COMMERCIALIZATION PATHWAYS AND THEIR IMPLICATIONS ON SMALLHOLDER RICE FARMERS' PRODUCTIVITY AND WELFARE IN MBARALI DISTRICT, TANZANIA

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ABSTRACT

Agricultural transformation from low productivity to commercial agriculture has been a policy of concern in Sub-Saharan African countries whose economies depend on agriculture. Different pathways to commercialization have been adopted, including smallholder commercialization, medium and large scale commercial agriculture while others have adopted inclusive commercialization. However, the existing literature is inconclusive on which pathway should be adopted particularly in Sub-Saharan Africa. This study aimed at evaluating the most effective commercialization pathway (smallholder or inclusive) and its impacts on productivity and welfare on smallholder rice farmers in the pathways versus rain-fed farmers in Mbarali District. The study used cross-sectional survey data collected from a sample of 256 farm households. The data was analysed using output and input commercialization indices (CCI and ICI) and propensity score matching. Results indicated that, the overall output commercialization was more than half of the produced rice (CCI=59%) but the use of improved inputs in the study area was low (ICI = 27%). The proportion of rice sold was higher in the inclusive pathway (80%) relative to smallholder pathway (70%) and rain-fed scheme (41%). Total factor productivity ranged between 1.17 - 1.21 and 0.98 – 1.02 in the smallholder and inclusive pathways respectively more than the in the rain-fed scheme. Farmers in the smallholder and inclusive pathways earned between 7.65 – 7.68 million and 5.42 – 5.48 million TShs respectively more than farmers in the rain-fed scheme. For dietary diversity score, food consumption score and value of assets, inclusive pathway was better-off relative to smallholder pathway and rain-fed farmers. Based on these findings, smallholder pathway was effective in rice total factor productivity and income earned while the inclusive pathway was most effective in commercialization and welfare improvement. Since each pathway has some positive impact relative to the other, both smallholder and inclusive pathways should be adopted to explore the synergies.

DECLARATION

I, FURAHA NDAKIJE RASHID, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor currently being submitted in any other institution.

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The declaration above is confirmed by:

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DEDICATION

This work is dedicated to my parents Mr. Ndakije Madaba Rashid and my mother Tatu Ramadhan Ndiyunze, who have always been the source of inspiration towards the completion of this study.

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LIST OF ABBREVIATIONS AND ACRONYMS

2SLS	Two Stage Least Square
APRA	Agricultural Policy Research in Africa
ASDP II	Agricultural Sector Development Program II
ATT	Average Treatment Effect on the Treated
BRN	Big Results Now
CAADP	Comprehensive African Agriculture Development Program
CCI	Crop Commercialization Index
CIA	Conditional Independence Assumption
FAO	Food and Agriculture Organization (of the United Nations)
FAOSTAT	Food and Agriculture Organization Statistics
FCC	Food Consumption Category
FCS	Food Consumption Score
Ha	Hectare
HDDS	Household Dietary Diversity Score
ICI	Input Commercialization Index
IV	Instrumental Variable
Kg	Kilogram
KM	Kernel Matching
LSAIs	Large Scale Agricultural Investments
MAMCOS	Madibira Agricultural and Marketing Cooperative Society
MPP	Marginal Physical Product
MT	Metric Ton
NAFCO	National Agricultural Food Company

NBS	National Bureau of Statistics
NNM	Nearest Neighbour Matching
OLS	Ordinary Least Square
PFP	Partial Factor Productivity
PSM	Propensity Score Matching
RCT	Rice Council of Tanzania
SAGCOT	Southern Agricultural Growth Corridor of Tanzania
SML	Inclusive Smallholder-Medium/Large scale pathway
SSA	Sub-Saharan Africa
TFP	Total Factor Productivity
Ton/ha	Ton per hectare
TShs	Tanzania Shillings
URT	United Republic of Tanzania
VMP	Value of the Marginal Product
WFP	World Food Program

CHAPTER ONE

1.0   INTRODUCTION

1.1   Background to the Study

Transforming the agricultural sector from low productivity to high productivity commercialization has been a critical policy of concern in most of Sub Saharan African (SSA) countries.

Agricultural sector plays a critical role in SSA since more than 70% of the population (about 904 million) live in rural areas, 43% live under poverty line of US $ 1.90 per day, 22% of the population are food insecure and over 75% of the poor are smallholders whose primary source of livelihood is agriculture (IFAD, 2012; Zhou *et al.,* 2013; World Bank, 2016). In Tanzania, 81% of the population live in rural areas where 31.3% are under poverty line relative to 15.8% in urban areas (MoFP-PED, 2019). The World Economic Forum (2015) estimated that, growth generated from agriculture is 2- 4 times more effective at reducing poverty than the growth in other sectors in SSA.

In Tanzania, agriculture is predominantly dominated by smallholder farmers where 91% of cultivated farms are considered to be small scale (up to 5ha) and account for about 80% of food production (Jayne *et al.,* 2016; URT, 2016). They are characterized by rain fed agriculture (95%), low technology, low use of improved inputs specifically fertilizer where farmers apply only 7 – 9kg of nutrients /ha which is very low relative to Malawi (27 kg), South Africa (53 kg) and China (279 kg) and far less than the 2006 Abuja declaration commitment of increasing fertilizer use to at least 50 kg nutrients/ha (Masso *et al.*, 2017; URT, 2016; Nkuba *et al.*, 2016).

This in turn has led to low productivity particularly in staple foods including rice whose average productivity is 2 tons/ha relative to global average of 4.3 tons/ha (Kirsten *et al.*, 2013; Zhou *et al.*, 2013). Similarly, despite the crucial role played by smallholder farmers in the sector, the sector's growth rate for the last decade remained stagnant at about 4.2 % which is below the CAADP development target that aimed at achieving a 6% agricultural growth rate per annum by 2015 (Keya and Rubaihayo, 2013; CAADP, 2014). As in other parts of SSA, Tanzania has encountered low improvement of cereal crops in terms of productivity. The noted increase in cereal production has been attributed to area expansion rather than an increase in production per unit area (URT, 2016).

To overcome this poor performance of the sector, transformation of the agricultural sector from smallholder subsistence to commercial oriented agriculture is inevitable (Kirsten *et al*., 2013). Agricultural commercialization is process by which subsistence/semi-subsistence oriented production is transformed into market oriented production through increased productivity and greater surplus that enhance the rise in output and input markets participation based on principles of profit maximization. (Von Braun, 1995; Pingali and Rosegrant, 1995). There are different pathways that agricultural commercialization can take.

Different scholars (Newsham *et al.,* 2018; Smalley, 2013; Oya, 2012; and Jayne *et al.,* 2014) have identified four pathways of commercialization: (i) Estate/plantation/large-scale commercial farming involving large land holding, growing a single cash crop, involves high mechanization and relies on hired labour. (ii) Out grower/contract farming – farmers produce and sell the output to a central buyer based on pre-agreed arrangements. (iii)

Medium-scale commercial agriculture – farmers with land holding ranging from 5 – 100 ha normally owned by urban- based investors and (iv) Smallholder pathway- owning less than 2 ha, rural, depend on family labour and sell surplus.

Each commercialization pathways leads into different local development impacts. Smallholder commercialization has been cited by scholars as a pivotal pathway towards increased productivity, food security and improved welfare since majority farmers are trapped into the process (Hailua *et al*., 2015; Osmani *et al*., 2015; Bellemare, 2012). Meanwhile, medium scale commercial farmers (5 – 100 ha) have also recently emerged in Sub Saharan Africa where the share of total farmland is estimated at about 20% in Kenya, 32% in Ghana, 39% in Tanzania and over 50% in Zambia (Jayne *et al*., 2016).

The rise of medium scale farming has been driven by an increase in interest in land by urban-based professionals financed by non-farm income. This pathway together with the large scale and contract farming can be the source of dynamism and technical change (Smalley, 2013) on one side and source of land scarcity, conflicts and food insecurity due to land acquisition from smallholder farmers on the other side (Jayne *et al*., 2016; Dancer and Tsikata, 2015).

In view of this paradox, during 2010, a multi-stakeholder initiative called the Southern Agricultural Growth Corridor of Tanzania (SAGCOT) was established as a pathway to commercialize agriculture in Tanzania (SAGCOT, 2013). This is an inclusive smallholder and commercial medium/ large scale agribusiness model, which aimed at increasing smallholders' productivity, income and welfare through adoption of modern technology (high-yielding seeds, fertilizer, machinery and good agronomic practices), improve access to inputs, extension services and markets by linking them with medium/large scale

commercial farmers (SAGCOT, 2013; West and Haug, 2017). Farmers' decisions to participate in either of the commercialization pathway depend on internal factors (household characteristics), external factors (business environment), farm factors and other support/institutions (Mariyono *et al*., 2017). This study aimed at evaluating the most effective commercialization pathway (smallholder or inclusive) and its impacts on productivity and welfare on smallholder rice farmers in the pathways versus rain-fed farmers in Mbarali District.

1.2   Problem Statement and Justification

Commercialization enhances trade efficiency through creating forward and backward linkages among economic agents (farmers, input suppliers, traders and consumers) through an increase in market participation (Poulton, 2017). This in turn leads to increased productivity, income, reduced poverty and ultimately welfare improvement (Hailua *et al*., 2015). However, despite the efforts made by the government of Tanzania to commercialize agriculture through the establishment of the SAGCOT smallholder-medium/large scale inclusive investment, crop productivity particularly for rice is still low on average at 2 tons/ha and 26.4% of rural farmers are still faced by basic needs poverty (URT, 2016; RCT, 2015; NBS, 2019).

Previous studies have mostly focused on determinants, levels, processes and outcomes of agricultural commercialization on employment, profitability, income and nutrition (Von Braun, 1995; Hailua *et al*., 2015; Okezie *et al*., 2012; Mitiku, 2014). In addition to that, Ochieng *et al.* (2016), conducted a study in Central African region on commercialization of food crops and farm productivity among smallholder farmers participating in an agricultural intervention. The study used partial factor productivity

(land productivity) which does not take into account other factors including labour, capital, managerial and physical factors. Similarly, a study by Carletto *et al.* (2017) in Uganda, Tanzania and Malawi showed that commercialization led to an improvement in nutrition.

Moreover, these studies did not take into consideration on which commercialization pathway should be adopted to overcome smallholder rice farmers' low productivity and welfare particularly in Tanzania. This study therefore aimed at addressing the gap on the commercialization pathway that should be adopted to bring about the desired improvement in productivity and welfare of the smallholder rice farmers in the study area.

1.3   Study Objectives

The general objective of this study was to examine the smallholder and medium/large scale commercialization pathways and their implications on smallholder rice farmers' productivity and welfare versus rain-fed farmers in Mbarali district. The major outcome of this study is to provide empirical evidence that will inform policy in Tanzania on the pathway that should be adopted to shape smallholder commercialization and livelihood. The study specific objectives were:-

i.   To determine the extent of smallholder rice commercialization in the area.

ii. To evaluate the impacts of smallholder and inclusive commercialization pathways on productivity of smallholder rice farmers in the pathways versus rain-fed farmers.

iii. To evaluate the impacts of smallholder and inclusive commercialization pathways on the welfare of smallholder rice farmers in the pathways versus rain-fed farmers.

1.4   Hypotheses

i.   The extent of commercialization has no impacts on the productivity of smallholder rice farmers.

ii.   The extent of commercialization has no impacts on the welfare of smallholder rice farmers.

1.5   Rationale of the Study

Improving smallholder agricultural productivity and access to both internal and external markets aiming at increasing welfare of farmers has been a matter of concern in Tanzania. Therefore, the findings from this study could be useful to policy makers in making informed decisions on which commercialization pathway to be adopted as a pathway out of the noted smallholder low productivity and welfare.

1.6   Scope of the Study

This study focused on two commercialization pathways (smallholder and inclusive smallholder-medium/large scale commercialization). The sampling frame of the study is smallholder rice farmers in Mbarali district, particularly in the selected wards (Madibira and Itamboleo wards).

1.7   Organization of the Study

The next sections are arranged as follows. Chapter two gives an analysis of literature relevant to this study, chapter three comprises the methodology that were used in this study. Chapter four gives the results and discussion while chapter five consists of conclusion and policy recommendations.

CHAPTER TWO

2.0   LITERATURE REVIEW

2.1   Theory of Agricultural Commercialization

The Agricultural commercialization theory asserts that commercialization is derived from the process by which subsistence/semi-subsistence oriented production is transformed into market oriented production through increased productivity and greater surplus that enhance the rise in output and input markets participation based on principles of profit maximization (Von Braun, 1995; Pingali and Rosegrant, 1995; Zhou *et al.*, 2013). This entails shifting from subsistence/semi-subsistence to primarily production for the market and smallholder farmers being complemented or replaced by medium or large scale farmers (Poulton, 2017).

It is indicated by share of production sold, share of land allocated to crops that are sold, quantity of inputs purchased and volume/value of production sold (Poulton, 2017). Several factors determine the extent of household commercialization including internal factors including resource endowments, experience, level of education, family size, off- farm income and external factors including institutions and infrastructure (Zhou *et al.*, 2013).

2.2   Theory of Production and the Concept of Welfare

In this study, the household is regarded as both a producer and consumer. From the theory of production, the main motive for a rational producer is profit maximization (Debertin, 2012). Similarly, the resource use efficiency derived from the ratio of total output to the resources employed is known as productivity. Productivity is either partial factor productivity (PFP) where output to a single input used is measured or total factor

productivity (TFP) involving one or more outputs to a bundle of inputs. Factors contributing to improved total factor productivity includes socio-economic, environmental and managerial factors (Anyaegbunam *et al*., 2012; Benzaquen, 2017).

Since TFP reflects the reality that output produced in agricultural sector is dependent on the interaction of several production factors, thus, it was used in this study. TFP was calculated as the return to factors of production expressed as the value of rice output to the value of inputs (land, labour and capital; where capital comprised of hiring costs of machinery used, seed, fertilizer, oxen and irrigation infrastructure costs).

Similarly, from the welfare theory, welfare means command on marketable and non-marketable goods and services reflected by the level of disposable income or consumption expenditure (Ravallion and Lokshin, 2001). This reveals an individuals' preference, utility and ultimately welfare. There are three aspects of welfare namely poverty, inequality and vulnerability (Ravallion and Lokshin, 2001). In this study, poverty was used as an indicator of welfare measured by expenditure on food and non-food goods and services, asset ownership and household income since they are likely to reflect if a household will remain poor in the future unlike income measures alone which has high variation due to under or over reporting (Wossen *et al*., 2017; URT, 2016).

2.3   Welfare Measures

2.3.1   Household dietary diversity score

Household dietary diversity score (HDDS) is the number of food groups consumed by the household over the preceding 24 hours before the survey (FAO, 2011). It is a qualitative measure that shows the economic ability of the household or an individual to have access

to a variety of food groups. The variable is used as a proxy to measure nutrient adequacy of an individual. It has also been evidenced that there is an association between an increase in dietary diversity, socio-economic status and household food security (Hatloy *et al*., 2000; Hoddinot and Yohannes, 2002). This study used a total of 11 food groups each assigned a weight of 1 as used in previous study (WFP, 2008).

These food groups included cereals/grains, root tubers, pulses, nuts and seeds, milk, meat, fish, vegetables, fruits, oil and fats, sugar and sugar sweetened beverages based on local study area context modified from 12 food groups used by FAO (2011). The score ranged between zero (not consumed a certain food group) to 11 (if consumed all the food groups). In this study, the HDDS was calculated based on last seven days before the survey instead of last 24 hours recall period proposed by FAO (2011). This gives an indicator of an individual habitual diet unlike the 24 hours recall period (Kennedy *et al*., 2018).

2.3.2   Food consumption score

Food consumption score (FCS) is a weighted frequency of food groups consumed by the household or an individual in a reference period (WFP, 2012). It captures the dietary quality and dietary quantity dimensions of food security (Wiesmann *et al*., 2009). It indicates availability, access and consumption of food variety at household level based on dietary diversity, food consumption frequency and nutritional importance of given food group (WFP, 2008). It is derived from the weighted frequency of eight food groups (main staples, pulses, vegetables, fruits, meat and fish, milk, oil and fats, sugar and sugar sweetened beverages each assigned a weight of 2, 3, 1, 1, 4, 4, 0.5 and 0.5 respectively based on nutritional density of each food group (WFP, 2008). It is given by;

$$FCS = \sum_{i=1}^{8} (b_i x_i) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (1)$$

Where "i" is the food group, b is the weight assigned to each food group based on nutritional importance and x is the frequency of consumption of food groups consumed in the last seven days before the survey. After calculating FCS, three household food consumption categories namely poor food consumption, borderline and acceptable consumption level were established.

Poor food consumption households are those with FCS ranging from 0 -21, borderline (21.5 – 35) and acceptable food consumption (>35) (WFP, 2008). Furthermore, for household that use oil and sugar almost each day, the food consumption categories ranges are further increased from 21 and 35 to 28 and 42 respectively (Ibid). Poor and borderline food consumption categories represent food insecure households and acceptable category represents food secure households.

2.4   Indicators of Agricultural Commercialization

Before examining the observed smallholder productivity and welfare outcomes of smallholder and medium/large scale commercialization pathways, it is crucial to confirm that the established initiatives (smallholder and Inclusive smallholder-medium/large scale pathways) have actually stimulated commercialization. This section reviews the indicators for measuring smallholder commercialization.

2.4.1   Share of production sold

This measures the percentage of the proportion of the crop output marketed. It is given by a crop commercialization index (CCI) expressed as:

CCI = [(Gross value of all crop sales)/(Gross value of all crop produced)] x 100 …..…(2)

It is a continuum of values ranging from 0 which indicates total subsistence while as the index approaches 100, this signifies a higher degree of commercialization (Strasberg *et al*., 1999; Carletto *et al*., 2017; Von Braun, 1995). This is a most widely used indicator though it has some weakness. The index does not make meaningful distinction between a farmer who produce 2 bags and sell all these two bags with the one who produces 40 bags and sell 20 of them. Based on the index, the first farmer with CCI of 100% would appear to be more commercialized than a second farmer with an index of 50%. Despite this weakness, the index is used since in practice, there are very few smallholder farmers   (at least at the lower levels of economic development) that sell all of their produce and similarly few large scale farms that do not sell most of their produce (Leavy and Polton, 2007; Poulton, 2017). Similarly, instead of using the physical output, the ratio of value of sold and total produced output was used to address the weakness of the index.

