DETERMINANTS OF TOTAL FACTOR PRODUCTIVITY OF MAIZE IN RUVUMA REGION, TANZANIA: THE EFFECT OF INPUT SUBSIDIES

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ABSTRACT

Ruvuma Region has been receiving subsidy fertilizer since the reintroduction of the NAIVS programme by the government of Tanzania in 2003/04 crop season. The current study examines the performance of small holder farmer's maize production in terms of Total Factor Productivity (TFP) and its determinants in Tanzania especially in Ruvuma Region, since it is one of the major maize's producing regions in Tanzania. More specifically the study was undertaken to estimate the TFP of maize production in Ruvuma region, to determine socio-economic factors influencing TFP of maize production and to assess the effect of input subsidy on TFP of maize. The study used secondary data for the year 2008 before the National Agricultural Input Voucher Scheme (NAIVS) and 2012 after NAIVS programme. The data was obtained from the Department of Agricultural Economics and Business, University of Dar es salaam office. Factors that affected maize TFP growth were also identified using Ordinary Least Square (OLS) model while the Chow test was used test the effect of input subsidy of TFP for maize produced by smallholder farmers. The Results reveled that NAIVS programme had a significant effect on TFP for maize production. In 2012 farmers maize TFP growth was higher (TFP=2.35) compared to 2008 (TFP=1.30) and this is equivalent to average productivity growth of 1.05 between 2008 and 2012 and the difference was highly significant (t= 3.282). There are also factors affecting TFP of maize in 2008 and 2012. Such factors are; household age, farm size, maize quantity harvested, quantity of fertilizer and voucher receipt. The Chow test indicates that the NAIVS programme positively contributed to improving maize. The study recommends that NAIVS should be upscaled and made sustainable. It also suggests that, the productivity of smallholder farmers can be enhanced by the use of fertilizers to improve agricultural yields particularly now that the government is promoting industrialization.

DECLARATION

I, Nelson Cosmas Ngalya, 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 being concurrently submitted in any other institution.

______________________ ___________________

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The above declaration is confirmed by:

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(Supervisor)

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DEDICATION

I dedicate this work to my beloved late father COSMAS JIDASUGA NGALYA who laid the foundation of my education and put all of his effort for me to fulfill my dreams. May his humble soul continue to rest in eternal peace. Amen.

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LIST OF ABBREVIATIONS AND ACRONYMS

%	Percent
ACT	Agriculture Council of Tanzania
AERC	African Economic Researech Consortium
DANIDA	Danish International Development Agency
EA	East Africa
ECDPM	European Centre for Development Policy Management
ERP	Economic Recovering Programme
ESRF	Economic and Social Research Foundation
FAO	Food and Agriculture Organization of United Nation
FAOSTAT	Food and Agriculture Organization of United Nation Statistic
GDP	Gross Domestic Product
GoT	Government of Tanzania
IITA	International Institute of Tropical Agriculture
MAFC	Ministry of Agriculture, Food and Cooperatives
NAIVS	National Agricultural Input Voucher Scheme
NBS	National Bureau of Statistics.
OLS	Ordinary Least Square
PFP	Partial Factor Productivity
RSS	Residual Sum of Squares
SAP	Structural Adjustment Program
SSA	Sub Saharan Africa
SUA	Sokoine University of Agriculture
TFP	Total Factor Productivity
URT	United Republic of Tanzania

USA	United States of America
USD	United States Dollar
VIF	Variance Inflation Factor
WEMA	Water Efficient Maize for Africa

CHAPTER ONE

1.0 INTRODUCTION

This study aimed to estimate the Total Factor Productivity of maize in Ruvuma region towards improvement of productivity as well as household food security. This chapter presents the background information relevant to the study, a statement of the problem and justification, significance of the study, research objectives, hypotheses and organization of the dissertation.

1.1 Background information

Maize is a staple food crop whose consumption is widespread across the world. It is the third most important grain after wheat and rice, with high potential for production and productivity improvement (Langade *et al.*, 2013). Maize, wheat and rice account for 94% of all cereal consumption. The consumption of these cereals varies widely by region; wheat is the preferred cereal in Central Asia, the Middle East, South and North America and Europe. Rice is the major cereal in Asia, while maize (also referred to as corn) is preferred in Southern and Eastern Africa, Central America and Mexico (Ranum *et al*., 2014).

Current world maize production is about 10.14 billion metric tons with the United States of America, China and Brazil being the top three maize-producing countries in the world. USA is the largest producer, producing over 30% followed by China 21% and Brazil 7.9% (De Groote *et al*., 2013). The entire African continent produces only 7 percent of the global supply of maize, the largest African producer being Nigeria with nearly 8 million tons, followed by South Africa (IITA, 2012). In sub-Saharan Africa (SSA), maize is the most important cereal crop and staple food for about 1.2 billion people (IITA, 2009) and occupies a third of the cultivated area (IITA, 2009).

According to FAO (2012), maize accounts for about one fifth of the total calories consumed per day and about 17% to 60% of the daily protein. Also, maize has industrial end uses for human consumption such as making flour, beer, cornflakes, starch and syrup. Maize can also be used for making animal feeds.

1.1.1 Importance of maize in Tanzania

In Tanzania, majority of households are engaged in small-scale farming for income generation and for a significant share of their food (Cochrane and D'Souza, 2015). Agricultural production in Tanzania provides employment and it is a source of livelihood for about 80% of its people and it contributes about 27% of GDP and 35% of foreign currency earnings (Muhihi *et al.*, 2012).

Maize has been identified as a key crop to enhance income generation, poverty alleviation and food security (Prasanna *et al.*, 2014). Maize was introduced in Tanzania during the 17th century and it had spread to the hinterland by the mid-19th century by Portuguese explorers and Arab traders (Suleiman and Kurt, 2015). Maize soon became an important cereal crop all over the country and it was accepted by many ethnic groups. More than half of the cultivated land in Tanzania is allocated to cereal crops but, maize is the major and most preferred staple crop among all staple and cash crops being produced (Suleiman and Kurt, 2015). Maize is grown by more than 60% of the crop-growing households, on over 40% of the cultivated land (ESRF and ECDPM, 2015).

The popularity of maize is evidenced by the fact that it is grown in all the agro-ecological zones of Tanzania. Over two million hectares of maize are planted per year with average yields ranging between 1.2–1.6 tons per hectare. Maize accounts for 31% of the total food production and constitute more than 75% of the cereal consumption in the country

(WEMA, 2010). Moreover, Tanzania is a major maize producer in Sub-Saharan Africa being ranked 1, 4 and 19 top maize producing countries in East Africa (EA), Africa and in the world (FAOSTAT, 2014). Globally, Tanzania has ranked among the top 25 maize producing countries in the world, during the last five decades (Barreiro-Hurle, 2012). Major maize producing regions include Ruvuma, Mbeya, Iringa, Rukwa, Katavi, Kilimanjaro, Kigoma, Mwanza and Tabora (Lyimo *et al.*, 2014). Most of the crop is produced by small scale farmers who are resource poor, cultivating land holdings of about 1-3 ha in a rainfed system (Lyimo *et al.*, 2014).

Agricultural subsidies to enhance maize production have been employed in Tanzania since the 1970s under the national maize project (1970-1984). The most recent subsidies programme was introduced in 2008 under the National Agricultural Input Voucher Schemes (NAIVS) which is presented in the next section.

1.1.2 National agricultural input voucher scheme (NAIVS 2008–2012) in Tanzania

The National Agricultural Input Voucher Scheme (NAIVS) is a market smart input subsidy programme designed in response to the sharp rise in global grain and fertilizer prices from 2007 and 2008. The main aim of the subsidy programme was to raise maize and rice production and thus achieve Tanzania's household and national food security (World Bank, 2014). In response to the international food price crisis of 2007/08 and poor short rains season maize harvest in Tanzania during the same period, the government of Tanzania (GoT), with significant financial support from the World Bank, established this programme (NAIVS), (from 2 districts in 2007/08 to 58 districts distributed across 11 Regions in 2008/09 (Mather, 2016). Thus, the (NAIVS) was launched as a market-smart subsidy aiming at providing small-scale farmers' access to critical agricultural inputs, such as fertilizers and improved seeds, at a 50% subsidy particularly for maize and rice (Kriti, 2013). The NAIVS invested approximately US$300 million to provide more than 2.5 million smallholder farmers with a limited quantity of subsidized fertilizer and seed, sufficient for one acre of maize or rice (World Bank, 2014).

