that practiced value addition were able to get higher gross margin per unit of the products sold as compared to their counterparts. The difference in the gross margins however was not much which could be explained by the fact that only 16% of the groups which added value were involved in higher forms of value addition such as processing. These managed to go this far because of the support provided by the intervention. The rest of the groups practiced the lower forms of value addition such as cleaning and grading. Changing the form of agricultural commodities through processing requires

processing equipment and facilities that the farmer groups would rarely have access to due to limited funds.

4.4.4 Sensitivity analysis with Rosenbaum bounds on probability values

Stata Mhbounds was applied to compute Mantel-Haenszel bounds to check sensitivity of estimated average treatment effects and critical hidden bias. The hidden bias comes in due to unobserved factors which influence the participation decision (Becker and Caliendo, 2007). Table 10 contains the test results. $\Gamma = 1$ indicates an absence of unobserved factors. The bounds were increased by 0.05 and the various levels of bounds indicates at which degree of unobserved positive or negative selection the effect would become significant. From the results the Q_mh+ and Q_mh- test statistic gave a similar result across all bound of odds assigned due to unobserved factors. The negative values of Q_mh+ therefore shows negative selection bias where farmer groups tend to have low gross margins, even with participation in value addition. The bias was however not significant at different bound levels in the case of overestimation and underestimation of the treated effect as indicated by P_mh + and P_mh- values. Result on the table further show that the study was insensitive to bias that would double or triple the odds of change in the level of gross margin per unit because of participation in value addition.

Table 10: Mantel-Haenszel (1959) Bounds for gross margins per unit

Gamma	Q_mh+	Q_mh-	p_mh+	p_mh-
1	.	.	.	.
1.05	-0.1797	-0.1797	0.5713	0.5713
1.1	.	.	.	.
1.15	-0.1797	.	0.5713	.
1.2	-0.1797	.	0.5713	.
1.25	.	-0.1797	.	0.5713
1.3	.	-0.1797	.	0.5713
1.35	.	-0.1797	.	0.5713
1.4	-0.1797	.	0.5713	.
1.45	-0.1797	.	0.5713	.
1.5	-0.1797	-0.1797	0.5713	0.5713
1.55	.	-0.1797	.	0.5713
1.6	.	.	.	.
1.65	-0.1797	.	0.5713	.
1.7	-0.1797	-0.1797	0.5713	0.5713
1.75	-0.1797	.	0.5713	.
1.8	.	-0.1797	.	0.5713
1.85	-0.1797	.	0.5713	.
1.9	-0.1797	-0.1797	0.5713	0.5713
1.95	-0.1797	.	0.5713	.
2	.	-0.1797	.	0.5713

CHAPTER FIVE

CONCLUSION AND RECCOMENDATIONS

5.1. Conclusion

The types of value addition techniques practised by the farmer groups were cleaning, grading, packaging, processing and labelling. Only the beneficiaries of DED were involved in the high levels of value addition which included processing and labelling with only a few of the non-beneficiaries taking part in packaging. On the factors that influenced the groups' decision to engage in value addition, being located in Malomo and participating in the project positively influenced the decision to add value. On the other hand, practicing animal farming, having an increased number of enterprises and belonging to a single gender group had a negative influence on the groups' decision to add value. Lastly, it was found that adding value to agricultural commodities (Honey, tomatoes and groundnuts) increased the gross margins of those involved. Farmer groups who added value to their products obtained higher gross margins per unit of a product than those who did not. The difference in the gross margins between the two groups that came about due to value addition was MK251.08.

5.2. Recommendations and policy implications

Strategies be put in place to enhance the farmers ability to engage in higher forms of value addition techniques. These may include creation of an enabling environment for credit access by the farmers which can be invested in value addition equipment and facilities. Another way would be to build the capacity of the farmer groups through training on value addition. Furthermore, to enhance the farmers' product competitiveness on both the local and global market there is a need for product certification. Therefore, a policy provision of affordable product certification process would assist the farmers to attain this with ease.