2.4.2   Share of land devoted to crops that are sold

This indicator of commercialization is based on classifying crops that are mostly produced for the market and those that are for home consumption. For market oriented crops, the increase in acreage allocated for a crop relative to other crops signifies the importance of the crop to the producer as a source of income (Poulton, 2017).

2.4.3   Quantity of inputs purchased

An increase in the use of inputs purchased from the market over time is one of the major indicator for commercialization since it enhances livelihood impacts for producers and the economy as a whole (Poulton, 2017). However, this should be used to complement other indicators and not used as a primary indicator since an increase in the use of purchased inputs could be promoted by external agencies while there is no already established

effective linkages to remunerative markets. Similarly, some households may purchase inputs using non-farm income including remittances with no intention of selling the produce to the market. It is given by an input commercialization index (Pingali and Rosegrant, 1995, Von Braun, 1995) expressed as:

ICI = [(Gross value of all purchased inputs) / (Gross value of all crops produced)] x 100

………………………………………………………………….………………. (3)

2.5 Review of the Impacts of Agricultural Commercialization on Smallholders

Agricultural commercialization particularly in Sub Saharan Africa has been debated as a pathway to economic growth, food security and poverty reduction. Some studies found that commercialization had positive spillovers in the form of increased market participation though input use and increased quantities of output sold, improved productivity, nutrition and income   (Hailua *et al*., 2015; Osmani *et al*., 2015; Kirui and Njiraini, 2013, Mitiku, 2014; Sebatta *et al*., 2014). It also creates forward and backward linkages of the rural economy with other sectors through increased marketed output and purchased inputs (Kirsten *et al*., 2013). Commercialized smallholder farmers in Zambia attained a yield of 3 tons/ha relative to 1 ton/ha for non-commercialized farmers (Chapoto *et al.,* 2012). However, agricultural commercialization may also lead to negative impacts including food insecurity due to diversion of resources from food to cash crop production creating overdependence on vicinity markets leading to unstable market prices (Jayne *et al*., 2016; Dancer and Tsikata, 2015).

2.6 Commercialization Pathways

Different regions in the World have adopted different models towards agricultural commercialization based on the strengths and weaknesses inherent in each model as well

as based on resource endowments. Some including the south East Asian region countries transformed the agrarian sector through smallholder commercialization during the period of green revolution in 1960s (Asfaw *et al*., 2012) while other countries including Brazil have succeeded through investing in large scale commercial farming - plantations and estates (Deininger and Byerleee, 2010). Other commercialization pathways that have been widely adopted particularly in SSA include out grower/contract farming and currently through the rise of medium scale commercial farming (Poulton, 2017).

Unlike South East Asia where smallholders stand as vital route in the transformation process brought by their efficiency in the use of resources including family labor, intensification, total factor productivity and production mediated to the market (Rigg *et al*., 2016), efforts that have been devoted to transform smallholder agriculture in SSA including the CAADP and in particular Kilimo Kwanza "Agriculture First" initiative in Tanzania have not led to expected impacts and the region still realizes production below its potential (Byerlee and Deininger, 2013). This can be explained by agronomic factors (low use of inputs, climate change, low tech-know how) and policy issues that are not mediated towards the market (market controls) and lack of clear focus to smallholder farmers in sub Saharan Africa (Van Donge *et al*., 2012).

It is argued that large scale agricultural investments-plantations and estates model (LSAIs) should then be the priority for poverty alleviation and economic growth (Otsuka, 2013), since they are the source of technology transfer, employment and produce towards the markets to eliminate constraints inherent to smallholder farmers (Kleemann, 2015). However, Smalley (2013) and Dancer and Tsikata (2015) argued that, plantations give low wage employment to few people while leaving the majority, affect local food production

through dispossession of land from smallholders as well as diverting labor from smallholders. Already, this has been proven in SSA where many LSAIs have failed to deliver the expected outcomes (Smalley, 2014).

Similarly, in recent years, medium scale commercial farming has also emerged as a pathway to commercialize agriculture in SSA (Jayne *et al*., 2016). The rise of medium scale farming has been driven by an increase in interest in land by urban based professionals financed by non-farm income. This pathway can be the source of dynamism and technical change on one side and source of land scarcity, conflicts and food insecurity due to land acquisition from smallholder farmers on the other hand (Jayne *et al*., 2016).

Due to inherent strengths and weaknesses observed in each commercialization model, to achieve the desired improvement in economic growth, productivity and welfare of the majority, inclusive investments where smallholders and large scale farmers share resources and reduces transaction costs in a win-win situation via out grower and contract farming to raise their productivity and sell more of their produce, is an indispensable pathway (Henley, 2012).

This results from spillover effects from large scale farmers to smallholders through access to high yield-enhancing inputs, credit, markets and non-price factors including training on good agronomic practices (GAPs) and technical assistance (Oya, 2012; Bellemare, 2012). For example, Adewumi (2013) argued that, there was an efficiency level of 90% on the frontier by farmers within inclusive investments as compared to less than 50% by farmers outside the investment after adoption of new technology in Nigeria.

Similarly, a study by Herrmann and Grote (2015) found a very strong positive per capita income of 140% and a negative poverty difference of (-40%) by making comparison to sugar cane out growers and non out growers in Malawi. Contrary to these positives of the model, the model is also argued to lead to social differentiation by including only top tiers of smallholders endowed with resources, leads also to food insecurity due to over reliance on cash crops rather than food crops (Smalley, 2013; Wang *et al*., 2014). The current available literature is still inconclusive on which model is suitable in bringing about the expected outcomes.

2.7   Rice production in Tanzania

In Tanzania, rice is the second most important food grain after maize and is a priority crop in the second Agricultural sector development Program (ASDP II), and in the Southern Agricultural Growth Corridor of Tanzania (SAGCOT), with annual consumption per capita of 25.4 kg (RCT, 2015). The rice sector is 90% dominated by smallholder farmers who produce both local varieties and some improved varieties including SARO 5 and NERICA 1,2,4,7. Employs about 1.5 – 2 million people in the country (RCT, 2015). Large scale rice farms play a limited role since they are limited in number.

Rice is mostly produced in lowland rain-fed system; others include an upcoming low land irrigated rice and upland rain-fed rice (RCT, 2015). About 25% of total rice produced in Tanzania comes from Mbeya (Mbarali and Kyela districts) and Morogoro (Kilombero, Mvomero and Ulanga districts) regions. Other producing areas include Mwanza, Shinyanga and Katavi regions while the rest of the country produce rice in small amounts (RCT, 2015).

Despite the potential for rice production in the country due to availability of irrigable land (29.4 million hectares), the sector is still faced with various challenges including over dependence on rainfall, inadequate financing and low productivity which is averaged at 2 ton/ha and the noted increase in production has been attributed to area expansion (RCT, 2015; URT, 2016) as shown in Fig. 1.
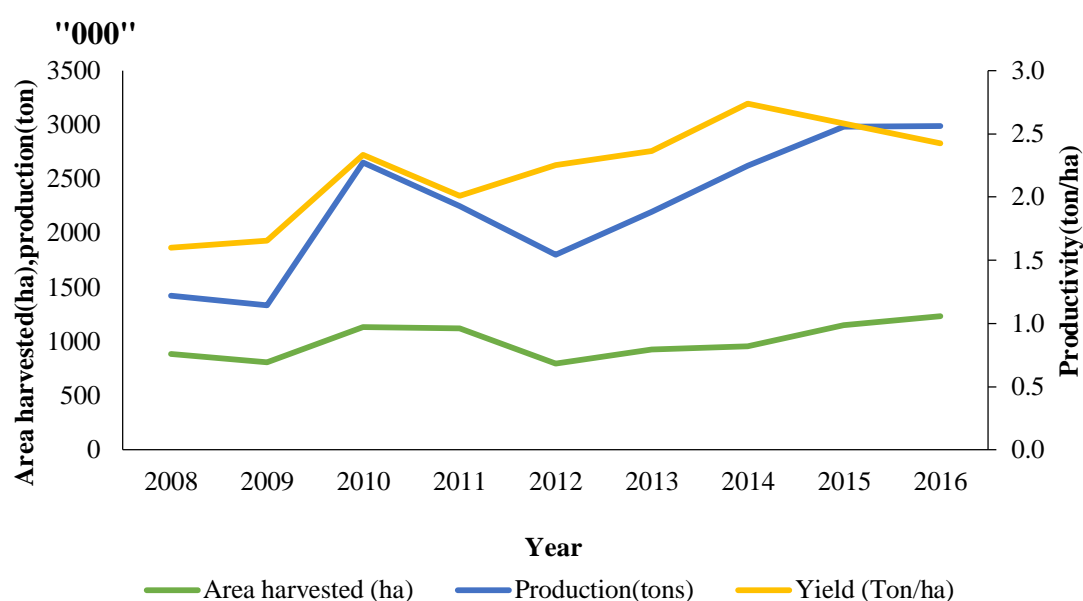
Source: FAOSTAT, 2017

Figure 1:   Rice production, harvested area and productivity trend in Tanzania (2008 - 2016)

Nonetheless, despite this poor performance of the rice sector, Tanzania is the largest rice producer in East African region and the fifth in Sub Saharan Africa. The sector experienced an annual growth rate estimated at 6% between 2000 and 2012 (FAOSTAT, 2017).

Table 1 below show the Tanzania rice production and productivity trend relative to other East African rice producing countries and some selected countries in the rest of the World from 2014 to 2016 production years.

Table 1:   Rice production and productivity in the selected countries from 2014 to

        2016

Country	Production ("00000" MT)			Productivity (ton/ha)		
	2014	2015	2016	2014	2015	2016
Bangladesh	523.3	512.8	525.9	4.60	4.50	4.60
Brazil	121.8	123.0	106.2	5.20	5.80	5.50
China	2082.4	2098.1	2110.9	6.81	6.89	6.93
Egypt	54.7	48.2	63.0	9.53	9.43	9.37
Ghana	6.04	6.4	6.9	2.70	2.75	2.82
Kenya	1.1	1.2	1.2	3.95	3.96	4.03
Madagascar	39.8	37.2	38.2	4.11	4.27	4.43
Uganda	2.4	2.4	2.5	2.49	2.49	2.53
Tanzania	26.2	29.8	29.9	2.74	2.58	2.43
Vietnam	449.7	451.1	434.4	5.75	5.76	5.58

Source: FAOSTAT, 2017

As can be noted from Table 1, Tanzania had the largest production relative to Kenya, and Uganda though has a relatively low productivity to that of Kenya. The largest producer in Africa is Egypt which experienced highest productivity with an average productivity of 9.4 ton/ha between 2014 and 2016. Other largest rice producers include China with an average productivity of 6.9 ton/ha, Brazil (5.5 ton/ha), Vietnam (5.7 ton/ha), Bangladesh (4.6 ton/ha) and Madagascar (4.3 ton/ha). This calls for strategies and efforts to strengthen and commercialize the sector in Tanzania.

2.8   Strategies Made By Tanzania to Commercialize the Rice Sub Sector

Given poor performance of the rice sub sector, Tanzania has put forward a number of strategies to modernize the sector. These strategies include the establishment of the National Rice Development Strategy in 2009 which aimed at enhancing the dissemination and adoption of modern farming practices (fertilizer application, high-yielding seeds,

plant spacing, the use of machinery, and other recommended agronomic practices) to smallholder farmers (Herrmann, 2017). It also aimed at doubling rice production in the country to 2 million tons by the year 2018 (RCT, 2015).

Similarly, in 2010, a multi-stakeholder initiative called the Southern Agricultural Growth Corridor of Tanzania (SAGCOT), a strategy to further fuel KILIMO kwanza initiative was established (SAGCOT, 2013). The two pathways under this study are found in the SAGCOT initiative. This aimed at linking smallholder farmers with commercial agribusinesses in an inclusive model comprising both medium/large scale and smallholder farmers so as to harness the spillover effects and synergies (Ibid). The corridor is divided into six clusters: Mbarali, Kilombero, Ihemi, Sumbawanga, Rufiji and Ludewa (SAGCOT, 2013).

A cluster is geographic agro-ecological zone with concentration of interconnected input suppliers, service providers and associated institutions (West and Haug, 2017). Among the identified clusters, Mbarali and Kilombero clusters are highly potential in rice production. Other strategies that were established to further improve the rice sub-sector include the second agricultural development program (ASDP II) and the phased out big results now (BRN) launched in 2018 and 2013 respectively of which rice is a priority crop in all the two strategies.

2.9   Linkage between Commercialization, Productivity and Welfare

Agricultural commercialization is driven by factors including population and urbanization (demand promoting factors), climate change (environmental factors) and policy (enabling factors). The decision of the household to commercialize is determined by both internal

factors (e.g resource endowment) and external factors (institutions, infrastructure, environmental etc.).

Participating in either of the commercialization pathway entails having access to production, market, financial and post- harvest services which leads into an increase in input and output market participation thereby transforming the sector and ultimately impacting on productivity and welfare as shown in Fig. 2.
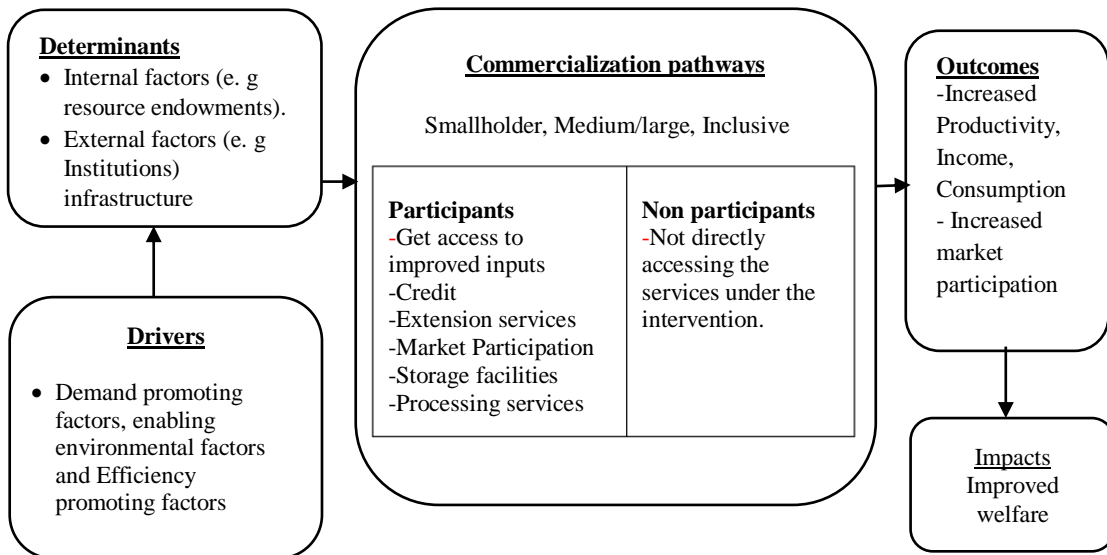
Source: Adapted from Zhou *et al.* (2013)

Figure 2:   Conceptual framework

CHAPTER THREE

3.0   METHODOLOGY

3.1   Study Area

The study was carried out in Madibira scheme – a smallholder commercialization pathway in Madibira ward where three villages (Mapogoro, Ikoga and Nyamakuyu) were selected. Furthermore, the study covered Kapunga scheme – an inclusive smallholder-Medium/large scale pathway located in Kapunga village and the rain-fed smallholder farmers located in Mbalino village both in Itamboleo ward of Mbarali district. These two pathways were compared, and they were also compared with rain-fed smallholder rice farmers as a reference group. The district is located at latitude 7^0 and 9^0 South of Equator and longitude 33.8^0 and 35^0 East of Greenwich. It lies within the Usangu basin which is potential for rice production and is characterized by extensive irrigated rice schemes consisting of both smallholder and medium/large scale farmers.
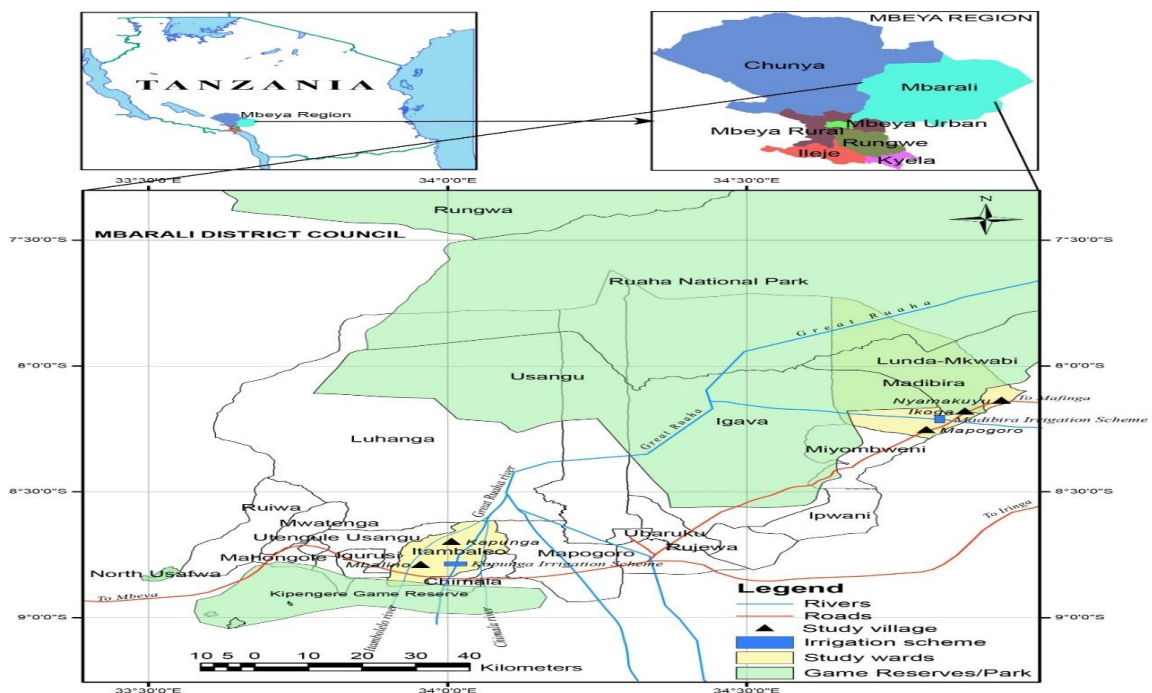
Source: Author

Figure 3:   Study Area

3.2   Population and Economic Activities

Based on the 2012 Tanzania population and housing census, Mbarali District had a total population of 300 517, of which 145 867 were males while 154 650 were females. The growth rate of the district population was estimated at 2.8% from which the current population is projected to be 354 673 (NBS, 2013).