The primary objectives of the NAIVS programme was to improve household and national food security; secondly to strengthen input supply chains for improved seed and fertilizer, and also to improve physical access to fertilizer for smallholders and reduce the financial risk involved for both smallholders and the supply chain suppliers.

1.2 Problem Statement and Justification

Improving agricultural productivity has been an important area of research by scholars and various research institutes in Tanzania in order to ensure that the needs of a growing population do not outpace the ability of producers to supply adequate maize for food and other needs. Studies by Msuya and Ashimogo (2005); Olujenyo (2008) and Avila (2010) pointed out that inefficiency is common in agriculture production. Fortunately, there is room for improving farmers' agricultural productivity but there has been limited empirical attention given to identifying specific factors that limit the potential for improving maize production efficiency. While, many studies have been conducted in different regions of Tanzania to assess the impact of subsidies on farm productivity. For example, Mng'olage (2008) in Mbeya rural district evaluated the distribution of subsidy fertilizer to smallholder's farmers' and found that there has been a significant increase in maize production level since the inception of the subsidy programme in Tanzania. Similarly, Kato (2013) conducted a study in Ruvuma to assess the impact of agricultural input subsidies on poverty in Tanzania. Another study was conducted by Edward (2013) in Morogoro to examine the impact of NAIVS on rice production at Kiroka Irrigation schemes.

According to DANIDA (2012), about 50% of maize produced in the country comes from the Southern highland regions of Ruvuma, Iringa (now subdivided to Iringa and Njombe regions), Rukwa (now subdivided to Rukwa and Katavi regions) and Mbeya (Now subdivided to Mbeya and Momba regions). Hence, there is a need to undertake research to identify factors that account for total factor productivity of maize production in Tanzania with specific reference to Ruvuma region.

Several studies have been carried out on maize production in Tanzania with a view of enhancing maize productivity. They include, Bezabih *et al.* (2011) on climate change and total factor productivity while Msuya (2007) conducted a study on maize productivity. Almost all these studies had national coverage, they lack a focus at the regional level. This creates a knowledge gap that must be filled. The current study therefore examines the performance of smallholder farmer’s maize production in terms of TFP and its determinants in Tanzania especially in Ruvuma Region, since it is one of the major maize producing regions in Tanzania.

1.2.1 Significance of the study

This study is important to planners and policy makers as the findings will help them to understand the factor affecting Total Factors Productivity for maize at the regional level especially in Ruvuma region, thereby device strategies to address the constraining factors. Based on the findings of this study planners and policy makers should be able to come up with policies, programmes and projects geared towards increasing maize productivity in order to achieve food self-sufficiency in the country.

1.3 Objectives of the Study

1.3.1 Overall objective

The overall objective of this study is to assess the determinants of TFP among maize farmers in Ruvuma region.

1.3.2 Specific objectives

i. To estimate the TFP of maize production in Ruvuma region in 2008 and 2012.
ii. To determine socio-economic factors influencing TFP of maize production in Ruvuma region.
iii. To assess the effect of input subsidy on TFP for maize in Ruvuma region.

1.4 Hypotheses of the Study

i. For the first specific objective, the null hypothesis states that; The TFP for maize production in Ruvuma region in 2008 and 2012 are the same.

Mathematically this is presented as;

H0: $TFPm_{2008}$= $TFPm_{2012}$ where $TFPm_{2008}$ and $TFPm_{2012}$ is the TFP for Ruvuma region for the year 2008 and 2012 respectively.

ii. For the second specific objective, the null hypothesis states that; Farmers' Socio-economic factors have no influence on their TFP for maize production in Ruvuma region.

Mathematically this is presented as

H0: B_i= B_j whereby Bi and B_j are regression coefficient for the i^{th} and j^{th} variable in a regression equation between TFP and the farmer's social economic characteristics.

i^{th} = individual farmer j^{th} =Farm plot.

iii. The null hypothesis for the third specific objective states that; the input subsidy since 2008 had no effect on the TFP for maize production in Ruvuma region.

Mathematically this is presented as

H0: $TFP_{2008}= TFP_{2012}$ or H0: $TFP_{2008}- TFP_{2012} = 0$ Where $TFPm_{2008}$ and $TFPm_{2012}$ is the TFP for Ruvuma region for the year 2008 and 2012 respectively.

1.5 Organization of the Dissertation

The dissertation is organized in five chapters; Chapter 1 describes the introduction that covers the background information, problem statement, objective of the study and hypotheses, Chapter II reviews relevant literature related to the study, the history of subsidy and provides an overview of the NAIVS. The methodology is covered in Chapter III while results of the study are discussed in Chapter IV. Chapter V presents the conclusion and recommendations based on the findings.

CHAPTER TWO

2.0 LITERATURE REVIEW

This section reviews some of the literature on TFP. Under this section the definition of key concepts used in the study such as NAIVS, its role, achievement, the role of subsidy fertilizer programme, analytical issue and the conceptual framework are discussed.

2.1 Definition of key Concepts

2.1.1 Productivity

Productivity is an economic measure of output per unit of input. It is defined as the efficiency of a production system presented as a ratio of units of output per unit of input in the production system (James and Carles, 1996). Productivity can be divided into two sub-concepts; Partial Factor Productivity (PFP) and Total Factor Productivity (TFP). Partial Factor Productivity is the average productivity of a single factor, measured by the total output divided by the factor applied (Andy, 2012). Meanwhile, Total factor productivity is the productivity of all factors taken together; it measures changes in output due to contemporaneous changes in all factors of production or input (Farrell, 1957). The later is more complete, hence more desirable to use because it takes into consideration changes of all the inputs used in the production process compared to partial factor productivity which measures the change in productivity given change in one of the variable input such as land or labor while other factors are held constant (Andy, 2012).

2.1.2 Production function

The relations between inputs and outputs can be described by using a production function, a cost function, profit function or a revenue function. A production function describes the technical relationship between inputs and outputs of a production process.

According to Beattie and Taylor (1985), a production function is the maximum output attainable from a given level of inputs and a given technology. A production function is presented in general mathematical form as given in equation 1 and Fig.1.

Y = f (X)…………………………………………………………………………………. (1)

Where Y is an output,

X is a vector of inputs and

f (.) is a suitable functional form

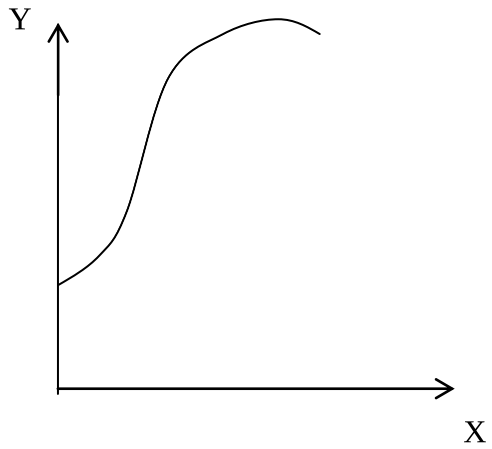

Figure 1: Production Function

Adapted from Beattie and Taylor (1985)

2.1.3 Total factor productivity (TFP)

Total factor productivity is measured as an index of aggregate output relative to a combined index of aggregate conventional inputs (Coelli *et al.*, 2005). It is a measure of economic performance that compares the amount of goods and services produced (output) to the amount of combined inputs used to produce those goods and services. Its level determines how efficiently and intensely the inputs are utilized in production (Comin, 2010).

According to Montesdeoca (2014), there are five forms of TFP. First, factors may be negatively productive, such that adding more inputs actually reduces output. Second, adding inputs may result in no change in outputs, such factors would be non-productive. Third, each additional unit of an input may raise the output slightly. Fourth, increasing inputs by 1% may raise outputs by more than 1%. In such a case factors would be positively productive. Finally, there can be a case where there is a decrease in inputs, but outputs increase, thus factors are highly productive. This occurs under conditions of technological change and management improvements that make better use of inputs. In the next section, the voucher system for providing subsidized inputs to farmers in Tanzania is discussed.

2.1.4 Importance of input voucher schemes

The input voucher system is a method of providing some goods or services to an individual who has been given funds solely for the purchase of the specified goods or services. In order to ensure that the money provided has been spent for the specified purpose, a coupon or "voucher" is given which can only be exchanged for the specified goods (Saakshi, 2009). The beneficiaries (farmers) use the voucher to acquire and use more fertilizer (i.e. in addition to what they bought without the subsidy), thereby increasing their production, income and living standards (URT, 2013). Households were given these vouchers annually for three years, after which they were expected to "graduate" and use their newly increased incomes to purchase their own inputs from the market (World Bank, 2010).