Efforts should be made by all stakeholders to boost provision of agricultural extension services which leads to an increase in the adoption rate of value addition activities among the farmers. Additionally, there is a need to sensitise farmers on the benefits of engaging on value addition as a way of diversification rather than being involved in a series of unrelated enterprises which causes then to be at a loss owing to insufficient management capacity. Promotion of groups with more gender equality should be encouraged for farmers to reap off the benefits that come with enhanced collaboration of ideas and efforts from both gender groups, which improves performance, as well as decision making capacity.

Value added agriculture should be promoted as one of the strategies for improving the socio-economic wellbeing of smallholder farmers through increased income. Planned initiatives need to focus more on adding value to the raw commodities.

5.3. Suggestions for further research

While this research only covered the effect of value addition on income of the farmer groups, further research can be conducted to establish the effect of value addition on the welfare of individual farmers. Additionally, the study focussed on specific issues and did not examine the aspects of DED project in a holistic manner. Therefore, further research can also be conducted to determine the effect of DED on productivity as well as commercialisation.

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APPENDICES

Appendix 1: Questionnaire

Introduction

This study is conducted to find out the effect of value addition on income among DED beneficiary groups in Ntchisi District, Malawi. The information to be provided hereunder will be used purposely for this research &will be treated as confidential.

Questionnaire identification

Questionnaire Number …….

Location……

Name of farmer group……..

Name of enumerator…….

Date……...

1.0. PERSONAL DATA FOR RESPONDENTS

1.1. Name of the respondent(s)……

1.2. Position in the farmer group

[1]	Chairman	[ ]
[2]	Secretary	[ ]
[3]	Treasure	[ ]
[4]	Member	[ ]
[5]	Other (specify)……..	[ ]

2.0. FARMER GROUP CHARACTERISTICS

2.1. How many members does the group have?

……

2.2. What is the gender composition of the members (in percentages)

[1] Male ……

[2] Female ……

2.3. Where is the group located?

[1] Malomo [ ]

[0] Outside Malomo [ ]

2.4. Are you affiliated to any organisation?

[1] Yes [ ]

[0] No [ ]

2.5. If yes, to which category does it belong?

[1] Government [ ]

[2] Non-Governmental Organisation [ ]

[3] Commercial organisation [ ]

[4] Other (specify)…… [ ]

2.6. Is the group registered?

[1] Yes [ ]

[0] No [ ]

2.7. If yes, which year was it registered? .....

3.0. INSTITUTIONAL FACTORS

3.1. Does the group have access to formal/informal credit

[1] Yes [ ]

[0] No [ ]

3.1.1. If yes, which sources of credit do you access from?

[1] Banks [ ]

[2] Money lenders [ ]

[3] Traders [ ]

[4] Intermediaries [ ]

[5] Rotating savings &credit [ ]

[6] Others, specify [ ]

3.2. Do you sell your produce to the market?

[1] Yes [ ]

[0] No [ ]

3.2.1. What is the distance to the nearest market? ..... (Kilometres)

3.3. Did you have any contact with an extension officer during the last season?

[1] Yes [ ]

[0] No [ ]

3.3.1. If yes, how many contacts did you have? ……

3.4. Have you ever been trained on any subject matter before?

[1] Yes [ ]

[0] No [ ]

3.4.1. If yes, what type of training was it?

[1] Value addition [ ]

[2] Market research [ ]

[3] Financial management [ ]

[4] Business plan development [ ]

[5] Record keeping [ ]

[6] Savings mobilisation (VSL) [ ]

[7] Production [ ]

[8] Water conservation [ ]

[9] Others, specify…… [ ]

4.0. VALUE ADDITION INFORMATION

4.1. Which type of enterprise do you handle in your business (main)?

.....

4.2. How many enterprises does the group operate?

.....

4.3. Do you add value to your products? [1] Yes [0] No

4.4. If yes, what is the motive?

…….....

4.5. If no, why?

……..……...