The economy of Mbarali district depends on agriculture sector which employs over 80% of the inhabitants in the district. The major agricultural activities include crop production (paddy and sunflower) used mainly as cash crops; maize and beans used as food crops. They also engage in livestock keeping particularly cattle, goat and poultry rearing, trade, fishing as well as informal and formal employment activities.

The farming activities particularly paddy farming rely heavily on irrigation schemes which are widely scattered in the district. These includes among others the Madibira and Kapunga smallholder schemes covering a total area of 4 570 ha and 875 ha respectively, and Kapunga estate covering 3 200 ha among other schemes (Mbarali, 2014). The Kapunga smallholder farmers' scheme is located alongside the Kapunga estate owned by an investor after being privatized by the government.

Before privatization, the farm was owned by a parastatal company known as the National Agricultural Food Company (NAFCO). Besides the estate, there are also a number of medium scale farmers most of whom are urban dwellers as well as the study area inhabitants who interact with both smallholder and large scale farmer (Kapunga estate). The nature of interaction is on irrigation water use, tenant arrangements where smallholder and medium scale farmers use the investors' land to produce rice with pre-agreed

arrangements including selling part of the output to the investor. Through this interaction (Inclusive Small-medium/large scale) farming, the study sought to evaluate the impacts of this commercialization pathway (Inclusive pathway) as a result of spill -over effects relative to the Madibira smallholder pathway on smallholder rice farmer's productivity and welfare and versus the rain-fed smallholder farmers (baseline group).

3.3   Research Design

The study used quasi-experimental design, utilizing cross sectional survey data collected from rice farmers in Mbarali District in May/June 2018. Since participating in the smallholder and medium/large scale commercialization is voluntary, random allocation to treatment or control group is not possible (White and Sabarwal, 2014). Instead, a quasi – experimental approach where a comparison group that is similar as possible to the treatment group in terms of baseline (pre-treatment) characteristics was established.

The comparison group captures what would have been the outcome if the program/policy had not been implemented (Caliendo and Kopeining 2005). Thus, three groups consisting rice farmers surrounding the scheme but not participating/rainfed was used as a control/baseline (treatment 1), rice farmers participating in the Madibira smallholder commercialization pathway (treatment 2) and smallholder rice farmers in Kapunga inclusive small-medium/large scale pathway (treatment 3) were evaluated.

The rain-fed farmers used as a control group and Kapunga inclusive commercialization pathway are both found in Itamboleo ward where the latter group has access to irrigation facilities, access to inputs and training from the government and private agencies including MVIWATA(Tanzania network of famer groups) and USAID and are linked to the input

and output markets through the established cooperatives including the Kapunga agricultural marketing cooperative society (AMCOS) while the former group has no access to these facilities. Similarly, the Madibira smallholder pathway farmers found in Madibira ward have access to irrigation facilities which was financed by the government and World Bank. They have also access to input and output markets through the madibira agricultural marketing cooperative society.

3.4 Sampling Technique and Sample Size

The study used two stage probability sampling. At first, a random selection of wards producing rice in Mbarali cluster were selected. In this process, Itamboleo and Madibira Wards were selected. In this stage, a list of rice farmers participating in the Madibira smallholder rice commercialization pathway were established from the Madibira Agricultural and Marketing Cooperative (MAMCOS). Similarly, a list of smallholders participating in the Kapunga inclusive smallholder-medium/large scale farmers found in Itamboleo ward was considered in conjunction with the number of smallholder farmers practicing rain-fed agriculture.

Table 2:   Distribution of sample respondents

Pathways/scheme	Ward	Villages	No respondents	Percentage
Rain-fed farmers	Itamboleo	Mbalino	110	43.0
Inclusive pathway		Kapunga	56	21.9
Smallholder pathway	Madibira	Mapogoro	48	18.8
		Ikoga	25	9.8
		Nyamakuyu	17	6.5
Total			256	100

Source: Field Survey, May/June 2018

At the second stage, proportionate probability sampling was established based on strata that were identified. A total sample of 256 smallholder farmers were interviewed in this study of which 90 were farmers participating in the Madibira smallholder scheme, 110 were non-participating farmers and 56 were farmers in the Kapunga inclusive small-medium/large scale farmers which satisfies a condition for large sample properties where the sample size should be $\geq$30 (Kothari, 2004).

3.5 Analytical Framework

Objective 1: To Determine the Extent of Smallholder Rice Commercialization in the Area Following Von Braun (1995), this objective was addressed by the use of both crop (rice) output and input commercialization indices (CCI and ICI) as described below;-

$$\text{CCI}_i = \frac{\sum_{i=1}^{n} S_y}{\sum_{i=1}^{n} Q_y} * 100; Q_y \geq S_y; 0 \leq \text{CCI} \leq 100 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(4)}$$

Where CCI_i = Crop (rice) commercialization index of ith household growing rice, S_y = Value of rice sold in monetary terms and Q_y is the monetary value of total quantity of total rice produced where y ranges from 1, 2…..y_n Similarly, from input side, input commercialization index (ICI) is given by;

$$\text{ICI}_i = \frac{\sum_{i=1}^{n} M_x}{\sum_{i=1}^{n} Q_y} * 100; Q_y \geq M_x; 0 \leq \text{ICI} \leq 100 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(5)}$$

M_x is the gross value of crop inputs acquired from the market and Q_y is the gross value of total rice produced. With reference to the work by Strasberg *et al* (1999) and FAO (1989), households whose $\text{CCI}_i \geq$50% are commercial oriented, 25%$\leq \text{CCI}_i$ <50% are in transition and those with CCI_i < 25% are subsistence oriented.

Objective 2: To Evaluate the Impacts of Smallholder and Inclusive Commercialization Pathways on Productivity of Smallholder Rice Farmers in the pathways versus Rain-fed Farmers in the Study Area.

The decision to participate in either of the commercialization pathway is modelled using random utility framework (Becerril and Abdulai, 2010).

$$Z_i^* = \alpha + X_i\beta + \varepsilon \text{ With } Z_i = \begin{cases} 1 \ if \ Z_i^* > 1 \\ 0 \ Otherwise \end{cases} \text{..} (6)$$

Where z^* is a latent binary variable for participation, $Z_i = 1$ if a household participated in either of the pathway and $Z_i = 0$ if the household did not participate. The conventional approach commonly used to measure the impacts of an intervention in this case, participation in either of the commercialization pathway on smallholder rice farmers' productivity and welfare would be through the use of an Ordinary least square (OLS) comprising of a dummy variable given by;-

$$Y_i = \theta X_i + \beta Z_i + \mu_i \text{ ....} (7)$$

Where Y_i is the average outcome variable of household i, X_i is a vector of household socio-economic characteristics and Z_i is a dummy variable taking the value of 1 for participants and 0 for rain-fed/reference group.

However, the use of OLS in impact evaluation would yield biased estimates since the model assumes that participation in an intervention is exogenously determined while it is potentially endogenous (Herrmann and Grote, 2015; Ogutu *et al.,* 2014). This is because, assignment into treatment is not always random, but maybe due to purposive placement into the program or self –selection. This in turn leads to selection bias due to observed or unobserved heterogeneity in the sample (Ochieng *et al.,* 2016). The bias occurs when

unobserved factors influence both the error term and the outcome variable, resulting into biased estimates and overestimated effects (Ogutu *et al.,* 2014; Woodridge, 2010).

The main problem in impact evaluation of an observational study is establishing what would be the outcome of an intervention on the participants if they had not participated, in other words, the counterfactual (Li, 2013). To solve the problem, a counterfactual or comparison group was established through the use of propensity score matching (PSM) (Caliendo and Kopeining 2005) as an evaluation tool. Propensity score (P) is the conditional probability of being assigned to a particular treatment given a vector of observed covariates X_i to facilitate causal inference (Dehejia and Wahba, 2002; Woodridge, 2010). It is given by;-

$$P (X) = P (Z_i =1|X_{ij}) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(8)}$$

Where Z (0, 1) is an indicator for exposure to treatment and X_{ij} is a matrix of covariates influencing the outcome variable, in this case productivity. Following Rosenbaum and Rubin (1983), two binary logit models were used for both smallholder scheme and Inclusive Scheme using rain-fed rice farmers as control group to estimate the propensity scores P(X). The logit model (Gujarati, 2004) can be described as:-

$$\text{Let } P_i = E(Y = 1|X_i) = \frac{1}{1+e^{-X_i'\beta}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(9)}$$

Where P is the probability of participating in a commercialization pathway and Y is the outcome (productivity). The rain-fed/reference group is represented by (1 – P). Then, the logit equation is specified as;

$$\left(\frac{P_i}{1 - P_i}\right) = \frac{p(Z_i = 1|X_{ij})}{1 - p(Z_i = 1|X_{ij})} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(10)}$$

Applying natural logarithms on both sides gives,

$$\ln\left(\frac{P_i}{1-P_i}\right) = Z_i = \beta_0 + \sum_{j=1}^{k} \beta_i X_{ij} + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (11)$$

Where P is the propensity score, X_{ij} = is a matrix of observed values influencing participation and productivity based on economic theory and literature review, j is the response category and ε_i is the matrix of unobserved random effects. The model can further be specified as;

$$Z_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \ldots + \beta_7 X_7 + \delta_1 D_1 + \delta_2 D_2 + \ldots + \delta_5 D_5 \ldots\ldots\ldots\ldots\ (12)$$

Where X_1 is age of household head, X_2 is education level of household head, X_3 is the household size, X_4 is the farm size, X_5 is the distance to the market place, X_6 is off-farm income, X_7 is the net income from rice, and D_1, D_2, D_3, …. D_5 are dummies for sex, access to improved seed, access to extension services, access to market information, and producer/marketing organizational membership respectively.

Equation 11 can further be manipulated into the odds ratio given by;

$$\frac{P_i}{1-P_i} = exp\left(\beta_0 + \sum_{i=1}^{k} \beta_i X_{ij}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (13)$$

The response probabilities can be obtained by equation 14 given by,

$$P_i = \frac{\exp(\beta_0 + \sum_{i=1}^{k} \beta_i X_{ij})}{1 + \exp(\beta_0 + \sum_{i=1}^{k} \beta_i X_{ij})} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (14)$$

Equation 14 is intrinsically linear because the logit model is linear in X_i. It shows that the probability of participation in either of the commercialization pathway P lies between 1 and 0 and they vary non-linearly with X_i. The partial effects for continuous variables to account for the causal – effect can be calculated using quotient rule as;

$$\frac{\partial P_i}{\partial X_i} = P_i(1 - \text{P})\beta_j \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots . . \dots \dots (15)$$

The partial effects for discrete variables was calculated as the difference of mean probabilities estimated for the respective discrete variable.

Then, the estimated propensity scores were stratified into 6 blocks. According to Rosenbaum and Rubin (1983), at least 5 blocks can remove 90% of bias caused by raw comparison through covariate overlap. To ensure the strata balance; t-test, test for standardized bias, joint significant test and pseudo R^2 were used (appendix 3) as proposed by Li (2013) and Caliendo and Kopeinig (2005). Then, the covariates in each block were matched using the nearest neighbor matching (matching a treated farmer with a control group farmer with closest propensity score). It is a most straight forward estimator among other estimators. It is given by (Li, 2013):-

$$\text{ATT} = \frac{1}{N^T}\left(\sum_{i \in T} Y_i^T - \frac{1}{N^T}\sum_{j \in C} Y_j^C\right)\dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots . (16)$$

Where N^T and N^C represent number of cases in the treated and control groups while Y_i^T and Y_j^C represent the observational outcomes for case "i" in the matched treated group and case j in the matched control group. Furthermore, kernel matching estimator was used, this matches all treated units with weighted average of all controls to construct the counterfactual outcome. It leads to lower variance since more of the information is used. The kernel estimator is given by (Li, 2013):-

$$\text{ATT} = \frac{1}{N^T}\sum_{i \in T}\left\{Y_i^T - \sum_{j \in C} Y_j^C K\left(\frac{e_{j\,(x)} - e_{i\,(x)}}{h_n}\right)\Big/\sum_{k \in C}\frac{e_{k\,(x)} - e_{i\,(x)}}{h_n}\right\}\dots \dots \dots \dots \dots \dots \dots . \dots . \dots (17)$$

Where e_i (x) and e_j (x) denote propensity scores in the treated group and control group respectively, e_j (x) - e_i (x) is the distance of the propensity score, h_n is the bandwidth while K (.) is the weight function.

This was followed by estimating the average treatment effect on the treated (ATT) which is the average difference in outcome (productivity) between the matched control and the treated group as described in equations 18, 19 and 20 below (Hailua *et al*, 2015; Rosenbaum and Rubin, 1983; Li, 2013).Let Y_1 be the productivity when the household is subject to treatment (Z=1) and Y_0 be the same variable when the household did not receive treatment (Z=0), then the observed productivity outcome can be given by;

$$Y= ZY_1 + (1\text{-}Z) Y_0 \text{ .... (18)}$$

$$ATT = E (Y_1 - Y_0 \mid Z_i = 1) = E [E\{Y_1 - Y_0 | Z_i = 1, P(X)\}] \text{ .... (19)}$$

$$ATT = E[E\{Y_1 | Z_i = 1, P(X)\} - E\{Y_0 | Z_i = 0, P(X)\} | Z = 1] \text{ .... (20)}$$

Where, ATT is the average difference in productivity between smallholder rice farmers receiving treatment in the smallholder and inclusive commercialization project and those who do not, P(X) are the propensity scores, and Z_i is an indicator for treatment which equals 1 if individual received treatment and 0 otherwise. From equation 8, we can only observe the outcome variable of participants E ($Y_1 \mid Z_i = 1$), but we cannot observe the outcome of participants if they had not participated E ($Y_0 \mid Z_i = 1$).

Again, estimating P(X) requires the following two assumptions to be satisfied (Rosenbaum and Rubin, 1983): Conditional independence assumption (CIA) which states that "given a series of observed covariates (X's), commercialization is independent of potential outcomes (productivity and welfare) denoted by:

$$(Y_1, Y_0) \perp Z | X, \forall X$$

This assumption requires that the set of covariates must contain variables that jointly influence the outcome variable (productivity) and the treatment (commercialization). The second assumption is the common support/overlap condition that rules out the predictability of Z given X: $0 < P(Z=1|X) < 1$. It guarantee that farmers with the same X's have the probability of being included in the analysis and those falling outside the common support region are left out in the estimation of ATT (Li, 2013).

Objective 3: To Evaluate the Impacts of Smallholder and Inclusive Commercialization Pathways on Welfare of Smallholder Rice Farmers in the Pathways versus Rain-fed Farmers in the Study Area.

This objective was addressed as objective two above using propensity score matching. Welfare was measured by the use of food consumption score (FCS) and household dietary diversity score (HDDS), expenditure on education, access to health insurance, value of durable assets owned like farm implements, types of housing materials and income unlike previous studies (Amare *et al*, 2012; Asfaw *et al*, 2012) that have used single measure of welfare. Using a logit model;

$$\ln\left(\frac{P_i}{1-P_i}\right) = Z_i = \beta_0 + \sum_{j=1}^{k}\beta_i X_{ij} + \varepsilon_i \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (21)$$

Where, Z_i is a binary for participation in the smallholder and inclusive commercialization pathways, X_{ij} = is a matrix of observed household socio-economic characteristics influencing both participation in either of the commercialization pathway and welfare as used in objective two which were also employed in this objective given by:-

$$Z_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \dots + \beta_7 X_7 + \delta_1 D_1 + \delta_2 D_2 + \dots + \delta_5 D_5 \dots\dots\dots\dots\dots\dots (22)$$

Where X_1 is age of household head, X_2 is education level of household head, X_3 is the household size, X_4 is the farm size, X_5 is the distance to the market place, X_6 is off-farm

income, X_7 is the net income from rice, and D_1, D_2, D_3, …. D_5 are dummies for sex, access to improved seed, access to extension services, access to market information, and producer/marketing organizational membership respectively.

The household dietary diversity score and food consumption score measured by the number of food groups consumed and frequency of food group consumption for the last 7 days before the survey which reflects on food security and nutritional adequacy was estimated. Expenditure on education was measured in TShs spent on educational matters for the last 12 months; access to health insurance (whether the household had access to the community health fund or National health insurance fund and other facilities) for the last 12 months; and income measured by household annual total income from all income earning sources.

3.6   Validity and Robustness of the Estimation

The validity of the Propensity Score Matching (PSM) estimates relies on two criteria; (1) All the important pre-participation features which influence participation and outcome variables can be accounted for and (2) Participating households and rain-fed/reference group are similar in these characteristics (Dehejia and Wahba, 2002). However, the first criterion assumes that selection into an intervention is based only on observable characteristics, which in real practice is unlikely.

To account for the PSM weakness, instrumental variable (IV) was estimated as validity and robustness check. An instrumental variable is a variable that influences treatment (commercialization pathway) but does not directly affect the outcomes where it can only

affect the outcome through the treatment (Woodridge, 2010; Ochieng, 2016; Barrett *et al*, 2012).

Instrumental variable estimates account for both selection and endogeneity problems that are likely not to be eliminated by PSM (Barrett *et al*, 2012). Endogeneity problem arises from reverse causality of some variables that influence each other (example: Commercialization, productivity and income), omitted variables due to data unavailability and as a result of measurement error (Woodridge, 2010; Herrmann and Grote, 2015).