If designed correctly, use of vouchers can promote competition among sellers, providing them an incentive to improve their services. Vouchers also allow for greater economic diversity by offering small farmers opportunities to purchase inputs which were previously unaffordable. Thus, vouchers would also help to shift small farmer mindset to focus attention on how to get as much value as possible from their vouchers (Kachule and Chilongo, 2007).

In addition, vouchers reduce transaction costs since beneficiaries are given a choice on the type and quantity of the input available, thereby reducing their search cost. At the same time, it allows participation of the private sector in the factor market and it has the potential for market development at the local level (Mangisoni *et al.,* 2007). In the next section the role of a subsidy for productivity improvement is presented.

2.1.5 Role of subsidy for productivity improvement in Tanzania

A subsidy is a form of financial assistance, paid to a business or an economic sector and is used to support businesses that might otherwise fail, or to encourage activities that would otherwise not take place (Pratap and Gupta, 1991). Subsidies can be regarded as a form of protectionism or trade barrier by making domestic goods and services artificially competitive against imports. Financial assistance in the form of a subsidy may come from the government. A subsidy is the opposite of a tax in that, under a subsidy, the government pays a certain amount to a private producer in order to have them sell their commodities at a price less than the cost of producing the commodity (Saakshi, 2009). Most subsidies are set in place by the government for producers or they are distributed as subventions in an industry to prevent its decline (Todaro and Smith, 2009). Agricultural input subsidies can be a useful instrument for promoting greater equality among farmers by targeting the subsidies specifically to the poorest smallholders. Meanwhile, the poorest smallholders are most likely constrained by market failure, such as credit constraints and vulnerability to the risks of crop failures (Kato, 2016). So, providing subsidies to small-holder farmers is very important for improving productivity.

A subsidy improves both household and national food security and also reduces poverty (Wiggins, 2010). A subsidy also helps to stimulate agricultural production and improve firms' productivity. Subsidies transfer income to farmers who are poor, or those who live in remote disadvantaged areas or both (Lameck, 2016). In addition, a subsidy seeks to address imperfection in the input market and stimulate demand as well as improve utilization of productive resources thereby increases productivity (Wiggins, 2011). A subsidy for fertilizer and improved seeds under the NAIVS covering maize and rice varieties to farmers in Tanzania was expected to boost food production, reduce prices of food staples and increase incomes (Coy, 2011).

In the case of Malawi monitoring Survey report for the subsidy programme revealed that between 2005 and 2006 the number of people below the poverty line declined from 50% to 45%, which was attributed to the increase in fertilizer application from 17% of the households in 2005 to 30% in 2006. Apart from the impact of good rainfall, it was estimated that the fertilizer subsidy led to an increase in maize production by about 25% (Whitworth, 2007). After reviewing the role of subsidy for productivity improvement, the next section reviews the history of subsidy programmes in Tanzania.

2.2 Historical Review of Subsidies in Tanzania

The problem of low fertilizer use in Africa is not a recent phenomenon and there has been series of efforts to address the problem. However, the link between fertilizer policy and fertilizer use in Africa is not very direct (Hepelwa *et al*., 2013). As in many African countries, after independence, 1974-1984 the government of Tanzania subsidized agricultural inputs for a wide range of crops. The gorevenment was in fact a monopoly supplier of inorganic fertilizer (Crawford, 2006). In the years before the mid-1970s, a number of sub Saharan African countries developed food security programmes by providing subsidized inputs, farm credit, extension services and marketing facilities to farmers as well as by controlling markets and food crop prices (Maxwell, 2001). The history of input subsidy in Tanzania can be traced back to 1967 when the Tanzanian Villagization programme was adopted to agglomerate rural living units to enable rural development by providing for the rural population services such as schools, health centers, piped water, electricity and access to roads (Coulson, 1982).

The importation and distribution of agricultural inputs were state-controlled with highly subsidized input prices. The farmers subsidy programme was halted in 1982 due to the withdraw of FAO funding and inability of the government to fiancé farm (Putterman, 1995). However, the mid-1970s (1973-1976) witnessed a decline in farm production including that of food crops, mainly due to drought and the massive displacement of rural people into new ujamaa village. The economic crisis of the mid-1980s led to the commencement of the Economic Recovery Programme (ERP) in 1986 financed by the World Bank through the IMF. The ERP involve market liberalization including agricultural markets and foreign exchange, removal of domestic price controls and reform of state monopolies (Putterman, 1995).

During the early 1990s as part of the Structural Adjustment Programme (SAP), the government phased out the subsidy over a five-year period. Initially the subsidy to 70% was reduced during the 1990/91 agricultural season. Subsequent reduction occurred during 1991/92 to 55%, in 1992/93 to 40%, in 1993/94 to 25% when it was zero rated (0%) in 1994/95 (Skarstein, 2005).

Following abolition of the agricultural subsidy, a continuing decline in production of maize was observed (Isinika *et al*., 2011). In 2003/4 the government re-introduced the subsidy for inputs to support technology adoption by smallholder farmers because utilization levels of improved agricultural inputs in Tanzania had declined to very low level (URT, 2013). The subsidy was administered by subsidizing transport for companies that were directly involved in the distribution process. This was done to reduce input cost below the market price for all farmers (URT, 2013).

This led to problems related to smuggling subsidized inputs to neighboring countries, late delivery of inputs, re-bagging subsidized fertilizers in warehouses and quality deteriorating of the inputs. Many of the targeted farmers could not easily access the inputs under the programme's modalities because it was difficult to identify beneficiaries and non-beneficiaries (Aloyce *et al.*, 2014). The government therefore argued that the best way to improve national food security in the face of high international food prices was to promote the use of agricultural inputs in order to raise productivity. The NAIVS was adopted to provide farmers better access to inputs. A detailed description of the NAIVS program is presented in the next section.

2.3 National Agricultural Input Voucher Schemes (NAIVS)

The NAIVS programme was introduced in 2008/2009 to overcome the limitations of the previous subsidy programme. The objective of NAIVS was to increase smallholder farmer's access and use of critical agricultural inputs so as to increase production and productivity of food and cash crops, thereby contributing to food security and poverty reduction (Kriti, 2013). Under NAIVS, the Government expenditure on fertilizer subsidy increased from 31.9 billion in 2008/2009 to 128.7 billion in 2010/2011. Also, the quantity of subsidized fertilizers increased from 130 000 tonnes to 201 015 tonnes in 2010/2011 (Aloyce *et al.*, 2013).

The NAIVS programme was launched in 2008 to take over from the transport subsidy which was discontinued. The NAIVS provided vouchers to farmers aiming at elevating the purchasing power of smallholder farmers (World Bank, 2010). After learning about Malawi's targeted voucher approach for distributing fertilizer subsidies, the Agricultural Council of Tanzania (ACT) organized an official tour for staff from the Ministry of Agriculture, Food Security and Cooperatives (MAFC) to visit Malawi and study their voucher scheme, which ACT believed would help solve the problem of how to ensure that smallholders actually received fertilizer at a subsidized price (World Bank, 2010). For various reasons, instead of using a government parastatal to distribute both vouchers and fertilizer (as Malawi had done), the NAIVS programme was designed to accommodate the participation of private dealers to whom farmers submitted their vouchers to get inputs. According to Minot and Benson (2009) Tanzania voucher programme appeared to be more successful in promoting the development of a private distribution network.

The NAIVS programme primarily targeted the poorest farmers who had limited experience of using improved seeds and fertilizers, but they had other farming resources such as land and labour. Targeting was done so as to improve farmers' income, livelihood and overcome poverty (DANIDA, 2011). Selection of farmers to receive vouchers was based on the following criteria; Cultivating less than one hectare of maize or rice, farmers who had not applied improved agricultural inputs, as well as the needy and most vulnerable households. This reduced the risk of displacing commercial (non-subsidized) input sales and promoted pro-poor growth (Dorward, 2009).

Lastly, the recepients had to show the willingness and ability to co-finance half the cost of the voucher inputs (Aloyce *et al.*, 2014). The programme was designed to give preference to female-headed households and households with minimal experience in using improved inputs. Households were given these vouchers annually for three years, after which they were expected to "graduate" and use their newly increased income to purchase their own inputs (Mather, 2016). The NAIVS programme was piloted in 2007/2008 and fully implemented in 2008/2009, continuing each subsequent year until its final round in 2013/2014 (FAO, 2014). The next section presents the objectives and achievements of NAIVS to improve farm productivity.