4.6. What forms of value addition do you carry out on your commodity

[1]	Cleaning	[ ]
[2]	Grading	[ ]
[3]	Processing	[ ]
[4]	Packaging	[ ]
[5]	Labelling	[ ]
[6]	Branding	[ ]
[7]	Specifications	[ ]
[8]	Other (specify)……..	[ ]

GROSS MARGINS

Please give me the following details about your enterprise (tomato/ honey/groundnuts) for the year 2016

(a) Income

Product	**Quantity**	**Price per unit**	**Total Value**

(a) Variable costs

Resource/Inputs/labour	**Quantity used**	**Cost per unit**	**Total Costs**
Seed			
Fertiliser			
Pesticides			
Herbicides			
Manure			
Sacks			
Transport			
Casual Labour			
L&clearing			
Planting			
Harvesting			
Weeding			
Fertiliser application			
Spraying			
Others			
Total variable costs			

Appendix 2: A test for multicollinearity using Variance Inflation Factor

```
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
crop_farm_~y |      3.73    0.268320
animal_far~y |      2.26    0.443422
 Beneficiary |      2.17    0.460190
Train_Valu~d |      1.75    0.570096
 NoOfContact |      1.58    0.631816
    Location |      1.42    0.706556
     Num_Ent |      1.33    0.749650
MarketDist~e |      1.28    0.781378
male_only_~y |      1.28    0.781439
female_onl~y |      1.27    0.788259
   CreditACC |      1.21    0.824257
Train_Prod~n |      1.21    0.825393
-------------+----------------------
    Mean VIF |      1.71

.
```

Appendix 3: Probit model results

Probit regression

Number of obs	=	100
Wald chi2(12)	=	48.15
Prob > chi2	=	0.0000
Pseudo R2	=	0.4643

Log pseudolikelihood = -34.340801

ValueAddition	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
CreditACC	-.1042106	.5031975	-0.21	0.836	-1.09046	.8820383
MarketDistance	.0129603	.0409018	0.32	0.751	-.0672057	.0931263
NoOfContact	-.0048036	.0817114	-0.06	0.953	-.164955	.1553478
Train_Value_add	.6705873	.5106438	1.31	0.189	-.3302562	1.671431
Location	1.06913	.5888822	1.82	0.069	-.0850576	2.223318
Train_Production	.3749349	.3456592	1.08	0.278	-.3025446	1.052414
crop_farm_dummy	.7159576	.762738	0.94	0.348	-.7789814	2.210897
animal_farm_dummy	-2.519857	.6783136	-3.71	0.000	-3.849327	-1.190387
Beneficiary	1.855879	.5409178	3.43	0.001	.7957	2.916059
Num_Ent	-.4500359	.1453812	-3.10	0.002	-.7349777	-.1650941
male_only_dummy	-1.275129	.4367523	-2.92	0.004	-2.131148	-.4191103
female_only_dummy	-1.195952	.4923916	-2.43	0.015	-2.161022	-.2308819
_cons	-.7830225	1.360351	-0.58	0.565	-3.449262	1.883217

```
.
. mfx

Marginal effects after probit
      y  = Pr(ValueAddition) (predict)
         =  .74079761
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
Credit~C*	-.0330266	.15519	-0.21	0.831	-.337201	.271147	.81
Market~e	.0041972	.01324	0.32	0.751	-.021756	.03015	3.697
NoOfCo~t	-.0015556	.02648	-0.06	0.953	-.053455	.050343	5.21
Train_~d*	.1929386	.12594	1.53	0.126	-.053902	.439779	.27
Location	.346239	.18305	1.89	0.059	-.012534	.705013	1.24
Train_~n*	.1177663	.10772	1.09	0.274	-.093363	.328895	.39
crop_f~y*	.2519217	.27929	0.90	0.367	-.295485	.799328	.75
animal~y*	-.7704696	.0951	-8.10	0.000	-.956866	-.584074	.12
Benefi~y*	.6048228	.14964	4.04	0.000	.311535	.898111	.62
Num_Ent	-.1457446	.04599	-3.17	0.002	-.235876	-.055613	2.32
male_o~y*	-.4658474	.15453	-3.01	0.003	-.768711	-.162984	.17
female~y*	-.4283171	.17168	-2.49	0.013	-.7648	-.091835	.24

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Appendix 4: Propensity score matching model results

Logistic regression — Number of obs = 100; LR chi2(11) = 47.74; Prob > chi2 = 0.0000; Log likelihood = -40.233697; Pseudo R2 = 0.3724

ValueAddition	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
CreditACC	.4372753	.8136911	0.54	0.591	-1.15753	2.032081
MarketDistance	-.0072059	.0762878	-0.09	0.925	-.1567272	.1423154
NoOfContact	.2275982	.1179922	1.93	0.054	-.0036623	.4588588
Train_Value_add	2.246372	1.009174	2.23	0.026	.2684283	4.224316
Location	1.532239	.9576097	1.60	0.110	-.3446413	3.40912
Train_Production	.6322002	.7415273	0.85	0.394	-.8211665	2.085567
crop_farm_dummy	.3713665	1.399207	0.27	0.791	-2.371028	3.113761
animal_farm_dummy	-4.373578	1.6494	-2.65	0.008	-7.606342	-1.140813
Num_Ent	-.6539783	.2503597	-2.61	0.009	-1.144674	-.1632823
male_only_dummy	-1.508582	.807792	-1.87	0.062	-3.091825	.0746613
female_only_dummy	-1.098617	.748826	-1.47	0.142	-2.566289	.3690551
_cons	-.991506	2.342548	-0.42	0.672	-5.582815	3.599803