The IV estimator following (Woodridge, 2010) can be expressed as;-

$$\text{Consider } y = \alpha + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_K X_K + \varepsilon \text{ .... (23)}$$

$$E\,(\mu) = 0,\, \text{Cov}\,(X_i, \mu) = 0 \text{ and } j = 1, 2... \text{K- } 1$$

Where X_K used in this study as participation in commercialization pathway might be correlated with the error term μ; X_1, X_2... X_{K-1} are exogenous variables, X_K is potentially endogenous and β_K is the ATT. Then, an observable variable z_i called an "instrument" that was not included in equation 23 above was used to instrument X_K.

For the variable z_i to be used as an instrument, it must satisfy two conditions; (1) z_i is uncorrelated with the error term but correlated with X_K, i.e. cov $(z_i, \mu) = 0$ and (2) z_i does not directly affect the outcome y but the effect is through X_K (Caliendo and Kopeinig, 2005; Woodridge, 2010). The second condition implies a linear projection of X_K on all exogenous variables:-

$$X_K = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + ... + \alpha_{K-1} X_{K-1} + \theta_1 Z_i + v_K \text{ .... (24)}$$

Where E (v_K) = 0, v_K is uncorrelated with $X_1, X_2,\ldots,$ X$_{K-1}$ and z_i and the coefficient of z_i is non-zero ($\theta_1 \neq 0$). However, difficulties emanates from determining a truly, valid and strong instrument that fulfils all the satisfying conditions (Ibid).

Besides instrumental variable, ordinary Least Square (OLS) was employed particularly on outcome variables, where participating in the commercialization pathway was found to be exogenous with respect to the variables.

In the smallholder and inclusive commercialization pathways, household total income, total factor productivity, the number and frequency of food groups consumed, value of assets owned and access to health insurance were found to be exogenously determined and hence they were estimated by OLS as outcome variables. Only expenditure on education was found to be exogenously determined and hence was estimated by 2SLS as shown in equation 23. To account for heteroscedasticity problem, log transformation were performed to some variables.

$$Y=\alpha+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\delta_1D_1+\delta_2D_{2+}\delta_3D_3+\delta_4D_4+\delta_5D_5+\varepsilon\ldots\ldots$$

.... (25)

Where,

Y= output variables (household total income, household dietary diversity score, food groups consumption score, total factor productivity, value of assets and access to health insurance).

Z_i = dummy variable for participation in either of the commercialization pathway (smallholder or inclusive smallholder and medium/large scale pathways).

X_1=ln Age, X_2=education level of household head, X_3=ln household size, X_4=ln farm size, X_5=ln off –farm income, X_6=distance to the market, X_7=net income from rice, D$_1$….. D$_5$

are dummies for sex of the household head, access to improved seed, access to extension services, access to market information and farmer group membership.

Similarly, in the inclusive smallholder and medium/large scale pathway, the same independent variables used in equation 20 were employed to estimate the outcome variables estimated by equation 20 except for total income that was found to be endogenously determined and hence was estimated by two stage Least Square.

CHAPTER FOUR

4.0   RESULTS AND DISCUSSION

4.1   Descriptive Results

Table 3 and 4 present the descriptive statistics of socio-economic characteristics of sample respondents of the three treatments: rain-fed/reference farmers, smallholder commercialization pathway and the inclusive (small-medium/large scale) pathway farmers. For continuous variables found in Table 3, one way ANOVA test was used while for categorical variables in Table 4, chi-square test was carried out to assess group's similarities and differences as well as determining the sources of variation.

4.1.1   Household characteristics

From the descriptive statistics in Table 3, the average age of the sample respondents (household heads) was about 44.2 years. The difference in age between the three comparable groups was insignificant implying that the household heads age was almost the same although respondents in the rain-fed group had higher average age relative to the respondents in the two groups. The observed average age implies that most farmers were still in their productive age in the country (15 – 64 years).

The sampled respondents had an average family size of about 5.8 slightly higher than Mbarali district and Mbeya Regional family size of 4.3 reported by the National Bureau of Statistics (2012). Households in the two pathways had large family size relative to rain-fed farmers. The number of people in a household provide a source of labour force if the number of working age group is higher relative to the number of dependents. The

difference in the three groups was statistically insignificant implying that there was no variation in the family size between the groups.

Table 3:   Household, farm and land characteristics

Variable	Rain-fed group (n=110)	Smallholder Pathway (n=90)	Inclusive Pathway (n=56)	Total sample(N=256)	F	Prob>F
Age of the household head	44.6	43.6	44.1	44.2	0.20	0.821
Family size	5.56	5.92	5.93	5.8	1.15	0.318
Land and farm characteristics						
Farm size (ha)	1.6	2.5	2.2	2	5.70	0.004***
Distance to input market(km)	3.5	2.7	2.6	3	11.33	0.000***
Distance to output market	2.4	2.3	1.5	2.1	13.24	0.000***
Land productivity (t/ha)	1.85	4.31	4.37	3.27	125.6	0.000***
Total factor productivity(tfp)	2.2	2.49	2.03	2.26	1.89	0.153
Output commercialization Index	0.411	0.696	0.755	0.586	119.1	0.000***
Input commercialization Index	0.283	0.280	0.230	0.270	2.83	0.061*
Land owned now (ha)	2.68	3.20	2.49	2.82	1.58	0.208
Land owned 5 years ago	2.51	2.81	2.18	2.54	0.96	0.38
Household welfare indicators						
Dietary diversity score(hdds)	8.2	9.88	9.93	9.2	50.71	0.000***
Food consumption score	52.4	66.9	63.5	59.9	64.88	0.000***
Value of assets("0000"Tsh)	264.4	854.5	809.6	591.1	4.57	0.011**
Off-farm income("0000"Tsh)	81.19	109.61	166.91	109.93	3.06	0.049**
Annual income("0000"Tsh)	225.30	961.03	881.60	626.22	29.7	0.000***

*= Significant at 10%; ** = Significant at 5%; ***= Significant at 1%.

About 86% of sample respondents (household heads) were males (Table 4). There were more male household heads than females since females normally become household heads in the absence of an adult male considered capable of being household head (Martey,et al., 2012). The difference in sex composition was significant among the three groups. Similarly, about 81.7% of the respondents had formal education which was either primary education (52%), secondary education (22.7%) or tertiary education (7%). The literacy rate was higher in the smallholder pathway (91%) followed by respondents in the inclusive pathway (82.1%) and 73.6% for the household heads in the rain-fed scheme.

The difference in the literacy rate among the three groups was significant in all the education levels. Education helps farmers to make informed decisions and respond to market dynamics through the acquired skills and exposure (Ochieng et al., 2015).

4.1.2   Land and farm characteristics

From Table 3, the cultivated farm size was on average 2 ha, where farmers in the smallholder and inclusive schemes cultivated 2.2 ha and 2.5 ha respectively relative to 1.6ha for rain-fed farmers. The difference was significant implying that smallholder farmers in either of the commercialization pathway cultivated larger parcels of land compared to rain-fed farmers partially due to mechanization. On average, smallholder farmers owned 2.82 ha relative to 2.50 ha five years ago. An increase in farm size helps farmers to produce surpluses thereby stimulating higher levels of commercialization (Martey *et al.,* 2012).

Farmers operating in the smallholder pathway had 0.52 ha more than the rest of the groups. On the contrary, farmers in the inclusive scheme owned 0.19 ha less than rain-fed/reference group though the difference was not significant. This can be explained by the fact that in the inclusive pathway, there was a competition for land and normally resulting into land use conflicts between the smallholder and the rising medium and large scale farmers.

Total factor productivity expressed as returns to factors of production was 2.26 denoting increasing returns to scale. Farmers participating in the smallholder pathway received 0.29 more returns while smallholders in the Inclusive investment received 0.17 less returns than rain-fed/reference group though the difference noted was not statistically significant.

With regard to land productivity, the average productivity was 3.3 ton/ha where land productivity among farmers participating in the smallholder and inclusive schemes averaged at 4.3 ton/ha and 4.4 ton/ha respectively while for rain-fed farmers averaged at 1.86 ton/ha. This implies that, smallholders in the smallholder and inclusive schemes harvested 2.46 ton/ha and 2.51 ton/ha more than non-participating farmers, and the difference was statistically significant implying that there was a difference in land productivity between the three comparable groups.

4.1.3 Institutional and access variables

From Table 3, participating farmers in the smallholder and inclusive pathways accessed farm inputs at approximately 0.77 km and 0.87 km less than rain-fed/reference group respectively. The difference in distance to the nearest input market was found to be statistically significant implying that differences existed between the three groups.

On the output market, the average distance to the nearest market was two kilometre from the farmer's residence where they store their rice output. Again, rain-fed farmers were further 2.39 km from the nearest output market while farmers in the smallholder and inclusive schemes accessed the output markets at lesser than distance. The difference in distance to the market was statistically significant between the latter and rain-fed/reference group. As distance to the nearest input or output market increases, market participation decreases (Hailua *et al.,* 2015).

About 66% of rice farmers had access to extension services (Table 4), but the extent of access was significantly higher in the inclusive pathway (75%) relative to 73% and 55% in the smallholder pathway and rain-fed farmers respectively.

Table 4:   Social, Institutional, access and welfare variables

Variable	Rain-fed group (n=110)	Smallholder Pathway (n=90)	Inclusive Pathway (n=56)	Total sample(N =256)	χ^2	Prob> χ^2
Sex (1=male, 0=female)	92(83.6)	74(82.2)	53(94.6)	219(85.5)	4.9	0.087[*]
Education level of the household head						
No formal education	29(26.4)	8(8.9)	10(17.9)	47(18.4)	10.1	0.006[***]
Primary education	43(39.1)	67(74.4)	23(41.1)	133(52)	28.2	0.000[***]
Secondary education	26(23.6)	13(14.4)	19(33.9)	58(22.7)	7.6	0.023[**]
Tertiary education	12(10.9)	2(2.2)	4(7.1)	18(7)	5.7	0.057[*]
Access/institutional variables						
seed (1=improved, 0=local)	28(25.5)	37(41.1)	22(39.3)	87(34.0)	6.3	0.043[**]
Access to irrigation(1=yes,0=no)	4(3.6)	90(100)	56(100)	150(58.6)	240	0.000[***]
Access to extension(1=yes,0=n0)	60 (55)	65(73)	42(75)	167(65.7)	9.8	0.008[***]
Applied fertilizer(1=yes,0=no)	87(79.1)	85(94.4)	56(100)	228(89.1)	20.8	0.000[***]
Access to credit(1=yes,0=no)	12(10.9)	52(57.8)	22(39.3)	86(33.6)	49.8	0.000[***]
Access to market information(1=yes,0=no)	70(63.6)	67(74.4)	35(62.5)	172(67.2)	3.3	0.189
Cooperative membership(1=yes,0=no)	1(0.9)	65(72.2)	49(87.5)	115(44.9)	154	0.000[***]
Access to health insurance(1=yes,0=no)	43(39.1)	45(50)	34(60.7)	122(47.7)	7.3	0.026[*]

*= Significant at 10%; ** = Significant at 5%; ***= Significant at 1%.; Figures in parentheses are percentages.

Furthermore, of the sampled farmers (Table 4), only 34% had access to improved seeds. About 41% and 39% of farmers in the smallholder and inclusive pathways had access to improved seed while among the rain-fed/reference group, only 26% had access to improved seed. For irrigation facilities, about 59% of the sampled respondents had access to irrigation facilities.

Similarly, the proportion of farmers who applied fertilizer differed significantly among the three groups. Among farmers in the smallholder pathway, 94% applied fertilizer and all farmers in the inclusive scheme applied fertilizer while 79% of the rain-fed/reference group had applied fertilizer. In addition, about 33% of the respondents accessed credit that was used to finance agricultural activities and inputs. Of the three comparison groups,

57% of farmers in the smallholder scheme had access to credit, while 39% and 11% of farmers in the Inclusive scheme and rain-fed farmers had access to credit. Credit could be used to purchase inputs that may lead to an increase in productivity and thereby generate surplus production (Martey *et al*., 2012). About 67% of farmers in the study area had access to market information and it was not statistically different between the three groups.

Furthermore, 45% of sampled farmers were cooperative/association members. Among farmers participating in the smallholder scheme, 72% were cooperative members while in the inclusive and rain-fed/reference group, 88% and 1% of the farmers were cooperative/association members respectively. Cooperatives/associations act as social networks in which farmers can have access to information related to production and marketing as well as social capital formation (Martey *et al.,* 2012; Camara, 2017).

4.1.4   Household welfare indicators

4.1.4.1 Food security and food consumption pattern in the study area

Based on the household dietary diversity score, smallholder farmers in the smallholder and Inclusive schemes consumed more food varieties with household dietary diversity score of 9.88 and 9.93 respectively. They consumed on average 10 food groups out of 11 food groups (cereals, roots and tubers, pulses, nuts and seeds, milk, fish and sea foods, oils and fats, fruits, vitamin A rich vegetables and other vegetables, meat, sugar and sugar sweetened beverages) compared to rain-fed farmers (HDDS= 8.23). Farmers in the two pathways had 1.65 and 1.70 more food score than the rain-fed/reference group and this difference was statistically significant.

Based on the food consumption score (FCS), the frequency of consumption of 8 food groups (main staples, pulses, vegetables, fruits, milk, meat and fish, oil and fats, and sugar- sugar sweetened beverages) was 59.9 for the whole sample which implies generally that the sampled households were food secure following classification (WFP, 2008). However, the level of frequency of consumption of the food groups was higher (66.9 and 63.5) among farmers in the two pathways compared to those in the rain-fed/reference group whose FCS was approximately 52.4 implying that the former groups were more food secure than the latter group. The former groups consumed 14.6 and 11.1 times more than rain-fed/reference group.

On the pattern of consumption, grains constituted the largest share of all food groups consumed in a week compared to other food groups in all the three comparison groups of farmers. On average, a typical household consumed food grains for six days a week. The food grains was supplemented by vegetables, oil/fats, pulses, root tubers and fruits which had also higher frequency of consumption in all the three groups (Fig. 4).
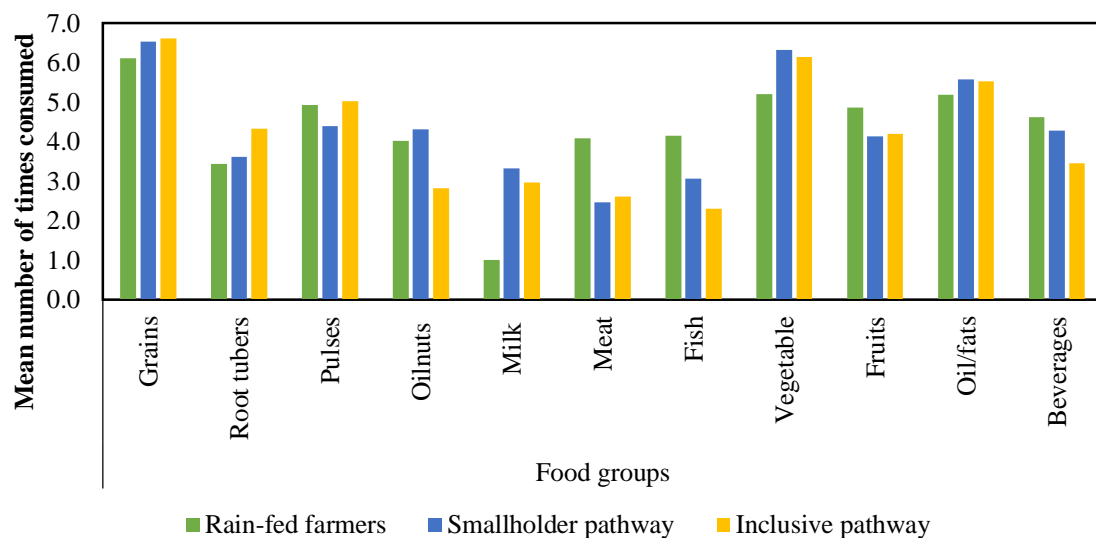
Figure 4:   Weekly food consumption pattern among the three groups

The frequency of consumption of the highly consumed food groups was higher in the inclusive pathway relative to the smallholder pathway and rain-fed farmers. However, the widely consumed food groups are rich in carbohydrates, vitamins, lipids and starch while foods rich in protein including meat, fish, milk and their products were consumed less frequently. This has health implications due to over reliance on monotonous starchy staples with little or without protein supplements from animals and fish as well as fresh fruits. For both groups of farmers, food rich in protein were less consumed relative to staples. For example, a typical household milk once a week for the rain-fed farmers and three times for households in the commercialization pathways

Furthermore, from the food consumption score estimates in Table 5, 4.3% of respondents were food insecure (Borderline food consumption category; FCS= 28.5 - 42) while 95.7% were food secure households (Acceptable food consumption category; FCS>42) as shown in Table 5 below.

Table 5:   Status of farmers' commercialization and food consumption categories

Variable	Rain-fed/Ref-group (%)	Smallholder pathway (%)	Inclusive pathway (%)	Total (%)	χ^2
Output commercialization index					
0 - 0.249	15(13.6)	1(1.1)	0(0)	16(6.3)	134.54[***]
0.25 - 0.499	71(64.5)	9(10)	1(1.8)	81(31.6)	
0.5 - 1	24(21.8)	80(88.9)	55(98.2)	159)62.1	
Input commercialization Index					
0 - 0.249	52(47.3)	45(50)	36(64.3)	133(52)	6.50
0.25 - 0.499	49(44.5)	36(40)	19(33.9)	104(40.6)	
0.5 - 1	9(8.2)	9(10)	1(1.8)	19(7.4)	
Food consumption category(FCC)					
Borderline	9(8.2)	2(2.2)	0(0)	11(4.3)	7.49[**]
Accepable	101(91.8)	88(97.8)	56(100)	245(95.7)	

Note: FCC (0-28) =Poor consumption, FCC (28.5-42) = Borderline, FCC>42 = Acceptable (WFP, 2008); percentages in parentheses; [**]P >0.05, [***]P>0.01.

Most of the food insecure households were found among the rain-fed/reference group (8.2%) and the rest were found among farmers in the smallholder pathway (2.2%) while there were no food insecure households among inclusive smallholder-medium/large scale farmers.