2.3.1 Objectives of NAIVS to improve farm productivity

The first objective of NAIVS was to improve smallholders' physical access to fertilizer and improved seed. This was achieved by a joint public-private sector effort to improve smallholders' effective demand for inorganic fertilizer and improved seed use for maize and rice production while ensuring that the private sector was prepared and organized to deliver sufficient fertilizer and seed to specific selected districts (URT, 2009).

The second objective of NAIVS was to reduce the credit constraint for smallholders and the risk of experimentation with this new technology (URT, 2012). The NAIVS programme also provided the private sector actors fertilizer and seed supply chains with a predictable level of increased effective demand for fertilizer and seed from smallholders. This reduced the risk of supply chain actors to service areas which previously had little or no demand for fertilizer and for improved maize and rice (Mather *et al.*, 2016). In addition, NAIVS exposed farmers who had never used modern agricultural inputs to improved seeds and fertilizer. The programme aimed to raise domestic grain production levels in order to increase national grain supply in the face of rising global prices for grains and fertilizer (URT, 2012). The next section discus the achievement of NAIVS to smallholder farmers and productivity.

2.3.2 Achievement of NAIVS to productivity improvement

The implementation of NAIVS led to increase use of new technologies such as hybrid seed among the smallholder-farmers because the voucher recipients had now joined other smallholder farmers who were already using their own cash for improved seed and fertilizer (Luhanga and Sungani, 2007).

Another achievement of NAIVS has been reported as increased agricultural productivity and food production (Baltzer and Hansen, 2012). Similarly, Kato (2013) reported that the distribution of the voucher system for subsidized inputs has shown a positive impact in Ruvuma region, especially in Songea and Tunduru districts where the production of maize increased, and it has been associated with increased cash income and improved living standards. Moreover, poor smallholder farmers who are the beneficiaries of NAIVS were expected to increase crop productivity per unit area and hence reduce extensive farming/shifting cultivation (Hepelwa *et al*., 2013). The Chow Test for structural change due to the subsidy is discussed in the next section.

2.4 Chow Test for Structural Stability

The Chow test is a statistical and econometric test to assess whether the coefficients in two linear regressions on different data sets are equal. The Chow test was invented by the economist Gregory Chow (Chow, 1960). Identifying structural change in models is of major concern to econometric practitioners. The Chow test is most commonly used in time series analysis to test for the presence of a structural break over time. It is perhaps the most widely used model for this purpose (Davies, 2014). The Chow test is preferred due to posing less computational difficulty compared to alternative approaches suggested in the literature such as co-integration tests. The Chow test does not lose any degrees of freedom through loss of an observations (Campos *et al*., 1996).

Application of the Chow test requires that the number of observations in both sub-samples should be nearly the same. In situations where there is a significant difference in the number of observations between sub-samples causing greater error variability in the two data sets, a transformation of the data is necessary to assure homoscedasticity before the test can be applied (Ghilagaber, 2004). The model in effect uses an F-test to determine whether a single regression is more efficient than two separate regressions when the data is split into two sub-samples (Chow, 1960). According to Davies (2014), running a Chow test involves the following stages;

i. First, run the regression using all the data, before and after the structural break, collect residual sum of squares for the whole sample (RSS_c).

ii. Second, run two separate regressions of the data before and after the structural break, collecting the residual sum of squares (RSS) in both cases, giving residual sum of squares before break (RSS_1) and residual sum of squares after break (RSS_2).

iii. Third, using these three values, calculate the test statistic from the formula as presented in equation 2 below;

$$F - \frac{RSS_c - (RSS_1 + RSS_2)/k}{RSS_1 + RSS_2 / n - 2k} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where by:

RSS_c combined RSS

RSS_1 before break RSS

RSS_2 after break RSS

F (k, n-2k) degrees of freedom.

iv. Fourth, find the critical valuesof the F statistics from the F-test tables, in this case it has F (k, n-2k) degrees of freedom.

v. The final stage of the Chow Test is to compare the coefficients in the two models using a t-test statistic. The null hypothesis in this case states that there was no structural change, if we reject the null hypothesis; it means we have a structural change in the data.

In the context of this study, structural change will be determined by analyzing whether there is significant difference in TFP and the overall production structure of the farmers before NAIVS (2008) and TFP after NAIVS (2012), thus testing whether there is any effect input subsidy on TFP (See in 3.5.3). The next section reviews various aspect of productivity in order to guide the analysis which follows.

2.5 Empirical Estimation of Total Factor Productivity

Nin Pratt (2007) analyzed the evolution of agricultural Total Factor Productivity (TFP) for sub-Saharan Africa. Looking for evidence of recent changes in growth patterns using a non-parametric Malmquist index. Their TFP estimates show a remarkable recovery in the performance of Sub-Saharan Africa's agriculture between 1984 and 2003 after a long period of poor performance and decline. That recovery is the consequence of improved efficiency in production resulting from changes in the output structure and an adjustment in the use of inputs, including an overall net reduction in fertilizer use but increased fertilizer uses in most of the best-performing countries.

Meanwhile, Montesdeoca (2014) measured changes in (TFP) from cropping system of maize in Mato Grosso Brazil from 2005 – 2012 using farm level data. They used the Tornqvist index to analyze the input and output factors driving TFP changes. This method minimizes bias that may have resulted from relative changes in input and output cost share. The study established that the TFP of successive maize crop systems increased by

6% between 2007 and 2012. Estimation of TFP considered both agricultural inputs like land, labor, fertilizer, seeds as well as machinery to be used in the production of maize and compared them with the output.

Another study by Andy (2012) was designed to analyze maize TFP growth in Jilin province in China; the author used the Data Envelopment Analysis (DEA) method together with the Malmquist index. The result indicated that beween 1995 and 2002 maize total factor of production (TFP) grew at an average annual rate of about 0.1%, improving to 1.66% average growth rate between 2002 and 2005.

Similarly, Hassan *et al.* (2014), analyzed maize TFP in Nigeria using the Data Envelopment Analysis (DEA) method employing Malmquist Index. In the same study factors affecting maize total factor productivity were identified using Ordinary Least Square (OLS) for secondary data from 1971 to 2010. The results revealed that over a forty-year period the mean value of total factor of productivity was 1.004 implying that maize TFP in Nigeria grew by only 0.4% during that 39 years' interval. In the next section, theoretical review is presented.

2.6 Theoretical Review

2.6.1 Theory of the firm

The study was guided by the theory of the firm (production), the main assumption being that; that producers or firms are rational economic agents aiming at maximizing profit. Farmers are assumed to be rational on how they choose enterprises and make production decisions given their resource endowments. Hence, firms strive to maximize their objective given available resource. This is technically known as efficiency. Efficiency is the act of exploiting material and human resources and coordinating these resources to achieve a specific goal (Farrell, 1957). In this study, productivity and resource use efficiency are measured by the TFP.

2.7 Conceptual Framework

Maize productivity among farmers is influenced by different farm level characteristics such as the quantity of fertilizer, quantity of seeds, quantity of chemicals and the quantity of labor, as well as socio-economic characteristics such as the farmer's age, gender, educationlevel, as well as institutional factors such as extension visit. Hence, the conceptual framework for this study puts forward the relationship between the aforementioned factors and their influence on productivity as illustrated in Figure 2 below;