```
. mfx

Marginal effects after logit
      y  = Pr(ValueAddition) (predict)
         =  .72933039
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
Credit~C*	.0913329	.17768	0.51	0.607	-.25691	.439576	.81
Market~e	-.0014225	.01506	-0.09	0.925	-.030946	.028101	3.697
NoOfCo~t	.0449296	.02293	1.96	0.050	-.000019	.089879	5.21
Train_~d*	.3378272	.11255	3.00	0.003	.117228	.558426	.27
Location	.3024756	.18302	1.65	0.098	-.056233	.661184	1.24
Train_~n*	.1204717	.13668	0.88	0.378	-.147415	.388358	.39
crop_f~y*	.0762652	.29879	0.26	0.799	-.509353	.661883	.75
animal~y*	-.7656633	.11079	-6.91	0.000	-.982799	-.548527	.12
Num_Ent	-.1291003	.04973	-2.60	0.009	-.226565	-.031636	2.32
male_o~y*	-.3417555	.18543	-1.84	0.065	-.705183	.021672	.17
female~y*	-.2391558	.17092	-1.40	0.162	-.574145	.095834	.24

(*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. mhbounds GM_per_unit, gamma (1 (0.05)2)

Mantel-Haenszel (1959) bounds for variable GM_per_unit

Gamma          Q_mh+      Q_mh-      p_mh+      p_mh-
-------------------------------------------------
    1              .          .          .          .
 1.05       -.179699   -.179699   .571305   .571305
  1.1              .          .          .          .
 1.15       -.179699          .   .571305          .
  1.2       -.179699          .   .571305          .
 1.25              .   -.179699          .   .571305
  1.3              .   -.179699          .   .571305
 1.35              .   -.179699          .   .571305
  1.4       -.179699          .   .571305          .
 1.45       -.179699          .   .571305          .
  1.5       -.179699   -.179699   .571305   .571305
 1.55              .   -.179699          .   .571305
  1.6              .          .          .          .
 1.65       -.179699          .   .571305          .
  1.7       -.179699   -.179699   .571305   .571305
 1.75       -.179699          .   .571305          .
  1.8              .   -.179699          .   .571305
 1.85       -.179699          .   .571305          .
  1.9       -.179699   -.179699   .571305   .571305
 1.95       -.179699          .   .571305          .
    2              .   -.179699          .   .571305

Gamma : odds of differential assignment due to unobserved factors
Q_mh+ : Mantel-Haenszel statistic (assumption: overestimation of treatment effect)
Q_mh- : Mantel-Haenszel statistic (assumption: underestimation of treatment effect)
p_mh+ : significance level (assumption: overestimation of treatment effect)
```