4.1.4.2 Household income, value of assets and access to health insurance

On average, a smallholder rice farmer had a gross annual income of about 6.26 million Tanzania shillings. Farmers in the smallholder and inclusive pathways had statistically higher income than rain-fed farmers by 7.36 and 6.56 million Tanzania shillings (Table 3) respectively. Similarly, smallholder farmers in the smallholder pathway had more valued assets relative to the rest of the two groups though rain-fed farmers had the least valued assets of the three groups.

On access to health insurance, about 47.7% of the sampled households had access to health insurance (either the National Health Insurance Fund or Community Health Fund insurer). Smallholders in the inclusive scheme had more access to health insurance (60.7%) compared to 50% and 39.1% of farmers in the smallholder scheme and rain-fed farmers respectively.

4.1.5   Rice output and input commercialization

From Table 3, and based on FAO (1989) and Strasberg *et al.* (1999), rice in the study area is a commercial crop (CCI ≥ 50%) with commercialization index of 59%. This implies that, on average, 59% of the total rice produced by smallholder farmers in the study area was sold. The crop was more commercialized among farmers in the inclusive smallholder-

medium/large scale pathway where 80% of the rice produced was sold compared to 70% for smallholder pathway and 41% for rain-fed farmers.

On the input side, results showed that, the extent of use of purchased improved inputs was low in all the three groups since only 27% of the inputs used by farmers were purchased from the market while the rest of the inputs used were either low productive local inputs as well as retained inputs from previous year. This signifies less use of improved inputs purchased from the market, leading to low productivity caused by the use of low-productive retained seeds. On the status of smallholder farmers' level of commercialization, 62.1% of the respondents were commercial oriented, 31.6% were still in transition (likely to commercialize) while only 6.30% were subsistence farmers as shown in Table 5.

Of the three comparison groups, 98.2% of smallholder farmers in the inclusive scheme, 88.9% of farmers in the smallholder scheme and 21% of rain-fed farmers sold more than 50% of total rice produced. This implies that, smallholders in the inclusive pathway were more commercialized than the smallholder pathway and rain-fed farmers.

On the input side, only 7.4% of farmers used improved purchased inputs while 40.6% used both local/retained and purchased inputs and 52% used entirely local low productive inputs. This implies that most of the rice farmers in the study area still use local low productive inputs which in turn leads to the observed low farm productivity. Based on farm size, 72.7% of the households cultivated on average less than 2 ha while only 3.1% cultivated more than 5 ha. Results show also a positive relationship between farm size and the degree of commercialization. This implies that households with larger farms tend to

produce and sell more relative to farmers with small farms due to economies of scale. These results are consistent with previous studies (Martey *et al.,* 2012). Fig. 9 show the relationship between commercialization and farm size.
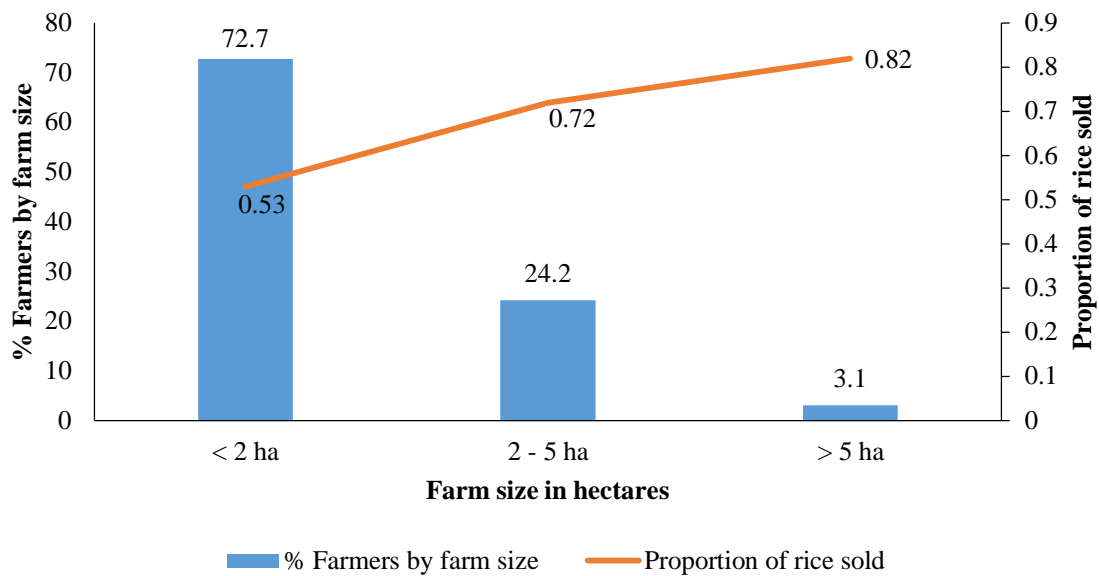
Figure 5:   Degree of agricultural commercialization by farm size

From the descriptive statistics, the three comparable groups seems to exhibit different socio-economic and institutional characteristics except for few variable including age, family size, total factor productivity, size of land owned and access to market information which were insignificant implying that all the three groups were almost similar in these characteristics. Evaluating the impacts of commercialization based on comparison of simple means from ANOVA and chi-square tests would yield biased estimates due to unobservable characteristics. In order to address the self –selection bias, PSM was used following previous studies (Hailua *et al.,* 2015; Amare *et al.,* 2012; Justus *et al.,* 2015; Herrmann and Grote, 2015) as shown in section 4.2.

4.2   Econometric Results

4.2.1   Determinants of agricultural commercialization

Before estimating the impacts of commercialization (ATT), binary logit models (Mitiku *et al.,* 2014; Herrmann and Grote, 2015) were used to estimate the propensity of participation in the smallholder and inclusive commercialization (Table 6).

As a rule of thumb, when there are J outcome categories, logit model predicts all pairs of log odds and normally a baseline category is chosen. The logit model usually pair each response category with the baseline category in this study referring to rain-fed rice farmers. The resultant model describes the effects simultaneously of x on J – 1 logits.

Table 10 shows the results of the determinants of participation in the inclusive and smallholder commercialization pathways. The estimated logit models were both significant at 1% and had the Pseudo R^2 of 85.97% and 54.56% for the Inclusive and Smallholder pathway respectively, implying that variation in the extent of participation in the inclusive and smallholder commercialization pathways were explained by the variation in the hypothesized variables by the values of Pseudo R^2.

Since the coefficients estimated in the logit model above show only the direction (positive or negative) of the effects of the hypothesized covariates on smallholders' probability of participation in the commercialization pathways, average marginal effects were further estimated to infer the extent of the effect of covariates on the treatment variable (participation).

Table 6: **Propensity score estimation of covariates affecting treatment in each of the commercialization pathway with rain-fed farmers as a baseline category**

Variable	Inclusive pathway		Smallholder pathway	
	Coefficient	Marginal effect	Coefficient	Marginal effect
Age of household head	0.0212	0.0006	-0.0238	-0.0023
	(0.0490)	(0.0013)	(0.0272)	(0.0026)
Education of household head	1.384	0.0366	-0.507	-0.0484
	(0.874)	(0.0223)	(0.333)	(0.0313)
Household size	0.141	0.0037	0.144	0.0138
	(0.321)	(0.0084)	(0.170)	(0.0162)
Farm size (ha)	0.522	0.0138	0.201	0.0192
	(0.708)	(0.0188)	(0.194)	(0.0184)
Distance to market(km)	-2.895**	-0.0765	0.363*	0.0347
	(1.116)	(0.0270)	(0.176)	(0.0162)
Off-farm income(Tsh)	3.91E-7*	1.03E-8	-2.32E-7	-2.22E-8
	(1.75E-7)	(4.30E-9)	(2.41E-7)	(2.30E-8)
Sex(1=male, 0=female)	5.310	0.1403	-0.301	-0.0287
	(3.363)	(0.0878)	(0.741)	(0.0708)
Seed(1=Improved, 0=local)	-2.133	-0.0564	1.177*	0.1124
	(1.783)	(0.0472)	(0.558)	(0.0517)
Extension service (1=yes)	2.992	0.0791	-0.168	-0.0161
	(1.929)	(0.0511)	(0.518)	(0.0494)
Market information(1=yes)	-3.275	-0.0865	0.0991	0.0095
	(1.711)	(0.0433)	(0.567)	(0.0542)
Cooper member(1=yes,0=no)	13.48**	0.3561	6.163***	0.5890
	(4.878)	(0.1166)	(1.133)	(0.0892)
Constant	-9.623		-1.485	
	(5.615)		(1.606)	
N	166		200	
Pseudo R^2	0.8597		0.5456	
LR chi2(11)	182.45		150.19	
Prob > chi2	0.0000		0.0000	

Standard errors in parentheses; * $p<0.05$, ** $p<0.01$, *** $p<0.001$

From Table 6, the propensity scores indicate that most of the hypothesized variables that affect farmers to participate in either of the treatment including age, family size, education level of the household head, sex, farm size, access to extension services and access to market information were insignificant. The result from these variables indicates that,

farmers in the two pathways (smallholder and inclusive) had similar characteristics with each other and with the rain-fed farmers that was used as a baseline category and hence worth comparing.

However, there was a variability in the three groups in some few characteristics which may be due to variability in the baseline category (rain-fed farmers). There were four variables which were observed to significantly lead to this variation in either of the treatments. These included cooperative membership, off-farm income, type of rice seed used in production of rice and distance to the nearest output market.

Cooperative membership, off-farm income and type of rice seed had positive significant effect on the probability of smallholders to participate in either of the commercialization pathways while distance to the nearest market, negatively affected the probability of participation in the commercialization pathways and the rain-fed scheme.

The influence of cooperative membership on participation in commercialization was positive and significant. This can be explained by the fact that cooperatives/associations act as social networks in which farmers can have access to information related to production and marketing as well as social capital formation (Martey *et al.,* 2012; Camara, 2017). Through information obtained from the cooperative, farmers can reduce transaction costs as well as selling at higher price. In addition, some cooperatives/associations provide resources including credit, inputs and training to its members. From Table 6, being a member of a cooperative/association increases the probability of participating in the smallholder and inclusive pathways by 42.8% and 80.2% respectively *ceteris paribus*

relative to rain-fed farmers[1]. This is consistent with previous study by Martey *et al.* (2012) in Ghana who found a positive influence of cooperatives on cassava and maize market participation.

Off - farm income also positively and significantly influenced participation in either of the treatment. From Table 6 above, it was observed that, an increase in the household's off-farm income by one Tanzania shilling, leads to an increase in the probability of participation in the inclusive commercialization pathway by 1.03×10^{-6} % *ceteris paribus*. This is similar to the findings by Hailua *et al.* (2015) and Muhammad-Lawal *et al.* (2014) who found that having off-farm income positively influenced participation in commercial agriculture holding other factors constant. The plausible reason could be, farmers tend to use off-farm income so earned to invest in rice production aiming at increasing production volume and sales.

Furthermore, consistent with other studies (Ochieng *et al.,* 2016; Hailua *et al.,* 2015), an increase in distance to the nearest output market negatively and significantly affected participation in commercialization. At the margin around the mean values, an increase in distance by one kilometre leads to a decrease in the probability of participation in the inclusive pathway by about 7.7%. This is also true for the rain-fed farmers that was used as a baseline category. This could be caused by higher transaction costs involved in accessing the output market as well as market information dynamics. Kirsten *et al.* (2013) argued that high transaction costs due to distant markets and poor infrastructure coupled with lack of reliable markets for the produce, low technology as well as poor agro-ecological conditions limits the extent of agricultural commercialization. Contrary to the

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[1] For log-lin models (ln $Y_i = \beta_0 + \beta_1 D_i$), the semi-elasticity with respect to the dummy D_i regressor with value 1 or 0, was calculated by the formula $(e^{\beta 1} - 1)*100$ (Gujarati, 2004: 333).

expectation, in the smallholder commercialization pathway, distance to the nearest market positively influenced participation in the commercialization pathway but it was not significant.

Improved seed used in rice production positively and significantly affected participation in the smallholder commercialization pathway but it was insignificant in an inclusive pathway. From the results, it was revealed that, for every one kg increase in the use of improved rice seed, the probability of participating in the smallholder commercialization pathway increased by 11.9% holding other factors constant. This could be brought as a result of high yielding type of improved rice seed including SARO 5 which is the dominant seed variety used by smallholders in production relative to low yield local seeds due to its expected returns under recommended management.

For the insignificant variables; Education of the household head had both positive and negative effect on the likelihood of participation in either of the commercialization pathway. Education provides production and managerial expertise that helps in making informed decisions. The results also show that there is strong competing effect through diverting skills acquired to off-farm employment opportunities. Age of the household head exhibited both positive and negative influence on the probability of participation though not significant. This is in conformity with a study by Hailua (2015) who found that an increase in age of the household head increased the extent of commercialization by 0.6% on average.

This is explained by the fact that age is a proxy for experience that help household heads to make correct choices on better production and marketing practices. Alternatively, there is a possibility that young people are more dynamic to adoption of productivity and marketing enhancing innovations. Household size had positive influence on both pathways though not

significant. Number of active members in a household serve as a source of family labour supply that may lead to an increase in production and hence surplus production leading to participation in either of the commercialization pathway. As it was observed in the descriptive results, farm size have positive influence on participation in both pathways due to economies of scale. This is consistent with the studies by Martey *et al.* (2012), Hailua *et al.,* 2015 and Ele *et al.* (2013) who also found positive influence of farm size on commercialization. It had negative influence in the smallholder pathway which could be explained by lack effective monitoring on the utilization of the agronomic and improved technologies imparted to the farmers.

This is in consisted with the study by Martey *et al.* (2012) who found similar results on maize and cassava commercialization in Ghana. Sex had both positive and negative effect on participation in either of the commercialization pathway. In the inclusive pathway, male headed household had more probability of participating in commercialization by 15.1% since they are the owner of productive resources and have high exposure to market opportunities relative to females. In the smallholder pathway, female headed households had higher likelihood of participating in rice commercialization by 2.9%. This could be explained by the fact that in the smallholder pathway, women do most of the agricultural value addition activities.

Furthermore, an analysis was conducted to assess the propensity score on covariates affecting participation in the two commercialization pathways (apart from the rain-fed farmers' group which was compared with each pathway as a baseline category in Table 6) between the smallholder pathway and inclusive pathway farmers with smallholder pathway set as a baseline category to delineate the source of similarities or variation in the two pathways as shown on Table 7 since comparison can be made on at least two groups with similar pre-treatment characteristics.

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Table 7: Propensity score estimation of covariates affecting treatment in the inclusive commercialization pathway with smallholder pathway as a baseline category

	Inclusive pathway	
Variable	Coefficient	Marginal effect
Age of household head	0.0244	0.0042
	(0.0234)	0.0039
Educ level of the household head	0.203	0.0347
	(0.121)	0.0200
Household size	-0.0474	-0.0081
	(0.116)	0.1983
Farm size (ha)	-0.155	-0.0265
	(0.112)	0.0188
Distance to market (km)	-1.150***	-0.1969
	(0.284)	0.3782
Off-farm income (Tsh)	7.06e-08	1.21E-08
	(9.22e-08)	1.57E-08
Sex(1=male, 0=female)	1.858*	0.3180
	(0.735)	0.1154
Type of seed used(1=Improved, local)	-0.207	-0.0354
	(0.427)	0.0729
Access to extension services(1=yes, 0=no)	-0.0710	-0.0121
	(0.526)	0.0899
Access to market information(1=yes, 0=no)	-0.872	-0.1492
	(0.468)	0.0763
Cooperative membership(1=yes, 0=no)	0.888	0.1520
	(0.604)	0.1011
Constant	-1.162	
	(1.473)	
N	145	
LR chi2(11)	45.26	
Prob>chi	0.000	
Pseudo R2	0.234	
Log likelihood	-74.0869	

="* $p<0.05$, ** $p<0.01$, ** $p<0.01$, *** $p<0.001$"; standard errors in parentheses

The insignificant variables in Table 7 indicates that participating in either of the two treatments was influenced by similar variables (age, education, household size, type of seed used, access to extension services, access to market information, off-farm income and cooperative membership) except for only two variables(sex and distance to the market)

which were found to be insignificant. The two groups are generally similar and hence worth comparing.

4.2.2   Propensity score distribution and overlap

The graphical presentation in Fig. 6 show the distribution of the propensity scores of participating farmers in an inclusive and smallholder commercialization pathways versus the reference group farmers. It also show the distribution of propensity scores between the smallholder pathway and inclusive pathway with smallholder pathway as a baseline category. For both pathways involved in the study, the common support/overlap region included most of the participating farmers. This is necessary for the matched sample to be the representative of the initial sample (Herrmann and Grote, 2015).

The Figure also shows that, there is sufficient overlap in the propensity scores distribution since the estimated density distributions have less mass around zero or one (Busso *et al.,* 2014). The distribution was more balanced in the smallholder pathway implying that participating and non-participating farmers in the smallholder pathway had most of the same characteristics compared to the inclusive pathway.
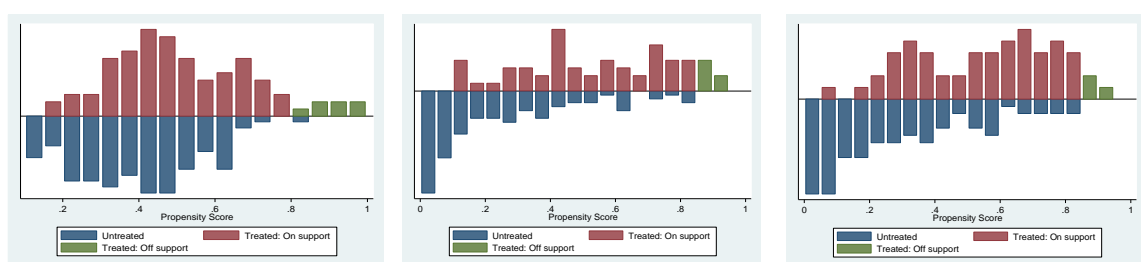
Smallholder pathway   Inclusive pathway   Inclusive pathway
(rain-fed=baseline)   (rain-fed=baseline)   (smallholder pathway=baseline)

Figure 6: Propensity score distribution and overlap

4.2.2   Impacts of commercialization pathways on productivity and welfare

This section summarizes the results of the propensity score matching (Nearest Neighbor matching and Kernel Matching algorithms) estimated to evaluate the impacts of the two commercialization pathways on productivity and welfare (Table 8).