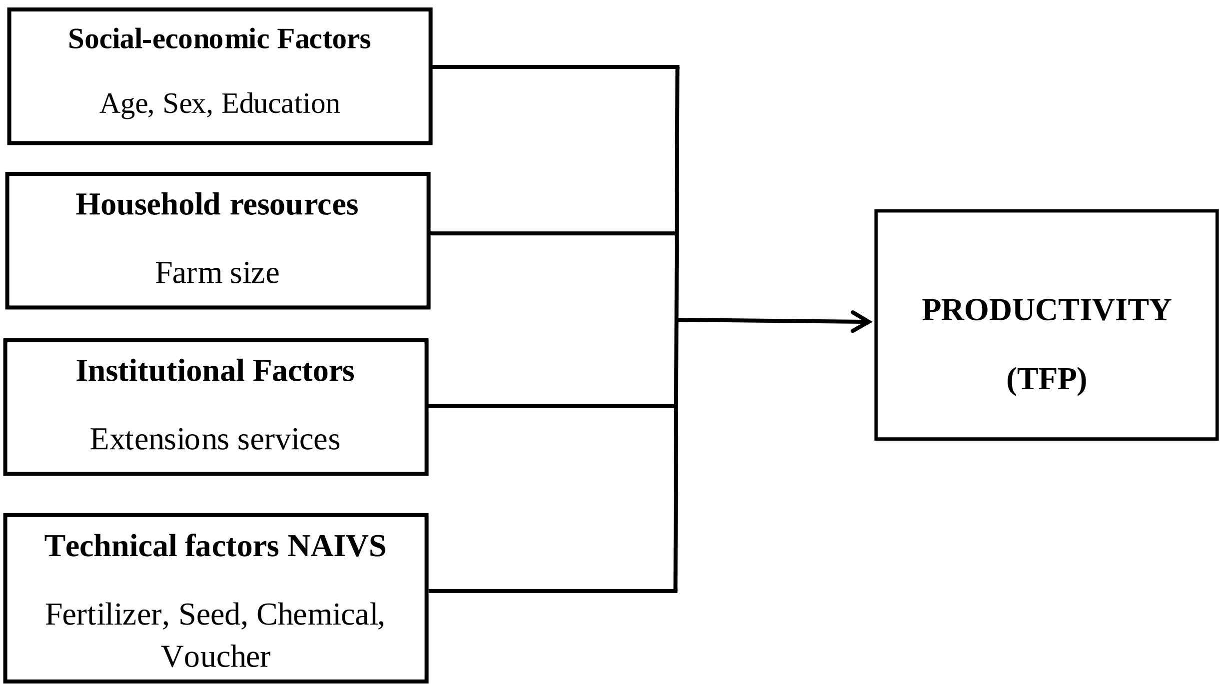

Figure 2: Conceptual Framework

Source: Own Conceptualization

CHAPTER THREE

3.0 METHODOLOGY

This section presents the methodology for this study, covering a description of the study area, followed by the research design. Then analytical tools, sources of data, data analysis and hypothesis testing are explained.

3.1 Study Area

The study was conducted in Ruvuma region which was selected because it is found within the five regions (others are Rukwa, Katavi, Iringa and Mbeya) of Tanzania which produce about 50% of maize in the country (DANIDA, 2012). Ruvuma region is located in the Southern Highland of Tanzania between latitude 11° 2' 26" South and longitude 37° 19' 45’’ East. Ruvuma region borders the Republic of Mozambique in the South, Lake Nyasa and the Republic of Malawi in the West, Njombe and Morogoro Regions in the North and Mtwara Region to the East.

The major economic activity is agriculture where maize is the main staple food crop, but also a leading cash crop. Other crops are cassava and rice used both as food and cash crops while the major cash crops grown are tobacco and cashew nuts (URT, 2012). The predominant ethnic groups in Ruvuma region are Ndendeule, Ngoni, Yao and Nindi. The Ndendeule cover about 80% of the District area.

3.2 Research Design

The study employed panel data involving two cross sections for 2008 before the commencement of NAIVS programme and 2012 after four years of implementing NAIVS. The study compared the TFP between the two periods. A cross-sectional design allows data to be collected at one point in time from individuals that are selected (Babbie, 1990). It is called cross-sectional because information that is gathered about the individuals represents what is going on at only one point in time (Chris and Diane, 2004).

3.3 Sampling Procedure

A total of 168 respondents were chosen randomly from a list of households practicing maize production in three villages; Bombambili, Mabengo and Nakawale in Ruvuma region. The following formula was used to determine sample size; $n = z^2pq/e^2$.

Where:

n = Required sample size,

t = Confidence level at 95% (standard value of 1.96),

p = Proportion of number of households cultivating maize in the project area (89% estimated),

e = Margin of error at 5% (standard value of 0.05).

Using the above equation, a sample of 150 maize household farmers was obtained. From the calculated sample size, 39 respondents were dropped due to problems of missing data, which reduced the sample size to 111 respondents for further analysis.

3.4 Source of Data

3.4.1 Secondary source of data

In order to execute models for this study, data for NAIVS programmes for 2008 and 2012 were obtained from the Department of Agricultural Economics and Business, University of Dar es salaam office. The data were processed using analytical models as derived under equation 3 and 6 in the next section. The specific data which was collected are as indicated in Appendix 1.

3.5 Analytical Tool and Hypotheses Testing

In this section the analytical tools for addressing each of the study objectives are derived.

3.5.1 Estimating total factor productivity

The first specific objective states that; to estimate the TFP for maize production in Ruvuma region between two time periods 2008 and 2012. The approach by Key and Mc bride (2003) for determining total factor productivity was adopted. This is given in equation 3 below;

$$TFP_i = \frac{PyY_i}{\sum_i^n P_{ij}X_{ij}} \qquad (3)$$

i= *1,2,3,…………n* *and for* *j= 1,2,3……..k*

Where;

TFP_i = Total factor productivity of the i^{th} farmer.

Y_i = Quantity of maize produced i^{th} farmer.

P_{yi} = Price of maize obtained by i^{th} farmer

P_{ij} = Price of j input used by i^{th} farmer.

X_{ij} = Quantity of j^{th} input used by the i^{th} farmer.

3.5.2 Factor that influence TFP

The second specific objective states that; to determine socio-economic factors influencing TFP of maize production in Ruvuma region for which an Ordinary Least Square (OLS) model was employed in order to predict the effect of independent variables on total factor productivity of maize.

The total factor productivity index computed for each farmer was used as the dependent variable, while the independent variables included their farm level characteristics such as quantity of fertilizer, farm size, voucher, quantity of maize harvested, as well as their socio-economic factors such as education, sex and age as all these are presumed to affect maize total factor productivity in Ruvuma region.

Using the TFP computed under the previous analytical model as an independent variable, an OLS model as presented in equation 4 was used to assess the effect of variation in independent variables on TFP. McDonal (2008); Banker and Natarajan (2008) used this approach to estimate the impact of contextual variables on productivity. Assuming a three-factor Cobb-Douglas production function for a representative economy at time *t* as it was presented in equation 4.

$$Y(t)= A(t)\left(K(t)^{\alpha} L(t)^{\beta} I(t)^{\gamma}\right), \ldots\ldots(4)$$

Where;

Y(t)= Output,

K(t)= Stock of physical capital,

L(t)= Labour,

I(t)= Land,

A(t)= Estimable exogenous technology, and

α, β, γ are parameters of the production function to be estimated. By natural logarithm transformation equation 4 becomes equation 5.

$$lnY(t) = ln\,A(t)+\alpha \ln\left(K(t)+\beta \ln L(t)+\gamma \ln I(t)\right) \ldots\ldots(5)$$

Equation 5 was adopted for determining factors that influence variation in TFP among maize farmers in Ruvuma region as presented in equation 6.

$$lnY = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 \ldots\ldots \quad (6)$$

Where;

lnY = Natural log for the maize total factor productivity scores as the dependent variable,

X_1= Quantity of fertilizer

X_2= Quantity of maize harvested,

X_3= Age

X_4= Sex

X_5= Education

X_6= Voucher

X_7= Farm size and

X_8 = Marital status

The coefficients β_0 represents the technology. While coefficient β_1----- β_8 are unknown parameters to be estimated, ε represents the error term that takes care of unobserved variables.

Table 1: Description of the explanatory variables used and their prior signs in determining the influence of socio-economic factors on TFP

Variable	Description	Expected sign
X_1= Age	Age of farmers measured in years	–
X_2= Education level	Highly educated farmers are more likely to participate in maize productivity than those with lower education levels	+
X_3= Farm size	Farm size measured in acres	+
X_4=Maize quantity harvested	Quantity of maize measured in kg	+
X_5= voucher	If a farmer uses improved maize seed	+
X_6= Sex	Males are likely to access voucher than female	+
X_7= Quantity of fertilizer	Quantity of fertilizer measured in kg	+
X_8=Marital status	Married households are more productive	+

3.5.3 Testing for TFP change

The third specific objective states that; to assess the effect of input subsidy on TFP of maize in Ruvuma region. The effect of input subsidy was analyzed using a Chow Test since it is able to show if corresponding regression coefficients are different for a split data set. The Chow Test was presented in equation 2 and repeated here;

$$CHOW = \frac{(RSS_P - (RSS_{2008} + RSS_{2012}))/k}{(RSS_{2008} + RSS_{2012})/(N_{2008} + N_{2012} - 2K)} \sim F_{\alpha, k+1, N_{2008}+N_{2012}-2K-2} \quad \ldots (7)$$

Whereby;

RSS_P = Pooled (combined) regression line,

RSS_{2008} = Regression line before break,

RSS_{2012} = Regression line after break,

$N_{2008} + N_{2012} - K$= Degree of freedom and

K= Number of parameters

The F values obtained from the analysis is then compared to the F value from the F table. The null hypothesis in this case states that there was no structural change in TFP resulting from the NAIVS subsidy. The alternative hypothesis states there was a structural change in TFP resulting from the NAIVS subsidy. In addition, a t test was used to show the effect of inputs subsidy by comparing the individual coefficients as shown in equation 8 below:

$\hat{\beta}_i = \hat{\beta}_j = 0$...(8)

Whereby

$\hat{\beta}_i$and $\hat{\beta}_j$ are the coefficient of $_I$ and $_j$ farmer are the same

3.6 Data Analysis

Survey data were coded and summarized using the statistical package for social science software version 16 (SPSS) programme at Sokoine University of Agriculture (SUA), before being transferred to STATA 11 software for analysis. The analyses to address each of the specific objectives were done according to analytical models derived in the previous section.