Table 8:   Impacts of commercialization pathways on productivity and welfare

Treatment	Inclusive pathway		Smallholder pathway	
Variable	ATT		ATT	
	NNM	KM	NNM	KM
Total factor productivity	1.021 **	0.983 *	1.21 *	1.17 ***
	(0.419)	(0.391)	(0.734)	(0.346)
Income("000000" TShs)	5.48 ***	5.42 ***	7.68 ***	7.65 ***
	(1.51)	(1.11)	(1.55)	(1.43)
Hhold dietary diversity score	3.79 ***	3.74 **	1.72 ***	1.79 ***
	(1.732)	(1.75)	(1.24)	(0.15)
Food consumption score	14.04 ***	13.59 ***	12.21 ***	12.90 ***
	(3.309)	(1.66)	(9.21)	(2.731)
Expend educ("00000"TShs)	9.37 ***	9.16 ***	0.950 ***	0.928 ***
	(1.78e)	(7.75e)	(0.142)	(0.162)
Assets("000000"TShs)	6.65 ***	6.61 ***	-0.596 **	-0.66 **
	(1.24)	(1.96)	(3.21)	(4.53)
Access to health insurance	0.357	0.367 ***	-0.456	-0.41 ***
	(0.551)	(0.062)	(0.303)	0.066

* $p<0.1$, ** $p<0.05$, *** $p<0.01$; figures in parentheses are standard errors, NNM=Nearest Neighbor Matching, KM= Kernel Matching, ATT= Average Treatment effect on the Treated.

Using the two PSM algorithms above, smallholder and inclusive commercialization pathways significantly and positively impacted on productivity and welfare. Productivity was measured in terms of returns to factors of production expressed as the ratio of gross value of output to the sum of values of factors of production employed. On the other hand, welfare was measured by several indicators including annual household income, household dietary diversity score (HDDS), food consumption score (FCS), expenditure on

education and access to health insurance. Smallholder and inclusive commercialization pathways were compared with the non-participating farmers (rain-fed) which was used as a reference group.

4.2.2.1 Impacts on smallholder rice farmers' productivity

Total factor productivity index ranged between 0.983 and 1.02 for the inclusive and between 1.17 and 1.21 for the smallholder commercialization pathways respectively more than that of rain-fed farmers. Farmers in the smallholder pathway gained between 17% and 21% more returns to factors of production invested relative to smallholders in the rain-fed scheme while in the Inclusive pathway, participating households earned 2.1% more than non-participating farmers. From these results, farmers in the inclusive small-medium/large scale pathway experienced almost a constant return to factors of production (returns ≈ 1) while farmers in the smallholder commercialization pathway experienced increasing returns (returns >1). This implies that, farmers in the smallholder commercialization pathway had more returns to factors of production relative to the other two groups of farmers.

4.2.2.2 Impacts on smallholder rice farmers' welfare

Using the income estimates from Table 8, the results shows that smallholders in the inclusive small-medium/large commercialization pathway earned an annual income ranging between 5.42 and 5.48 million Tanzania shillings more than rain-fed farmers. Similarly, smallholders in the smallholder pathway earned an annual income ranging between 7.65 and 7.68 million Tanzania shillings more than rain-fed farmers. These results imply that both commercialization pathways led to a significant increase in the household income but the impact was high in the smallholder pathway relative to inclusive

pathway. This is consistent with Hailua *et al.* (2015) study in Ethiopia who found that farmers participating in commercialization projects had higher incomes than rain-fed/reference group.

Based on the household dietary diversity score (HDDS) and food consumption score (FCS) as proxies for food security and nutrition, participating farmers in either of the commercialization pathways were more food secure than those not participating in the program. On average, a household in the inclusive and smallholder pathways consumed about four and two food group varieties respectively in a week before the survey more than non-participating farmers.

Similarly, smallholders in an inclusive and smallholder pathways consumed more quantities of food compared to non-participating farmers. The weighted frequency of food consumption among participating farmers in an inclusive pathway ranged between 13.59 and 14.04 times more while it was between 12.2 and 12.9 times more in the smallholder pathway relative to non-participating farmers respectively. This implies that, participating farmers had more economic ability of food access and were less likely to be faced by malnutrition and food insecurity than non-participating farmers.

The results are consistent with that found by Ochieng *et al.* (2015) in the Great Lakes Region (Rwanda and DRC) who found that, banana and legumes commercial oriented farmers were more food secure than non-commercial/subsistence farmers. This can be explained by the fact that, commercial oriented households could easily purchase more food varieties to supplement their own production using the income earned. Poor households are faced by lack of dietary diversity posing severe problems to their health

due to over reliance on monotonous starchy staples with little or without protein supplements from animals and fish as well as fresh fruits. As a comparison, farmers in an inclusive pathway were more food secure than farmers in the smallholder pathway though they were all well-off compared to non-participating farmers. Similarly, WFP (2012) argued that, the more poor households over-rely on their own produce, the greater the vulnerability to food insecurity.

Similarly, expenditure on education was higher among farmers in the inclusive and smallholder commercialization pathways relative to non-participating farmers. In the inclusive pathway, farmers spent 0.916 to 0.937 million Tanzania shillings more than that spent by non-participating farmers. Furthermore, farmers in the smallholder pathway spent 0.928 to 0.950 million Tanzania shillings more than that spent by non-participating farmers. This could be explained by the increased awareness of the importance of education through social networks in the cooperatives as well as an increase in a household income which provides them with freedom and ability to choose among the best educational institutions.

Furthermore, farmers in the inclusive pathway had more valued assets relative to non-participating farmers. This can be explained by the fact that, as the income earned by farmers in the inclusive pathway increases, farmers invested in assets including farm implements, more farm land, livestock, transportation facilities as well as household utensils which acts as securities for unforeseen events as well as for securing farm credit.

On average, the value of assets owned by farmers in the inclusive pathway ranged between 6.61 and 6.65 million Tanzania Shillings more than the value of assets owned by non-

participating farmers. Contrary to the expectation, the value of assets owned by farmers in the smallholder pathway was less than those owned by non-participating farmers. Similarly, about 36% of smallholders in the inclusive pathway had access to health insurance more than that of non-participating farmers. This gives them diversity on access to health services particularly on unforeseen events including outbreak of diseases and accidents among others.

Contrary to this, 41% of non-participating farmers had access to health insurance more than farmers participating in the smallholder pathway. The reason for this could be that farmers in the smallholder pathway had more income that could be used to finance unforeseen events and which gives freedom of choice of where to get the service unlike non-participating farmers who are more likely to be faced by resource constraints particularly when unpredictable events like diseases occur.

Generally, based on the results from the propensity score matching estimators, the results do not confirm the postulated hypothesis that commercialization has no significant impacts on productivity and welfare of smallholder rice farmers in Mbarali district. Hence, the null hypothesis is rejected, implying that commercialization have positive and significant impacts on productivity and welfare of smallholder rice farmers in the study area.

4.2.3 Sensitivity Analysis

As a robustness check of the results from the propensity score matching, 2SLS and OLS were estimated as shown in Table 9, to address the endogeneity and selection bias by the 2SLS through the use of instruments. The Durbin and Wu-Hausman test for endogeneity indicated that commercialization was endogenous with respect to expenditure on education (Table 9) and total income (Table 10) while the rest of the covariates were exogenously determined. This propelled the use of instruments to investigate the quasi-experimental sources of variation in the observed covariates.

In this study, cooperative membership and access to market information were used to instrument participation in either of the commercialization pathway. Cooperative membership plays as a medium for social network and source of social capital formation (Martey *et al.*, 2012) while access to market information enables farmers to make informed production and marketing decisions through forecasting market dynamics (Ochieng *et al.*, 2015).

These instruments were found to be plausible since they correlate with commercialization and not directly correlated with rice productivity and welfare. This was achieved by subjecting the instruments to joint significance test (F-test) to measure the strength of the instruments; Durbin and Wu-Hausman test for consistency and endogeneity as well as the Hansen's J over identification test for correctly model specification. Instruments used in the estimation of 2SLS must be strong since the use of weak instruments with low explanatory power leads into biased results (Hahn and Hausman, 2002).

Table 9: **OLS and 2SLS estimation of impacts of smallholder commercialization on smallholder rice farmers' productivity and welfare**

Variable	Outcome variables for productivity and welfare indicators				
	OLS estimates				2SLS
	ln_Income	ln_TFP	HDDS	ln_FCS	Expend-edu
Smallholder pathway(1=yes,0=else)	0.772[***]	0.0519	1.649[**]	0.231[***]	53096.8
	(0.143)	(0.171)	(0.498)	(0.0583)	(190194.4)
ln_age of the household head	-0.434[*]	-0.0622	-0.150	0.113	69575.8
	(0.173)	(0.207)	(0.603)	(0.0705)	(267649.2)
Education level of household head	0.155[**]	0.0571	0.357	0.0551[*]	46528.0
	(0.0522)	(0.0626)	(0.182)	(0.0213)	(81274.1)
ln_household size	0.143	0.0239	-0.264	0.0126	220981.7
	(0.118)	(0.141)	(0.411)	(0.0480)	(187436.0)
ln_farm size (ha)	0.559[***]	-0.55[***]	0.567	-0.0080	192206.4
	(0.0946)	(0.113)	(0.329)	(0.0385)	(145777.3)
ln_off-farm Income (Tsh)	0.233[***]	-0.0614	-0.0238	0.0108	16338.5
	(0.0418)	(0.0501)	(0.146)	(0.0171)	(65005.1)
Distance to market(km)	-0.0627	-0.0095	0.109	-0.0039	-13758.0
	(0.0325)	(0.0390)	(0.113)	(0.0133)	(50257.8)
Net Income from rice sales	3e-8[***]	4e-8[***]	-7.82e-9	1.76e-9	0.0891[***]
	(9.1e-9)	(1.1e-8)	(3.2e-8)	(3.7e-9)	(0.0146)
Sex(1=male, 0=female)	-0.0657	-0.0138	0.244	0.0911[*]	-253542.3
	(0.104)	(0.124)	(0.361)	(0.0423)	(161675.2)
Seed(1=improved,0=local)	0.0511	0.00619	0.145	0.0194	80275.7
	(0.0860)	(0.103)	(0.300)	(0.0351)	(133532.2)
Extension services(1=yes,0=n0)	0.0883	0.0740	0.363	0.0182	-58399.1
	(0.0869)	(0.104)	(0.303)	(0.0354)	(130258.4)
Market information(1=yes,0=no)	0.0788	0.0728	-0.125	-0.0043	
	(0.0863)	(0.103)	(0.301)	(0.0352)	
Cooperative Member(1=yes,0=no)	0.0341	0.0934	-0.365	-0.0095	
	(0.145)	(0.174)	(0.507)	(0.0593)	
Constant	12.23[***]	1.531	7.890[*]	3.166[***]	-617179.3
	(0.878)	(1.052)	(3.059)	(0.358)	(1367191)
Adj R[2]	0.824	0.168	0.227	0.337	0.531
Hansen J test					69.3(0.000)
Durbin Watson test					0.002(0.96)
Wu-Hausman test					4.8(0.03)
B-Pagan	0.9(0.34)	2.5(0.11)	0.03(0.9)	2.2(0.14)	

Standard errors in parentheses (upper table), "* $p<0.05$, ** $p<0.01$, ***$p<0.001$", p-values in parentheses (lower table), TFP=total factor productivity, HDDS=Household dietary diversity score, FCS=Household food consumption score and Expend-edu = household expenditure on education.

The joint significant test for the results showed that the instruments were strong, having F-value of 69.3 for the smallholder pathway in Table 9 and F-value of 61.5 in the inclusive pathway (Table 13) which is greater than the critical values as well as greater than ten (Staiger and Stock, 1997). The Hansen's J test revealed that the model was correctly

specified and this made the use of cooperative membership and access to market information as valid instruments for commercialization.

Table 10: **OLS and 2SLS estimation of the impacts of inclusive commercialization on smallholder rice farmers' productivity and welfare**

	Outcome variables for productivity and welfare indicators					
	2SLS	OLS estimates				
Variable	lncome	lncome	ln TFP	HDDS	FCS	Expend-u
Inclusive pathway (1=yes)	0.333*	0.781***	-0.197	1.823**	6.708**	-12319.0
	(0.172)	(0.198)	(0.208)	(0.599)	(3.984)	(322581.2)
ln(age of household head)	-0.249	-0.270	0.0487	0.0119	10.61**	961424**
	(0.170)	(0.177)	(0.187)	(0.537)	(3.575)	(288905.6)
Education of household head	0.142**	0.135*	0.121*	0.274	3.778***	207425.8*
	(0.0482)	(0.0517)	(0.0545)	(0.157)	(1.041)	(85248.6)
ln(household size)	0.0742	0.0671	0.0335	-0.214	2.004	148054.6
	(0.124)	(0.129)	(0.136)	(0.390)	(2.593)	(210075.4)
ln(farm size)	0.507***	0.545***	-0.67***	0.410	-2.143	24991.2
	(0.0966)	(0.102)	(0.107)	(0.309)	(2.055)	(166037.8)
Distance to market(km)	-0.0348	-0.0133	0.0175	0.147	-0.572	-17902.3
	(0.0373)	(0.0383)	(0.0404)	(0.116)	(0.772)	(63012.2)
ln(off- farm income)	0.307***	0.273***	-0.0511	0.0261	1.115	121664.1
	(0.0416)	(0.0445)	(0.0469)	(0.135)	(0.897)	(72537.4)
Net Income from rice sales	1.3e-***	1e-7***	1e-7$^{***"}$	-1.5e-8	-1.1e-7	0.0758
	(2.7e-8)	(2.4e-8)	(2.6e-8)	(7.3e-8)	(4.9e-7)	(0.0394)
Sex (1=male, 0=female)	0.0564	0.0560	0.222	0.124	6.05^{1*}	64367.4
	(0.123)	(0.128)	(0.135)	(0.388)	(2.580)	(209244.2)
Seed (1=improved, 0=local)	0.0414	0.0472	-0.152	0.358	0.821	-68634.8
	(0.0898)	(0.0946)	(0.0997)	(0.287)	(1.906)	(154219.5)
Access to Extension (1=yes)	0.0284	0.0154	0.00770	0.318	2.509	134430.1
	(0.0886)	(0.0951)	(0.100)	(0.288)	(1.915)	(154671.3)
Market information(1=yes)		0.0115	-0.0342	-0.104	0.0140	-25291.4
		(0.0911)	(0.0960)	(0.276)	(1.835)	(148273.6)
Coopeartive Member(1=yes)		-0.314	-0.0270	-0.134	1.366	280186.0
		(0.187)	(0.197)	(0.567)	(3.771)	(304620.6)
Constant	10.60***	11.08***	0.701	6.718*	-17.94	-5.9e6***
	(0.879)	(0.928)	(0.978)	(2.810)	(18.69)	(1512258)
Adj. R^2	**0.827**	**0.814**	**0.307**	**0.346**	**0.333**	**0.301**
F -test	**61.5(0.0)**					
Hansen J	**0.03(0.9)**					
DurbinW	**3.1(0.08)**					
WHausman	**2.84(0.1)**					
B-Pagan χ2		**0.1(0.76)**	**0.5(0.5)**	**2.3(0.1)**	**2.1(0.14)**	**121.9(0.00)**

Note: Standard errors in parentheses (upper table), "* p<0.05, ** p<0.01, ***p<0.001", p-values in parentheses (lower table), HDDS=household dietary diversity score, FCS= food consumption score, TFP=total factor productivity, expend-edu=household expenditure on education.

The results from 2SLS in Table 9 showed that households participating in the smallholder commercialization pathway spent about 53 097 Tshs on education more than non-participating farmers though the difference was not significant.

Similarly, participating farmers total annual income was 116.4% significantly more than rain-fed farmers and their total factor productivity was 5.34% more than that of rain-fed/reference group. Furthermore, households participating in the smallholder commercialization consumed about two food groups more and their frequency of consumption was about 26% times more than non-participating farmers signifying that they were more food secure than rain-fed/reference group. This implies that smallholder commercialization pathway had positive impacts on productivity and welfare of rice farmers in the study area.

Similarly, from Table 10, farming households in the inclusive commercialization pathway had more annual income than non-participating farmers. Results from the 2SLS showed that participating farmers' income was 39.5% more than non-participating farmers and it was significant while the results from OLS estimation shows a slightly higher difference in income (118.4%) and the difference was significant. Furthermore, participating farmers were more food secure than non-participating farmers in terms of dietary diversity and frequency of consumption, and had more valued assets.

On the contrary, participating farmers spent less on education and health insurance services though the difference was not significant. These confirms the results obtained through propensity score matching approach where smallholder farmers participating in the smallholder and inclusive commercialization were better-off in most of the indicators including total annual income, food security measured by household dietary diversity score and food consumption score as well as total factor productivity.

Table 11: **OLS estimation of the impacts of commercialization on rain-fed farmers' productivity and welfare by using smallholder pathway as baseline**

Variable	Outcome variables for productivity and welfare indicators				
	Income	TFP	HDDS	FCS	Expend-edu
Rain-fed farmers(1=yes)	-3864290***	-0.586	-1.80***	-14.81***	-862860***
	(966404.9)	(0.354)	(0.311)	(2.138)	(190252.7)
Age of the household head	57517.8	0.0185	0.0124	0.0677	9676.2
	(31338.3)	(0.0115)	(0.0101)	(0.0693)	(6370.4)
Education of household head	707865.7	0.0845	0.233	2.426*	112715.0
	(435575.7)	(0.159)	(0.140)	(0.964)	(87919.3)
Household size	-455428.7*	-0.0356	-0.00013	0.211	17459.9
	(179209.4)	(0.0656)	(0.0577)	(0.396)	(35819.4)
Farm size (ha)	2989864.4***	-0.0918	0.0386	0.382	163661.8***
	(156230.8)	(0.0572)	(0.0503)	(0.346)	(30795.5)
Distance to the market(km)	-493092.7	-0.133	0.0544	-0.0458	-91757.3
	(262206.6)	(0.0960)	(0.0845)	(0.580)	(52187.5)
Off-farm income (Tsh)	0.544**	-5.34e-8	-6.78e-9	1.04e-7	0.00703
	(0.165)	(6.1e-8)	(5.33e-8)	(3.66e-7)	(0.0326)
Sex (1=male, 0=male)	624639.9	-0.0271	0.260	3.782*	-320276.9
	(860431.1)	(0.315)	(0.277)	(1.903)	(172569.0)
Seed(1=Improved, 0=local)	140578.0	-0.183	0.0559	-0.125	145930.7
	(719810.5)	(0.263)	(0.232)	(1.592)	(142983.9)
Extension(1=yes, 0=no)	-20410.0	0.299	0.297	-0.207	119536.0
	(711065.2)	(0.260)	(0.229)	(1.573)	(141255.8)
Market information(1=yes)	233049.1	-0.254	0.0901	-0.306	35520.7
	(718232.9)	(0.263)	(0.231)	(1.589)	(144056.0)
Cooperative member(1=yes)	1214223.0	-0.243	-0.299	-0.428	-298609.4
	(1054648.4)	(0.386)	(0.340)	(2.333)	(208427.1)
Constant	-177358.4	2.545**	8.334***	54.28***	326339.8
	(2197669.9)	(0.804)	(0.708)	(4.862)	(444093.2)
R^2	0.7483	0.0049	0.2592	0.3731	0.3043

Standard errors in parentheses, * $p<0.05$, ** $p<0.01$, *** $p<0.001$, TFP=Total factor productivity, HDDS=Household dietary diversity score, FCS=Food consumption score, Expend-edu=Expenditure on education.

Table 11 shows that smallholder farmers in the rain-fed scheme had low productivity and welfare relative to the smallholder farmers in the smallholder pathway as it was observed in Table 6. For example, household's annual income in the rain-fed scheme was 3.9 million Tshs lower than a household in the smallholder pathway. Similarly, dietary diversity score and food consumption score were lower by 1.8 and 14.81 units respectively as compared to smallholder farmer in the smallholder pathway. Again, most of the covariates in the two groups were similar implying that they are worth comparing.

Based on these results, as indicated by the PSM, 2SLS and OLS, farmers participating in the smallholder commercialization pathway were more productive in terms of total factor productivity and had higher income relative to farmers in the inclusive commercialization pathway and non-participating farmers.

As a further robustness check of the quality of matches, covariates of participants and rain-fed/reference group were evaluated before and after matching to assess the similarity of the comparison groups. Before matching, the comparison groups were significantly different and the difference was eliminated after matching as shown on appendix 3.1 and 3.2. The difference between the comparison groups might be significantly different before matching, but the difference must be insignificant after matching for validity of the results (Caliendo and Kopeinig, 2005). The mean absolute bias before matching were 18.9% and 34% in the smallholder and inclusive pathways respectively and reduced to 2.5% and 18.7% after matching. Similarly, the estimated models did not encounter multicollinearity problem since the value of VIF ranged from 1.1 to 2.86 and the error terms for all models were homoscedastic after making some logarithmic transformation with exception of only the expenditure on education model in Table 10 which was found to be heteroscedastic.

CHAPTER FIVE

5.0   CONCLUSION AND POLICY RECOMMENDATIONS

5.1   Conclusion

This study aimed at evaluating the most effective commercialization pathway (smallholder or inclusive) and its impacts on productivity and welfare on smallholder rice farmers in the pathways versus rain-fed farmers in Mbarali District. The findings indicated that both smallholder and inclusive commercialization pathways positively impacted on the extent of smallholder rice commercialization, productivity and welfare even after controlling for potential endogeneity issues.

The overall level of rice commercialization was more than half of what was produced (CCI=59). However, the extent of rice commercialization was higher in the inclusive smallholder –medium/large scale pathway where 80% of rice produced was sold relative to 70% for smallholder farmers in the smallholder commercialization pathway and 41% for rain-fed farmers. The findings further indicated that, smallholder production system is characterized by low improved input use (ICI=27%). Only 7.4% of farmers in the study area purchased more than 50% of the improved inputs used in rice production while the rest used local low yield enhancing inputs retained from previous production seasons.

This is brought about by high transaction costs involved in purchasing the inputs propelled by poor road infrastructure, unavailability and untimely delivery of inputs, distant input markets and liquidity challenges facing smallholder farmers in the study area. However, though the extent of rice commercialization was higher in the inclusive smallholder-medium/large scale commercialization pathway, smallholder farmers in the smallholder

pathway were more productive in terms of returns to factors of production and had more total household income compared to farmers in the inclusive pathway. On the contrary, smallholders in the inclusive smallholder-medium/large scale pathway were better-off in terms of food security and expenditure on non-food items including education, assets and access to health insurance.

Since each pathway brought some impacts relative to the other pathway, investing in both commercialization pathways is crucial to explore the synergies of the coexistence of both commercialization pathways to bring about the desired improvement in agricultural productivity, growth, nutrition, creation of employment, poverty reduction and ultimately welfare improvement. In addition, the results further showed that, farmers' cooperatives, improved road infrastructure as well as increased farmers' farm and off-farm income are necessary for smallholder farmers to increase the extent of rice commercialization in the study area. For example, being a member of a cooperative/association increases the probability of participating in the smallholder and inclusive pathways by 42.8% and 80.2% respectively ceteris paribus, while an increase in distance to the nearest market reduces the probability of smallholder participation in commercial agriculture by 7.7% ceteris paribus.

5.2   Policy Recommendations

Although the agricultural commercialization strategies have shown positive impacts on smallholder productivity and welfare, rice farmers are still faced with several challenges. To overcome the identified challenges of low improved input use, low input purchasing power capacity due to high transaction costs, low productivity particularly in the rain-fed

production system and poverty, the following should be done by all agricultural stakeholders.

i. Programs intending to increase smallholder agricultural productivity should put more focus on productivity enhancing inputs which is still minimal in the study area and Tanzania at large.

ii. Producer and marketing cooperatives should be established since they are potential medium for social networks and social capital formation. Capacity building should then be at a forefront in the establishment of farmer cooperatives for smooth operations based on cooperative principles to overcome the problems including embezzlement of cooperative fund and farm produce.

iii. Investment in irrigation infrastructure. Irrigation facilities provides incentives for farmers to increase investment in farm production since the risk associated with farm failure is reduced. Though there are a number of irrigation schemes in the study area, most of these schemes depend on seasonal flow of water from surrounding rivers which does not permit farmers to produce rice throughout the year due to water scarcity and water use conflicts.

iv. Investment in infrastructure to connect potential production and consumption areas to reduce transaction costs along the rice value chain.

5.3   Suggested Area(s) for Further Research

This study is specific to rice and it is confined to Mbarali District only. To have a wider perspective and knowledge on the impacts of commercialization, further studies should be undertaken particularly on crops and livestock commercialization in Tanzania by focusing

on soil content, climatic, cultural, environmental and trade policy factors affecting agricultural productivity and commercialization in Tanzania and beyond.

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APPENDICES

Appendix 1: Description of variables used in estimation of PSM, OLS, 2SLS

Variable name	Description	Expected Sign
Age	Age of respondent in years	+/-
Education level of household head	Level of education of the respondent (primary, secondary, tertiary).	+
Household Size	Number of members in a household	+/-
Farm Size	Size of land (ha) cultivated with rice	+
Distance to market	Distance to an input and output market in (km)	-
Off farm income	Income from non –agricultural sources	+/-
Sex	Sex of the household head (1=Male, 0 = Female)	+
Seed	Used improved seed (1=yes, 0=no)	+
Extension services	Access to extension services (1=yes, 0=n0)	+
Access to market	Access to the market by the respondent	+
Cooperative Membership	Cooperative society member (1=yes, 0= no)	+
Commercialization pathway	Participated in commercialization (1=yes, 0=no)	+
Net Income from rice	Total net income from rice production	+

Appendix 2*:* **Food group weights based on importance and nutritional density**

Food items (examples)	Food groups	Weight	Justification
Maize, maize porridge, rice, sorghum, millet pasta, bread and other cereals. Cassava, potatoes and sweet potatoes, other tubers, plantains	Main staples	2	Energy dense/usually eaten in larger quantities, protein content lower and poorer quality (PER17 less) than legumes, micro-nutrients (bound by phytates).
Beans. Peas, groundnuts and cashew nuts	Pulses	3	Energy dense, high amounts of protein but of lower quality (PER less) than meat, micronutrient(inhibited by phytates), low fat
Vegetables, leaves	Vegetabl	1	Low energy, low protein, no fat, micronutrients
Fruits	Fruit	1	Low energy, low protein, no fat, micronutrients
Beef, goat, poultry, pork, eggs and fish	Meat and fish	4	Highest quality protein, easily absorbable micronutrients (no phytates), energy dense, fat. Even when consumed in small quantities, improvements to the quality of diet are large.
Milk yogurt and other diary	Milk	4	Highest quality protein, micro-nutrients, vitamin A, energy.
Sugar and sugar products, honey	Sugar	0.5	Empty calories. Usually consumed in small quantities.
Oils, fats and butter	Oil	0.5	Energy dense but usually no other micro-nutrients. Usually consumed in small quantities

Source: WFP (2008): Food consumption analysis

Appendix 3: Household characteristics before and after matching

Appendix 3.1 Smallholder commercialization pathway

Variable	Unmatched	Mean	
	Matched	Treated	Control
Age of household head	Unmatched	43.63	44.59
	Matched	43.52	45.93
Education level of household head	Unmatched	2.1	2.18
	Matched	2.11	1.92
Household size	Unmatched	5.92	5.56
	Matched	5.92	5.95
Farm size	Unmatched	2.46	1.59
	Matched	1.87	1.88
Distance to market	Unmatched	2.28	2.38
	Matched	2.40	2.40
Sex (1=male, 0=female)	Unmatched	0.822	0.836
	Matched	0.831	0.831
Seed (1=Improved)	Unmatched	0.411	0.255
	Matched	0.386	0.301
Extension access(1=yes)	Unmatched	0.72	0.55
	Matched	0.71	0.70
Access market inf(1=yes)	Unmatched	0.744	0.636
	Matched	0.723	0.723

Sample	Pseudo R^2	LR Chi2	P>Chi2	Mean Bias
Unmatched	0.105	29.01	0.0000	18.9
Matched	0.018	4.04	0.908	2.5

Appendix 3.2 Inclusive smallholder-medium/large commercialization pathway

Variable	Unmatched	Mean	
	Matched	Treated	Control
Age of household head	Unmatched	44.14	44.59
	Matched	44.02	44.34
Educ level of household head	Unmatched	2.29	2.18
	Matched	2.32	2.46
Household size	Unmatched	5.93	5.56
	Matched	5.78	5.4
Farm size	Unmatched	2.19	1.59
	Matched	2.02	1.71
Distance to market	Unmatched	1.4643	2.3818
	Matched	1.5	1.4
Sex (1=male, 0=female)	Unmatched	0.9464	0.8364
	Matched	0.94	0.90
Seed (1=Improved)	Unmatched	0.3929	0.255
	Matched	0.4	0.62
Extension access(1=yes)	Unmatched	0.75	0.545
	Matched	0.72	0.70
Access market inf(1=yes)	Unmatched	0.625	0.636
	Matched	0.66	0.72

Sample	Pseudo R^2	LR Chi2	P>Chi2	Mean Bias
Unmatched	0.273	58.00	0.0000	34.00
Matched	0.078	10.81	0.289	18.7

Appendix 4: VIF test for multicollinearity

Variable	VIF	1/VIF
Age of household head	1.3	0.7699
Education level of household head	1.19	0.8397
Household size	1.33	0.7529
Farm size (ha)	2.46	0.4063
Distance to market (km)	1.15	0.8706
Off-farm Income (TShs)	1.07	0.9367
Net income from rice (TShs)	2.86	0.3497
Sex of household head (1=male,0=female)	1.11	0.9026
Access to extension (1=yes, 0=no)	1.27	0.7901
Access to seed(1=improved, 0 =local)	1.15	0.8707
Access to market information(1=yes,0=no)	1.17	0.8582
Cooperative member(1=yes, 0=no)	1.38	0.7264
Mean VIF	1.45	

Appendix 5: Questionnaire for Rice Farmers

Questionnaire number**…………**

COMMERCIALIZATION PATHWAYS AND THEIR IMPLICATIONS ON SMALLHOLDER RICE FARMERS' PRODUCTIVITY AND WELFARE IN MBARALI DISTRICT, TANZANIA

My name is Furaha N Rashid. I am an MSc Agricultural Economics Student from Sokoine University of Agriculture located in Morogoro-Tanzania. I am doing research on how and to what extent the smallholder and inclusive smallholder-medium/large scale commercialization pathways have impacted on smallholder rice farmers' productivity and welfare in Mbarali District to inform policy makers on the effective pathway to go through. Your household was randomly selected to participate in this research. Participation is voluntary and your responses are highly valued and will be kept confidential. The interview will take about 1 hour to complete.

Before we start, do you have any question or is there anything I have said that you could need more clarification? May I proceed with the interview?

SECTION 1: INTRODUCTION
1. Household ID**……..……** Interviewer's name…………….………Name of the respondent………
1.1 Ward………….……………Village**……………………..** Date of the interview……………….……
1.2 Sex of respondent (1=Male, 2=Female)……………….………
1.3 What type of treatment/intervention is the farmer involved in?
   1. The smallholder rice commercialization program (Madibira scheme).
   2. Normal smallholder farmer not in any intervention
   3. Small holder farmer surrounded by medium/large scale farmers (Kapunga scheme)   (   )

SECTION 2: HOUSEHOLD CHARACTERISTICS
2.1. Sex of the household head   1 = Male, 2 = Female   (   )

2.2. Age of the household head   (in years)……………….………

2.3. Education level of the household head: 1 = No formal education, 2 = Primary education, 3= primary education with some certificate, 4 = Primary drop out, 5= Secondary education, 6= Secondary drop out, 7 = Certificate, 8=High school, 9 = Diploma, 10 = University degree, 11 = other, specify………………… (   )

2.4. Who are you in the household? 1 = head, 2 = head's spouse (wife/husband), 3 = Child, 4 = other …………………………………………………………………….. (   )

2.5. How many are you in your household?

Age (years)	Under 5	5 - 14	15 - 35	36 – 64	Over 64	Total
Number						

2.6. What is the family's main source of income/livelihood?
   1 = Agriculture, a) crop production (b) Horticulture
   2 = Livestock keeping, (a) cattle (b) goat (c) Pig (d) Poultry

3 = Trade, (a) food vending (b) crop sales (c) food processing etc), iv = Fishing, v= Bee keeping

4= Mining   vii= Transportation viii= Construction ix= Financial services (   )

2.7. What is/are your secondary source(s) of income?

(a)……………………….……… (b)…………………….………… (c) ……………….……

(d) …………………………… (e) ……………………………... (f)…………………….

SECTION 3: LAND OWNERSHIP, ACCESS AND LAND USE

3.1. Do you own land? 1 = Yes, 2 = No   (   )

3.2. If you own land, what is the size of land owned in acres in the last five production seasons?

Year	2013	2014	2015	2016	2017	2018
Land (acres)						

3.3. If you own land, how did you get the land? 1=bought, 2=inherited/allocated by father,

3=inherited/allocated by father-in-law, 4= allocated by village elder, 5= allocated by government,

6=settlement scheme, 7=free land-moved in, 8=rent in, 9= other, specify………………….……….

3.4 Tenure status: 1=owned w/ deed, 2=owned w/o deed, 3=owned by parent/ relative,

4=government/communal/co-operative,   5=CCRO   (HATI   ZA   KIMILA),   6=   other,

specify………………….………

3.5. If you do not own land, how do you get land for farming...?

3.6. Do you lease land? If you do, how much did you lease in the last season (acres)……………….

3.7. If you were to sell the parcel now, how much will you be willing to Accept/acre…………………?

3.8. Where is the location of the leased land? 1=this village, 2= this ward, 3=this district, 4= this region,

5=other region/s

3.9. What kind of infrastructure are included in the leased land? 1=Irrigation system, 2=store, 3= house

4=other, specify……………………

3.10. What was the proportion of land owned was cultivated in the last five production seasons?

Year	2013	2014	2015	2016	2017	2017
Land (acres)						

3.11 If field size owned is greater than area cultivated, what are the reasons for not cultivating entire piece,

1=cultivated land is enough for my family needs, 2=lack of capital, 3=lack of labor, 4=lack of market

that can absorb a larger surplus, 5=want to keep uncultivated land for future inheritance/use, 6=land is

unsuitable for cultivation, 7=used as grazing land, 8=left fallow in order to improve its fertility,

9=residential. (**Hint**: circle at least one answer).

3.12. If you own and lease land at the same time, why?

1……………………………..2…………………….……..3……………………………..

3.13 What is/are the main land use? 1=crop production, 2=pastures/fodder, 3=livestock keeping, 4=mixed

farming, 5=renting out, 6=residential, 7=Fallow, 8=other

(specify)……………………………………………………………………………………………

3.14. What are the main crop (s) largely grown in your farm (s)? 1 = Rice, 2 = Maize, 3= Beans, 4= sunflower, 5= Banana, 6= potato, 7= cassava, 8= vegetables, 9= Fruits 10. Wheat   (**Rank the crops eg 1= maize, 2= sunflower, 3=)**

Others, specify……………………………………………………………..