3.6.1 Objective one

The first objective sought to estimate the TFP of each respondent. Estimation was done according to equation 3. The null hypothesis states that; the TFP for maize production in Ruvuma region in 2008 is similar to that of 2012. In order to test the null hypothesis a paired t test was used as shown in equation 9.

$$t = \frac{[\hat{\beta}_{0(2012)}] - [\hat{\beta}_{0(2008)}]}{Se[\hat{\beta}_{0(2012)}] + Se[\hat{\beta}_{0(2008)}] - Cov[\hat{\beta}_{0(2008)}\hat{\beta}_{0(2012)}]} \sim N(0,\sigma^2) \ldots\ldots(9)$$

3.6.2 Objective two

The second objective intended to determine the effect of changes in selected independent variables on the variation on TFP. Estimation was done according to equation 6. The corresponding null hypothesis states that; Farmer's Socio-economic factors have no influence on the TFP for maize production in Ruvuma region. In order to test the null hypothesis t test was used as shown in equation 10 below:

$$\hat{\beta}_i = \hat{\beta}_j = 0 \ldots\ldots(10)$$

Whereby

$\hat{\beta}_i$ and $\hat{\beta}_j$ are the coefficient of $_I$ and $_j$ farmer are the same

3.6.3 Objective three

The third objective tested for structural change in the TFP as well as the individual coefficients due to introduction of the NAIVS programme using Chow Test. The Chow test was estimated according to equation 7. The corresponding null hypothesis states that; The TFP in 2008 before the subsidy is not significant different from the TFP in 2012 after the subsidy was introduced. This null hypothesis was tested using the Chow Test shown in equation 11 below;

$$CHOW = \frac{(RSS_P - (RSS_{2008} + RSS_{2012}))/k}{(RSS_{2008} + RSS_{2012})/(N_{2008} + N_{2012} - 2K)} \sim F_{\alpha, k+1, N_{2008} + N_{2012} - 2K - 2} \ldots..(11)$$

Whereby;

RSS_P = Pooled (combined) regression line,

RSS_{2008} = Regression line before break,

RSS_{2012} = Regression line after break,

$N_{2008} + N_{2012} - K$ = Degree of freedom and

K= Number of parameters.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents results based on the analyses as presented in the previous chapter. Section 4.1 presents the Socio-economic characteristics of the respondents. Section 4.2 presents the estimation of TFP and section 4.3 presents the OLS analysis results regarding the influence of socio-economic factors on TFP of maize in Ruvuma region. The last section (4.4), presents results from the Chow test to assess whether there is significant structural change in TFP before introducing NAIVS in 2008 and after implementing NAIVS for four years in 2012. This basically test whether there was a change in productivity measured by TFP following the expansion of the input subsidy programme in 2008 to cover fertilizer and improved seed.

4.1 Socio-economic Characteristics of the Respondents

4.1.1 Sex of the household head

Results from Table 2 show that majority of the households in the sample for Ruvuma region were male headed both in 2008 and 2012 being 85.6% and 83.8% respectively. Since, more than three quarters of the households were headed by male in both time periods which is consistent with the national data, female headed households constitute about 14.4% and 16.2% in 2008 and 2012. The fact that the percentage of male headed household is higher than female headed household can have an implication on decision making and the rate of market participation for agricultural output as Ruhangawebare (2010) observed that men are more involved in daily management of farming activities and thus they have more power upon making decision on agricultural output to be sold and the kind of inputs to be purchased.

Table 2: Socio-economic Characteristics of the Respondents

	2008			2012	
	Freq.	**Percent**		**Freq.**	**Percent**
Sex of head			**Sex of head**		
Female	16	14.4	Female	18	16.2
Male	95	85.6	Male	93	83.8
Age of Head			**Age of Head**		
21-30	17	15.3	21-30	6	5.4
31-40	31	27.9	31-40	27	24.3
41-50	30	27.1	41-50	34	30.6
51-60	17	15.3	51-60	21	18.9
Over 60Years	16	14.4	Over 60Years	23	20.7
Education Level			**Education Level**		
No formal education	1	0.9	No formal education	1	0.9
Primary education	101	91	Primary education	101	90.9
Secondary education	6	5.4	Secondary education	6	5.4
Tertiary education	3	2.7	Tertiary education	3	2.7
Marital			**Marital**		
Not Married	17	15.3	Not Married	17	15.3
Married	94	84.6	Married	94	84.7
Farm Size (hectares)			**Farm (hectares)**		
<5	105	94.6	<5	91	82
5-9	5	4.5	5-9	13	11.7
>9	1	0.9	>9	7	6.3
Total	111	100	Total	111	100

4.1.2 Age of the household head

The findings for the whole sample from Table 2 shows that majority (about 55%) in 2008 and 54.9% in 2012) of the households fall under the age category between 31 years and 50 years. This implies that maize productivity is mostly carried out by farmers who are in the economically active group aged between (31-40 and 41-50). The findings are supported by Bluemling and Mosler (2010) in their study on adoption of agricultural water conservation practices in China where they found that most adopters were within the economically working age ranging from 41-50 years. This group of farmers has a significant influence on decision making for adopting improved agricultural technologies. Also, they tend to devote more of their working time in agricultural operations which could lead to increased productivity (Babangida, 2016).

4.1.3 Education level of the household head

In relation to education in Table 2 show that majority of the households in the sample for Ruvuma region completed primary education both in 2008 and 2012 being 91% and 90.9% respectively. Very few household heads had attained secondary level of education being 5.4% in both 2008 and 2012. Primary education provides farmers basic abilities for acquiring new skills and adopting technology for improving maize productivity. Given their basic literacy and numeracy in Kiswahili it can be relatively easy and less expensive for farmers to adopt basic farming skills compared to those who did not have school at all. Mwangi and Nyanda who did their studies in 2015 indicated that education has a positive impact on adopting new agricultural technologies, which can influence farmers to use improved varieties leading to increasing productivity.

4.1.4 Marital status of the household head

With respect to marital status, majority of the sampled households in Table 2 in Ruvuma region involved in maize production were married couples being 84.6% and 84.7% in both 2008 and 2012 respectively. Less than one fifth of farmers involved in maize production were not married being 15.3% in both 2008 and 2012. In such households the female head would lead decision making regarding maize production. Often, married respondents have extra household labour for the farmers to engage in farming activities. The findings are consistent with Siri *et al*. (2016) who reported that married famers are more likely use family labour in productive activities.

4.1.5 Farm size of the household head

On farm size, results of the sample households show that, more than three quarters of farmers owned less than 5 hectares of land in both 2008 and 2012 being 94.6% and 82% respectively. About 0.9% of all farmers owned more than 9 hectares of land in 2008 and in 2012 about 6.3% of the farmers owned the same hectares. Also, 4.5% and 11.7% of famers owned between 5-9 Acres of land in 2008 and 2012 respectively, impliying that the proportional of households wirth larger farms increased in 2012 compared to 2008. This result is similar to Simtowe *et al.* (2007) who found that more small holder’s farmers hold land that is less than 5 hectares.

4.2 Estimation of TFP

The output in Table 3 provide descriptive statistics for average TFP of maize production in Ruvuma region between two time periods 2008 and 2012 by including the mean, median, maximum, minimum and standard deviation.

Table 3: Results for computation of TFP for 2008 and 2012

Variable	Mean	Sd	Medium	Max	Min	t -value
TFP_2012	2.35	0.08	1.09	12.55	0.11	
TFP_2008	1.30	0.30	1.07	4.61	0.02	
TFP Pooled	1.83	0.16	1.07	12.55	0.02	
Difference (TFP2012-TFP2008)	1.05	0.32	-	-	-	3.282
T value	3.282					

The analysis of estimation of TFP between 2008 and 2012 is presented on Table 3. From the results the mean TFP was 1.30 in 2008 and 2.35 in 2012 as shown in Table 3. This is equivalent to average productivity growth of 1.05 between 2008 and 2012 which is significant at 1% (t= 3.282). This means that participants of the schemes under the two periods were productive, but production improved during the NAIVS period. The improvement in productivity could be attributed to, among other factors such as introduction of subsides program (NAIVS).

The results also show the maximum and minimum of TFP among participants in 2008 being 4.61 and 0.02 respectively, with the medium of 1.07. However, looking at TFP for 2012, we observe variation between the maximum and minimum value of TFP. The maximum and minimum value of TFP for 2012 was 12.55 and 0.11 respectively, with the medium of 1.09. Looking at the TFP for the two periods, we observe an improvement in TFP growth between the two periods, which can also be attributed by the NAIVS programme. The findings are consistent with those of Kreuser, (2018) in his paper where he used a firm level data for the period 2010-2013 to estimate Total Factor Productivity in the South African manufacturing sector. They examined differences in the level and growth of productivity across manufacturing subsectors and examine the heterogeneity in productivity levels within sectors. The results revealed that productivity grew in most subsectors but there is heterogeneity across subsectors in the pace of growth. The results also reveled that firm size is positively correlated with productivity and its growth rate. Also, there is productivity premium associated with engaging in rural development and international trade.

Similarly, findings by Rezek *et al*. (2011) who estimated TFP growth in agriculture for a panel of 39 sub-Saharan African countries from 1961 to 2007. They also developed a set of outcome measures theoretically consistent with strong agricultural performance to serve as external validation of our results. The results reveled that, three estimation methods (stochastic frontier, generalised maximum entropy and Bayesian efficiency) generated relative rankings that are consistent with the development outcome measures, providing external validation of the methods.

4.3 Influence of Socio-Economic Factors on Maize TFP

4.3.1 Model stability

Multi-collinearity and heteroscedasticity test were done to assess the model accuracy and stability. In testing for multicollinearity (exact linear relationship amongst explanatory variables) the Variance Inflation Factor (VIF) was computed while the Breusch Pagan test was conducted to examine the variance of errors in the model. It was found that, VIF was 2.28 (below a threshold value of 5) implying that, there was no problem of multi-collinearity in the model. Moreover, the Breusch-Pagan post estimation test for heteroscedasticity was carried out and the Chi square (chi2(1)) =16.53 prob>chi2=0.0000 which means errors have constant variation. Regression results provided in Table 4 show the R^2 was 35% in 2008, 38% in 2012 and 40% for the pooled respectively.

This indicates that 35%, 38% and 40% of the variation in TFP is explained by all independent variables included in the model. The overall F-statistic is 4.54 in 2008, 4.18 in 2012 and 10.86 from pooled sample which is statistically significant ($p < 0.000$). This shows that the dependent variable is significantly jointly explained by the independent variables.

Table 4: Results of the ordinary least square 2008, 2012 and pooled

		TFP 2008			TFP 2012			TFP Pooled		
Variables	**Exp. signs**	**Coef.**	**Std. Err.**	**T**	**Coef.**	**Std. Err.**	**T**	**Coef.**	**Std. Err.**	**T**
Constant		1.6155	0.4709	3.43***	1.8253	0.7034	0.48	2.2795	0.7018	3.23***
HH head Age	-	-0.0113	0.0056	-2.04**	0.0404	0.0208	1.95**	-0.0110	0.0065	-1.70*
Education	+	0.1583	0.2770	0.57	-0.3211	0.9862	-0.33	0.2502	0.5387	1.74*
Farm size	+	0.2172	0.0621	-3.49***	-0.2152	0.0857	-2.51***	0.8166	0.0444	2.63***
Qty of maize harvested	+	0.0003	0.0001	4.76***	0.0001	0.0000	4.74***	0.1001	0.0211	4.74***
Voucher	+	-0.1395	0.2707	-0.52	0.5764	0.9778	0.59	0.6761	0.3953	1.71*
Sex of HH	+	0.0076	0.2606	0.03	-0.7590	0.8415	-0.9	0.2754	0.4597	1.69*
Qty of fertilizer	+	-0.0005	0.0002	-2.15**	0.0010	0.0004	2.39***	0.2720	0.0680	4.02***
Marital status	+	0.2313	0.2541	0.91	-0.4771	0.8660	-0.55	0.2720	0.0660	4.12
	Number of obs = 111 **F (8, 102) = 4.54** **Prob > F = 0.000** **R-squared = 0.356** **Adj R-square = 0.328** **VIF = 2.28**				**Number of obs = 111** **F (8, 102) = 4.18** **Prob > F = 0.000** **R-squared = 0.382** **Adj R-square = 0.317** **VIF = 2.28**			**Number of obs = 222** **F (8, 213) = 10.86** **Prob > F = 0.000** **R-squared = 0.409** **Adj R-square = 0.374** **VIF = 2.28**		

*, ** and *** statistically significant at 10%, 5% and 1% significance levels respectively

4.3.2 Socio-economic factors influencing TFP in Ruvuma region

Multiple linear regression model was estimated by Ordinary Least Square (OLS) to identify the determinants of the TFP of maize in Ruvuma region. Regression results presented in Table 4 shows that household age, farm size, maize quantity harvested and quantity of fertilizer in 2008 and 2012 were positive as expected and statistically significant compared to pooled results whereby the quantity of fertilizers, age of household, education, sex, farm size and voucher were significant in determining maize TFP.

The coefficients for age of households in 2008 as shown in Table 4 had a negative relationship with TFP but was positive in 2012 and statistically significant at 5% in both time periods. This imply that from 2008 as age increased by one year, TFP tends to decrease by -1.13% meaning that older farmers become less productive compared to younger farmers during the NAIVS programme. Younger farmers have more energy to devote enough time to farming which could increase their TFP. It may also be reasonable to argue that younger farmers are more receptive of new technologies and more risk taking than older farmers.

These findings are similar to those by Langyintuo and Mulugetta (2005) in assessing the influence of neighborhood effects on the adoption of improved agricultural technologies in developing agriculture; Rahelizatovo and Barham *et al*. (2004), in adoption of best-management practices by Louisiana dairy producers who found a negative influence of age to technology adoption and productivity. Meanwhile, the age of household heads in 2012 had a positive relationship with TFP implying that older people were more productive in 2012 than in 2008. It means that farming experience such as management skills improved over time contributing to the productivity gains. Results for the pooled data coefficient is negative and statistically significant at 10% which means the data for 2008 had a stronger influence on the pooled data compared to the data for 2012.

With regards to farm size as revealed in Table 4, the coefficient (0.2172) is positive (p< 0.000) in 2008 implying a positive influence of this variable on TFP, but it was negative in 2012 and statistically significant at 1%. This means in 2008, as the farm size increase by 1 acre, the TFP will also increase by 0.2172. The implication of these findings is that changes in agricultural productivity are also attributed to expansion of area under production. This result is similar to those found by (Simtowe *et al.*, 2007); Langytuo and Mekuria, 2008), who found that farmers with large pieces of land can afford to be more experimental because for them even a more relatively small percentage of their total land may be large enough to support land-intensive technology. In contrast the coefficient for 2012 is negative (-0.2152) which implies that farmers with smaller farms had higher TFP. This is consistent with NAIVS since it targeted farmers who had 2 hectares or less implying that farmers with small farms were more likely to receive vouchers and therefore applied inputs on their farms. The coefficient for pooled data is (0.8166) positive (p< 0.000) which means the data for 2008 had a stronger influence on the pooled data compared to the data for 2012.

Furthermore, the coefficients for maize quantity harvested were positive being 0.0003 and 0.0001 for 2008 and 2012 respectively highly significant (p< 0.01) in both years. This implies that an increase the maize quantity harvested by 1% will increase TFP by 0.0003% in 2008 and 0.0001% in 2012 under statistically *ceteris paribus*. The coefficient for pooled data is positive (0.1001) and highly significant (p< 0.000) implies that an increase the maize quantity harvested by 1% will increase TFP for maize by 0.1%. This increase could be explained by the introduction of the NAIVS program in the sense that the use of the voucher system brought farmers to the use of good technology.

The coefficient for the quantity of fertilizer in 2008 is negative (-0.0005) and highly significant ($p< 0.05$) implying that farmers who applied fertilizer scored a lower TFP. But the coefficient was positive in 2012 (0.001) and statistically significant ($p< 0.01$). These results mean that in 2008 as farmers increased the quantity of fertilizer by 1%; the TFP will decrease by 0.005% holding other factors constant. This may be due to the fact that % of farmers using fertilizers in 2008 could be so small that fertilizer contributed little to explaining variation in TFP. In contrast the data for 2012 shows that as you increase the quantity of fertilizer by 1%, the TFP will increase by 0.001% *ceteris paribus.* This implies that those famers who used more fertilizers appeared to have high TFP than those who did not use fertilizers. The coefficients for pooled data (0.272) is also positive and statistically significant ($p< 0.01$).