3.15. What is the size of land (acres) allocated for each crop mentioned in 3.14 above for the last production season?

Field (plot)	1	2	3	4	5	6	7	8	9	10
Crop										
Quantity(acres)										

3.16 What is the size of land (acres) allocated for each crop mentioned in 3.14 above in this season?

Field crop	1	2	3	4	5	6	7	8	9	10
Crop										
Quantity(acres)										

3.17 What was the cultivated land for each crop in the last four production seasons?

Year	Rice	Maize	Beans	sunflower	Banana	potato	cassava	Vegetable	Fruits	Wheat
2013										
2014										
2015										
2016										

Section 4: Rice Production

4.1 Did you grow rice in the last season (2016/17)? 1=yes, 2=no   (   )

4.2 What was the size (acres) of the field planted with rice in the last season......................................?

4.3 Who owns this field? 1= the farmer, 2= cooperative, 3=parent/relative, 4=government, 5=communal, 6=other……………………

4.4 Is this field owned 1= customarily, 2=statutory, 3= leasehold?   (   )

4.5 If you leased this field, how much did you pay per acre……………………….? For how long? 1= per season, 2= year, 3=other…………

4.6 What is the fertility status of the field: 1=poor, 2=fertile, 3=very fertile (   )   (**hint**: based on soil color, productivity or vegetation around)

4.7 Who mostly controls (makes important decision) this field? 1= male, 2 =female, 3 =both   (   )

4.8 What is the system of watering used? 1=Rain fed, 2=Irrigated (piped), 3=Irigation (gravity), 4=other, specify…………………………………………………………………   (   )

4.9 What are the Main tools used in cultivation? 1=hand hoe, 2=oxen, 3=tractor, 4=hand hoe and oxen, 5=hand hoe and tractor, 6=hand hoe, tractor and oxen, 7=other, specify……………………………

4.10 Why did you use the tool responded in question 4.9 above…………………………………….?

4.11 If a tractor was used during rice production in the last season, for what activity/ies was it used?

1 = First plowing (kukatua/kulima), 2 = Second plowing (kukatua/kulima), 3 = Harrowing

4 = Planting (kupandia), 5 = Fertilizer application, 6 = Weeding, 7 = Irrigation, 8 = Harvesting / combine, 9 =Threshing (kupura/kutenganisha mpunga na majani), 11 = Milling (milling), 12 = Carting farm products & inputs (kubebea mazao or mbolea or agriculture equipment Kama combined harvester), 13 = Transporting laborers.   (   )

4.12 How much (Tshs) do you hire a tractor per day…………………………? Per acre………………?

4.13. How much (Tshs) do you hire an oxen per day…………………………..? Per acre…………….?

4.14 What are the types of labor used in your farm? 1=family labor, 2=hired labor   (   )

4.15 Why did you use the type of labor mentioned

above…………………………………………………………………………………,………

4.16. If family labor, how many labor and hours/days were used by each laborer in your farm last season?

Activity	Cultivation	sowing	weeding	harvesting	threshing	Transporting output from field	Other	Total quantity
# of labor								
Hours/days								

4.17. How many family labor and hours/days were used by each laborer in your farm this season??

Activity	Cultivation	sowing	weeding	harvesting	threshing	Transporting output from field	Other	Total quantity
# of labor								
Hours/days								

4.18 If hired labor was used during rice production, for what activity was it used for?

1=cultivation, 2=sowing/planting, 3= weeding, 4= harvesting, 5= threshing, 6= transporting output from the field (Hint: circle at least one response)

4.19. How much (Tshs) did you pay for labor for each activity in the last production season?

Activity	Cultivation	sowing	weeding	harvesting	threshing	Transporting output from field	Other	**Total cost**
# of labor								
Cost(Tshs)								

4.20 How much (Tshs) did you pay for each labor for each activity in this production season?

Activity	Cultivation	sowing	weeding	harvesting	threshing	Transporting output from field	Other	**Total cost**
# of labor								
Cost(Tshs)								

4.21 Do you provide labor in other farms? 1=yes, 2=no   (   )

4.22 Which farm(s) do you provide labor? 1=large scale farmer, 2= medium scale farmer, 3=small scale

farmer, 4= at least two of those (   )

4.23 What types of activities do you provide labor to the farm mentioned on question above? 1= casual labor on temporary basis, 2=casual labor on permanent basis, 3= professional labor (managerial, agronomist, extension officer, machinery operator et.c)   (Hint: Circle at least one response)

4.24 How much (Tshs) were you paid for labor for each activity in this production season?

Activity	Cultivation	sowing	weeding	harvesting	threshing	Transporting output	Other	**Total**
# labor days								
Income								

4.25 What are the Planting/ Seed type used in your farm plot?   (   )

1=New Hybrid, 2=Retained Hybrid (didn't finish last last season, used again last season), 3=local var, 4=local seedling, 5=improved seedling, 6=hybrid & local variety, 7=hybrid purchased+ retained, 8=others (specify)…………………………………………...

4.26 What were the quantity and cost of the seed type mentioned above used in your farm that was purchased?

Season	Last season(kg)		Price/kg		This season(Kg)		Price/kg		Total (kg)
Seed type	Local var	Improved var	LV	Impr	Local var	Improved var	LV var	Impr	
Plot 1									
Plot 2									
Plot 3									
Plot 4									
Plot 5									
Total									

4.27. What are the reasons for using seed variety mentioned in question 4.19 above?

    i. ……………………………….....   v ……………………….........................

    ii. ………………………………...   vi ……………………………………………….

    iii. …………………………………..   vii ………………………………………………

4.28. Did you apply fertilizer in your rice farm? 1 = Yes, 2 = No   (   )

4.29. If not, what were the reasons for not using fertilizer?

    i. …………………………………………   iv ………………………………………………..

    ii. …………………………………………   v ……………………………………………….

    iii. …………………………………………   vi …………………………………………………

4.30 If yes, what were the types, quantity and cost per unit of fertilizer used in the last season?

Fertilizer type	DAP	NPK	TSP	CAN	UREA	SA	DAP+CAN	Other	manure	Minjingu
Quantinty(kg)/acre								……..		
Cost(Tshs)/unit								……..		

4.31 What are the type, quantity and cost per unit of fertilizer used in this season?

Fertilizer type	DAP	NPK	TSP	CAN	UREA	SA	DAP+CAN	Other	manure	Minjingu
Quantinty(kg)/acre								……..		
Cost(Tshs)/unit								……..		

4.32. Do you have access to irrigation facilities? 1 = Yes, 2 = N o   (   )

4.33. When did you start irrigation? Mention the year………………………..

4.34. Who provided you with irrigation facilities? 1= Large scale farmer, 2= own investment, 3= government, 4, MVIWATA, 5=private company, 6= CARI, 7=Africa Rice, 8=other, specify……………………………………………….. (   )

4.35. What are the other agricultural services being provided by service provider mentioned above? 1= seed, 2=mechanization, 3=fertilizer, 4=extension services, 5=markets, 6=credit, 7=training (formal/informal), 8 = land, 9 =other, specify…………………….. (   )

4.36. What are the conditions and terms associated with the access of the services mentioned above? 1=being a member of a group/association, 2= inhabitant of a given locality, 3= having land, 4= selling output to service provider, 5=investment capital, 6=other, specify……………

4.37 Are there any benefits of practicing irrigation? 1= Yes, 2= No   (   )

4.38. If yes, mention the benefits

    i. ……………………………………………   v …………………………....................

    ii. ……………………………………………   vi …………………………………

    iii. ……………………………………………   vii ……………………………………

    iv. …………………………………………………………………………………………

4.39. What challenges are you facing associated with accessing the services mentioned in question 4.32 and 4.35 above?

i. ………………………………………………   v …………………………….....................
ii. ………………………………………………   vi …………………………………………...
iii. ………………………………………………   vii ……………………………………………
iv. ………………………………………………

4.40. Where do you get the inputs? 1 = from fellow farmers in the village, 2 = large scale farmer, 3 =Vet shop at/outside the town center, 4 = Extension officer, 5= other, specify………………………………………………………………………… (   ).

4.41. What is the distance from the village to input suppliers?

Input supplier	Type of input (s) provided by supplier	Dist from a farmer/village to supplier (≈ km)
Large scale/medium scale farmer		
Vet shop at/outside the town center		
Extension officer		
Private company		
District agricultural office		

4.42. Did you get any training on good agronomic practices? 1 = Yes, 2 = No   (   )

4.43. If yes, who provided the training?

Formal training   Informal training

i. ………………………………..   i ……………………………...
ii. ………………………………..   ii ………………………………………………………
iii. ………………………………..   iii ………………………………………………………
iv. …………………………………   iv…………………………………………………………

4.44. What were the good agronomic practices learnt? 1= tillage, 2=early planting, 3= plant spacing, 4=seed selection, 5=weeding, 6=fertilizer application, 7=organic farming, 8= plant protection against pests/diseases, 9=harvesting, 10= other, specify……………………….. (   )

4.45. Fill the following table on farming practices learnt

Agronomic practice	How it is practiced(explanations)	Reasons for this practice

4.46 Are you applying the agronomic practices learnt? 1 = Yes, 2 = No   (   )

4.47 If yes, which practices have you added that you were not practicing previous years?

i. ………………………………..   v ……………………………...
ii. ………………………………..   vi ………………………………………………………
iii. ………………………………..   vii ………………………………………………………
iv. ……………………………………………………………………………………………………..

4.48 If not, why……………………………………………………………………………..?
4.49. Does extension officers pay visit to your farm(s)? 1 = Yes, 2 = No (   )
4.50. Is/are there any other than extension officers providing advice to you? 1=yes, 2=no   (   ), mention…………………………………………

4.51. What is the total rice produced and sold in the last production season?

Quantity Harvested				Sales				Buyer Type	KM to point of sale
Qty	unit	cost	unit	Qty	unit price	total rev	sales cost	1. Farmer group	
								2.Cooperative union	
								3. Consumer	
								4.Rural assembler	
								5. Middlemen	
								6. Rural grain trader	
								7. Rural wholesaler	
								8. Urban wholesaler	
								9. Urban grain trader	
								10. Exporters	
								11. Large scale farmer	

4.52. Have you ever applied for credit? 1= Yes 2= No   ( )

4.53. Did you get credit? 1 = Yes, 2 = No   (   )

4.54 What was it for? 1= financing agriculture (buying land, fertilizer, seeds, irrigation, paying labor etc), 2= off –farm activity, 3=solving family issues (education, health, food, shelter), 4=other, specify…………………………………………………………………………

4.55 Did you use it sorely for the intended cause? 1=yes, 2=no   (   )

4.56. Where were the credit from…………………….., ………………….., ………………………?

4.57. Are there medium/large scale rice farmers near you? 1=yes, 2=no   (   )

4.58. Where did the medium scale farmer come from? 1= the same village 2=neighboring village 3= urban areas (   )

4.59. What are the advantages of existence of medium scale rice farmers near you? 1=training on GAPs, 2=mechanization facilities, 3= processing facilities, 4= electricity, 5=source of input and output markets, 6=market information, 7=storage facilities, 8=transportation facilities, 9=other, specify……………………………………………………………………………………

4.60. What are the disadvantages of the existence of medium scale rice farmers in the village? 1= dispossession of land from smallholder farmers, 2= Land conflicts, 3=competition for water sources, 4= no fair competition, 4=other………………………………………………………...

4.61. How were the condition of the following before and after medium scale farmers came/started working in the village few years ago?

Item	Before	After
Road condition		
Input and output markets		
Irrigation		
Storage facilities		
Processing facilities		
Market information		

Section 5: Rice Marketing

5.1. When did you sell rice produced in the last season? 1 = before harvest, 2=soon after harvest, 3= sold when the price was high   ( )

5.2. Why did you sell at that time………………………………………………………………………?

5.3. Did you sell unprocessed rice or processed rice? 1= processed, 2 =unprocessed ( )

5.4. If you sold processed rice, why………………………………………………………………?

5.5. If you sold unprocessed rice, why……………………………………………………………?

5.6. Did you have access to processing facilities? 1=yes, 2=no   (   )

5.7. If yes, who owns the processing facility? 1= farmer, 2=private company, 3= large scale farmer, 4= government, 5= farmer's association(s), 6=other, specify……………………………………………..

5.8. How did you sell the rice produced? 1 = individually (go to question 15), 2 =through the group/association (   )

5.9. Are you in any kind of economic association? 1=yes, 2=no   (   )

5. 10. How did you form individual group (s)..?

5. 11. What were the objectives of the rice farmers' group /association in your village?

(a)………………………..……………   (b)………………………………   (c)………………………

(d)……………………………………   (e)…………………………….. (f)…………………………

5.12. What are the conditions for selling through the association?

i………………………………………………   iii………………………………………………...

ii…………………………………………   iv …………………………………………………...

5.13. What are the challenges of being in an association/group?

i………………………………………………   iii………………………………………………..

ii………………………………………………   iv …………………………………………………

5.14. What are the advantages of being in an association/group compared to individual channel?

i………………………………………………   iii………………………………………………

ii………………………………………………   iv …………………………………………………..

5.15. Did you have access to market information? 1 = Yes, 2 = No   (   )

5.16. What kind of market information do you have access to? 1= Product price 2= Potential buyers 3=Quantities demanded 4=Qualities (aroma, structure, sanitary) demanded 5= Transportation costs to the market 6=other, specify……………………………………………………………………

5.17. Where did you get the market information? 1=extension officer 2= Fellow farmer 3= private organization 4= Media (Mobile phone, radio, newspaper, TV)   **(Tick at least one response)**

5.18. What were the challenges in marketing your rice produce?

i.   ……………………………………………   iv……………………………………………………

ii.   …………………………………………   v……………………………………………………

iii.   ……………………………………………vi……………………………………………………..

SECTION 6: EXPENDITURE ON FOOD AND NON-FOOD GOODS AND SERVICES

6. 1. Did your household consume the following food groups in the last 7 days?

Food group	Description (For Interviewer)	1=yes, 0=no
1- Foods made from grains	Porridge, bread, rice, pasta/noodles or other foods made from grains	
2-White roots and tubers and plantains	White potatoes, white yams, manioc/cassava/yucca, cocoyam, taro or any other foods made from white-fleshed roots or tubers, or plantains	
3-Pulses (beans, peas and lentils)	Mature beans or peas (fresh or dried seed), lentils or bean/pea products, such as hummus, tofu and tempeh	
4- Nuts and seeds	Any tree nut, groundnut/peanut or certain seeds, or nut/seed "butters" or pastes	
5- Milk and milk products	Milk, cheese, yoghurt or other milk products	
6- Meat and poultry	Beef, pork, lamb, goat, rabbit, wild game meat, chicken, duck or other bird, eggs	
7- Fish and seafood	Fresh or dried fish, shellfish or seafood	

8- Vegetables	Green vegetables(e.g cabbages, amaranthus, spinach), carrots, tomato, onions, pumpkin, garlic, okra,	
9-Fruits	Ripe mangoes, oranges, pawpaw, pineaple, apples,	
10- Other oils and fats (not red palm oil)	Oil; fats or butter added to food or used for cooking, including extracted oils from nuts, fruits and seeds; and all animal fat	
11- Sugar-sweetened beverages	Sweetened fruit juices and "juice drinks", soft drinks/fizzy drinks, chocolate drinks, malt drinks, yoghurt drinks or sweet tea or coffee with sugar	

6.2 How many times did you consume the food group mention in question 6.1 above? (1 – 7 times)

Food group	Description (For Interviewer)	# of times/week
1- Foods made from grains	Porridge, bread, rice, pasta/noodles or other foods made from grains	
2-White roots and tubers and plantains	White potatoes, white yams, manioc/cassava/yucca, cocoyam, taro or any other foods made from white-fleshed roots or tubers, or plantains	
3-Pulses (beans, peas and lentils)	Mature beans or peas (fresh or dried seed), lentils or bean/pea products, such as hummus, tofu and tempeh	
4- Nuts and seeds	Any tree nut, groundnut/peanut or certain seeds, or nut/seed "butters" or pastes	
5- Milk and milk products	Milk, cheese, yoghurt or other milk products	
6- Meat and poultry	Beef, pork, lamb, goat, rabbit, wild game meat, chicken, duck or other bird, eggs	
7- Fish and seafood	Fresh or dried fish, shellfish or seafood	
8- Vegetables	Green vegetables(e.g cabbages, amaranthus, spinach), carrots, tomato, onions, pumpkin, garlic, okra,	
9-Fruits	Ripe mangoes, oranges, pawpaw, pineaple, apples,	
10- Other oils and fats (not red palm oil)	Oil; fats or butter added to food or used for cooking, including extracted oils from nuts, fruits and seeds; and all animal fat	
11- Sugar-sweetened beverages	Sweetened fruit juices and "juice drinks", soft drinks/fizzy drinks, chocolate drinks, malt drinks, yoghurt drinks or sweet tea or coffee with sugar	

6.3 Do you have access to health insurance? 1=yes, 0 = no

6.4. What was the expenditure (Tshs) on health insurance services in the last year?

Month	J	F	M	A	M	J	J	A	S	O	N	D	Total
NHIF													
CHF													
Other													

6.5. What was the expenditure (Tanzania shillings) on education services in the last year?

Month	J	F	M	A	M	J	J	A	S	O	N	D	Total
Expe(Tshs)													

6.6. What assets do you own?

Type of asset	Quantity	Condition		Price Purchase	Current value if it was to be sold(Tshs)
		Working/#	Not working		
Tractor					
Water pump					
Power tiller					
Plough					
Generator					
Solar Panel					
Car					

Bicycle				
Motorcycle				
House				
Livestock				
Television				
Mobile phone				
Land				
Others				

6.7. What are the types of housing materials used for roofing? 1 = Thatched roof, 2= Iron sheet roof, 3= Mud/earth roof, 4=wooden roof

6.8. What are the types of housing materials used for making floor? 1=mud/earth floor, 2= cement, 3=concrete, 4= cow dung

6.9. What are the types of housing materials used for making walls? 1=Wooden wall, 2= mud/earth, 3= cement walls, 4= brick walls

   (**Hint: Circle at least one answer from the answer choices given above**).

6.10. What is your current (2017) annual total income from all income sources?

Income source	Per day	Per week	Per month	Per season	Annual income
1. Crop production					
1.1 Maize					
1.2 Beans					
1.3 Sunflower					
1.4 Banana					
1.5 Potato					
1.6 Cassava					
1.7 Vegetables					
1.8 Fruits					
1.9					
1.10					
1.11					
2. Livestock keeping					
3. Trade eg shop, food et. c					
4. Fishing					
5. Carpentry					
6. Construction					
7. Wage from casual labor					
8. Remittances					
9. Transportation					
10. Cereal milling machine					
11.Salon					
12.Salary					
13.					
14.					
15.					
16.					
TOTAL ANNUAL INCOME					