The coefficients for education (0.1583), sex (0.0076) and marital status (0.2313) were positive but insignificant implying that a 1% increase of the corresponding variable would raise the TFP by the value of the corresponding coefficient. The corresponding value for 2012 were (-0.3211) for education, (-0.759) for sex of household heads and (-0.4771) for marital status. On the other hand, voucher was expected to be significant after NAIVS in 2012 but it was observed to be insignificant and this can be due to the small sample size. So, as we pool the sample significant effect could be seen. The results in Table 4 for pooled data, shows that voucher had a positive influence in TFP and statistically significant at 10%. This implies that an increase in unit of voucher by 1% would lead to increase in TFP by 0.6761. Voucher beneficiary farmers have more aggregate TFP than non-voucher beneficiaries. These findings imply that vouchers enable farmers to access and use critical farm inputs such as seeds and fertilizers. This attest to assertion by Gabagambi (2003) who posited that, increase in agricultural productivity was achieved through use of necessary farm inputs. In Ghana a 49% subsidy and establishment of 400 fertilizer retail outlets increased the use of fertilizers among smallholder farmers (Holden and Lunduka, 2010; Ogada *et al.,* 2010).

From the pooled data, except for age of household which is negative (-0.011), all the remaining coefficients are positive implying that a 1% increase in the variable would lead to a change in TFP by (%) equivalent to the coefficients being 0.2502 for education of the household head, 0.8166% for farm size, 0.1% for quantity of maize harvested, 0.6761% for voucher receipts, 0.2754% of male household heads, 0.272% for quantity of fertilizer used and 0.272% if respondent was married.

4.4 Chow Test for Structural Change

The Chow test was used to test for structural change in the TFP as well as the individual coefficients before the NAIVS programme in 2008 and after four years of implementing the programme. The null and alternative hypotheses are stated below;

H0: No structural change between 2008 and 2012

$TFP_{2008} = TFP_{2012}$ or $TFP_{2008} - TFP_{2012} = 0$

H1: There is structural change between 2008 and 2012

$TFP_{2012} > TFP_{2008}$

The Chow test was computed according to equation 11. Result from the chow test indicates that the chow statistics which follow under F distribution is equal to 11.7, which is larger than the tabulated value (3.265). In this regards the data shows there is a significant structural change between the two time periods (2008 and 2012).

Table 5: ANOVA 2008, 2012 and Combined

Source	SS	Df	MS	F Value
Model	23.3133	8	2.914	4.54
RSS _2008	65.4471	102	0.641	
Total	88.7605	110	0.807	
Model	51.585	8	6.448	4.18
RSS_2012	157.192	102	1.541	
Total	208.777	110	7.989	
Model	132.846	8	16.606	10.8
RSS_Pooled	324.237	212	1.529	
Total	49.608	221	0.224	

This means introduction of the NAIVS programme whereby vouchers receipts were distributed to farmers enabled them to acquire improved seed and fertilizer, thereby improving their productivity which contributed them to attaining higher mean value in 2012 (TFP=2.35) relative to 2008 (TFP=1.30) and the difference was highly significant (t=3.282). There was a likewise a significant between the maximum and minimum value of the two periods (Table 3).

The findings are consistent with Otieno *et al*. (2009) who used the Chow test to compare the intensity of market participation among rural and urban vegetable farmers in Kenya. Results showed that there is significant difference in the percentage of output sold, distance from farm to market and the unit price of sales for output between the rural and urban areas. Results of the current study are also similar to those by Bardhana *et al*. (2012) who analyzed factors that determine dairy farmers' choice of marketing channel and to what degree their market choice influence the level of commercialization or market participation in Uttarakhand in India. The Chow test was used to examine differences between data from diverse regions (plains and hill). Their results showed that, distance to market has negatively influenced likelihood of producers' market participation, irrespective of hills or plains.

4.5 Summary of the Findings

Generally, the NAIVS programme had a significant effect on TFP on maize production. In 2012 farmers maize TFP growth was higher compared to 2008. The mean value in 2012 (TFP=2.35) relative to 2008 (TFP=1.30) and this is equivalent to productivity growth of 1.05 between 2008 and 2012 and the difference was highly significant (t= 3.282). Looking at the TFP for the two periods, we also observe a significant difference between the maximum and minimum improvement during the two periods, which can also be attributed by the NAIVS programme.

There are also different factors affecting TFP of maize in 2008 before the programme and in 2012 after the programme. Such factors are household age, farm size, maize quantity harvested, quantity of fertilizer and voucher. From the pooled data, except for age of household which is negative (-0.011), all the remaining coefficients are positive implying that a 1% increase in the variable would lead to a change in TFP by percentage (%). The Chow test statistics which follow under F distribution is equal to 11.7, which is larger than the tabulated value (3.265). In this regards the data shows there is a significant structural change between the two time periods (2008 and 2012). Hence, the Chow test indicates that the NAIVS programme positively contributed on productivity improvement of maize for farmers with small farms, who were targeted by the NAIVS programme.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study aimed at examining the performance of small holder farmer's maize production in terms of TFP and its determinants in Tanzania especially in Ruvuma Region. Achievement of this objective was addressed by performing several analyses including, computation of TFP for maize production in Ruvuma region in 2008 and 2012, determining socio-economic factors influencing TFP of maize production and testing for structural change in TFP between the two periods.

From the present findings it was concluded that average mean TFP after introduction of NAIVS programme was higher (2.35) in 2012 compared to the mean TFP of the maize production before the programme (1.30) in 2008. This shows that NAIVS programme had a significant effect on TFP for maize production because farmers productivity growth in 2012 was higher compared to 2008.

Regression analysis was conducted to identify factors which affecting TFP of maize farmers. It was found that factors which had a negative significant effect on TFP before NAIVS programme (2008) were households age (-0.0113) and quantity of fertilizer (-0.0005) but the maize quantity harvested and farm size had a significant positive effect on TFP being (0.0003) and (0.2172) respectively. In contrast factors which affected TFP significantly positively after NAIVS progamme (2012) were households age (0.0404), quantity of maize harvested (0.0001) and quantity of fertilizer (0.001). Only farm size affected TFP significantly negative (-0.2152) implying that NAIVS has successful reached smaller farms which had been targeted by the programme. The results obtained from regression and also the Chow test, indicate that NAIVS programme have significant effect on TFP for maize. In fact, the probability of TFP to increase by 0.6761 and 0.2720 due to fertilizers and voucher increase by 1%. This can be attributed to the introduction of the NAIVS program whereby vouchers were given to the smallholder farmers so that they can be able to improve their productivity.

5.2 Recommendations

Based on the discussions above, the following recommendations can be drawn from this study to stakeholders in the maize subsectors including policy makers, farmers and researchers in future for attaining better performance of maize productivity and improving the performance of subsidy programmes;

i. It is recommended that; NAIVS should be upscaled and target more beneficiaries to such a time that farmers would graduate to replace subsidized with commercial input.

ii. The findings indicate that quantity of fertilizer, households age and maize quantity harvested have a significant positive influence on TFP of maize productivity. It suggests that, productivity of smallholder farmers can be enhanced by the use of fertilizers. Hence, agricultural intervention that considers the importance of fertilizer should be promoted in order to reach large number of smallholder's farmers to improve agricultural productivity.

iii. Since the input subsidy shows a positive effect on TFP after NAIVS proramme, it is recommended that the government should assist the farmers in developing their capacity on fertilizers usage along with complementary measures such as emphasize improved agronomic practices to maximize the effect of fertilizers for improving productivity.

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APPENDICES

Appendix 1: Required Data and Sources of Data

S/N	Analytical model	Type of Data	Source of data
1	Computation of TFP	Maize yield for each farmer in 2008 and 2008	NAIVS 2008 and 2012
		Type of maize seed used (binary variable 1 for improved, 0 for local) for 2008 and 2012	
		Quantity of seed used (Kg) by the i^{th} farmer	
		Price of seed for i^{th} farmer	
		Quantity of inorganic fertilizer by type (nitrogenous, phosphate, compound etc)	
		Value of input used	
2	OLS factors influencing variation of TFP	TFP for each farmer in the sample	NAIVS 2008 and 2012
		Quantity of fertilizer	
		Quantity of maize harvested	
		Each farmer’s sex	
		Farm size	
		Each farmer’s age	
		Each farmer’s educational level	
		Voucher	
		Marital status	