A COMPARATIVE ANALYSIS OF BUSINESS MODELS OF TWO-WHEEL TRACTORS IN BABATI DISTRICT, MANYARA REGION, TANZANIA

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ABSTRACT

The study was conducted in Babati district in Manyara Region to sightsee the viable business model for supplying two-wheel tractors to the farmers whether individual or formal group of farmers. In this study, the influence of socio-economic factors and institution factors in adopting and purchasing two-wheel tractors were identified. The methodology involved a cross-sectional research design with sample size of 88 farmers from both owners and non-owners. Purposive sampling technique was used to select Babati district among five districts in Manyara region and systematic sampling was employed to select key informants. The main methods of data collection used were structured questionnaires and interview. Descriptive and inferential statistical analyses were undertaken for qualitative and quantitative data analysis using Statistical Package for Social Sciences. For the owners of Two-Wheels Tractors (2WTs), 63.6% were in age category of 31-70, 90.9% were male and more than 90% with household members less to 10, 68.2% have more than 16 acres of land size cultivated. Binary logistic regression was: Land size was statistically significant and is positively related to the ownership and purchasing of 2WTs at 1%, age of the farmer is statistically significant and is positively at 5% while household size was negative statistically significant at 5%. From cost-benefit analysis findings using CBA at 23% discount rate, individual business model had B/C ratio of 2.59 while for group business model had B/C ratio of 1.47, indicating that individual business model is viable. The study recommends that incentives for agriculture investors that include zero-rated duty on farm inputs including fertilizer, seeds, tractors and zero rated VAT on agricultural exports to be encouraged.

DECLARATION

I, **Baraka Mbesa**, 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.

06.03.2017

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The above declaration is confirmed

13.03.2017

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Date

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DEDICATION

This dissertation is dedicated to my parents Mr. John and Mrs. Grace Mbesa whom together laid the foundation for my education, patience and support they showed up during the time I was studying up to the very end of writing this dissertation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS AND ACRONYMS

AGITF	Agricultural Inputs Trust Fund
ASDS	Agricultural Sector Development Strategy
BCR	Benefit-Cost ratio
CAMARTEC	Center for Agriculture Mechanization and Rural Technology
CIMMYT	International Maize and Wheat Center
DASIP	District Agriculture Sector Investment Project
EGM	Expert Group Meeting
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GO	Government Organization
IRR	Internal Rate of Return
KKIGR	Kilimo Kwanza Initiative for Green Revolution
NBS	National Bureau of Statistics
NGO	Non-Government Organizations
NPV	Net Present Value
SACCOS	Savings and Credit Co-operative Society
SSA	Sub-Saharan Africa
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
URT	United Republic of Tanzania

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Most developing countries and, indeed, African countries have an economy strongly dominated by the agriculture sector accounting on average for 15% of Gross Domestic Product (GDP), contributing more than 80% of trade in value, more than 50% of raw materials to industries and provides about 63% of total employment for the majority of Africa's people (World Bank, 2012).

Agriculture is the mainstay of the Tanzanian economy contributing about 31% of GDP, 30% of export earnings and employs about 78% of the total labour force (Africa Economic Outlook, 2013). Approximately 80% of Tanzanians live and earn their living in the rural areas with agriculture as the mainstay of their living. As the numbers make clear, agriculture remains the primary source of livelihoods for the majority of households in Tanzania. Agriculture has strong inter-sectoral linkages with the non-farm sector, both backward and forward linkages, control of inflation, since food contributes about 50% of the inflation basket. Thus, agricultural development remains a key to the country's economic and social development, at least in the foreseeable future (Ngaiza, 2012).

Agriculture is the predominant economic sector in Manyara region as it employs about 83% of the total population who mainly practice both crop production and livestock keeping and the total arable land is 1,568,117 ha but the area under cultivation is about 867,523 ha (approx. 54.7% of the arable land) (URT, 2012). The agricultural production depends mostly on small-scale farmers who practice a semi-traditional farming system characterized by low use of farm inputs.

One of the most important inputs in agricultural practices is the development and use of increased levels of farm power and appropriate mechanization techniques. Increased agricultural production and improved rural livelihoods cannot be achieved without the adoption and use of increased levels of farm power and mechanization or establishment of machinery hiring center whereby farmers can easily hire two-wheel tractors (2WTs) and other machinery for early farming and hence good production (FAO, 2013 and Clarke, 1997.).

Different farm powers used in Manyara region during agricultural operations are animal power, meaning that cattle are widely used for draught and takes about 39.9% of tillage operations. Secondly, farm power based on four-wheel tractors (4WTs) is about 39.5%. Thirdly, 2WTs provide about 0.45% of farm power while the rest is hand hoe. Estimates show that Manyara region has about 1,256 of 4WTs, 187 of 2WTs and 125,988 pairs of animal drought power (URT, 2012).

Most agricultural systems in African countries, especially in SSA, are based on subsistence farming and the cash incomes of farmers remain relatively low due to low production and productivity and thus results to very little surplus cash generation due to these subsistence farming situations. This may lead to a very low potential to invest in inputs. Inputs, apart from seed and fertilizer, also include agricultural machinery and therefore demand for tools and machinery remains low.

This lack of investment in production and productivity enhancing technologies has resulted in very low levels of productivity that again leads to a continuing situation of low farm incomes (Sims and Kienzle, 2006).

According to Houmy *et al.,* (2013), the low of demand for mechanization will drive another debilitating element which is the supply side. Thus, the low supply of tools equipment and power sources will tend to lead to higher costs of agricultural mechanization, to higher costs of ownership and running costs of agricultural machinery. Finally, creation of vicious circle from high cost of farm machinery back to the low demand agricultural mechanization as described in the figure 1.

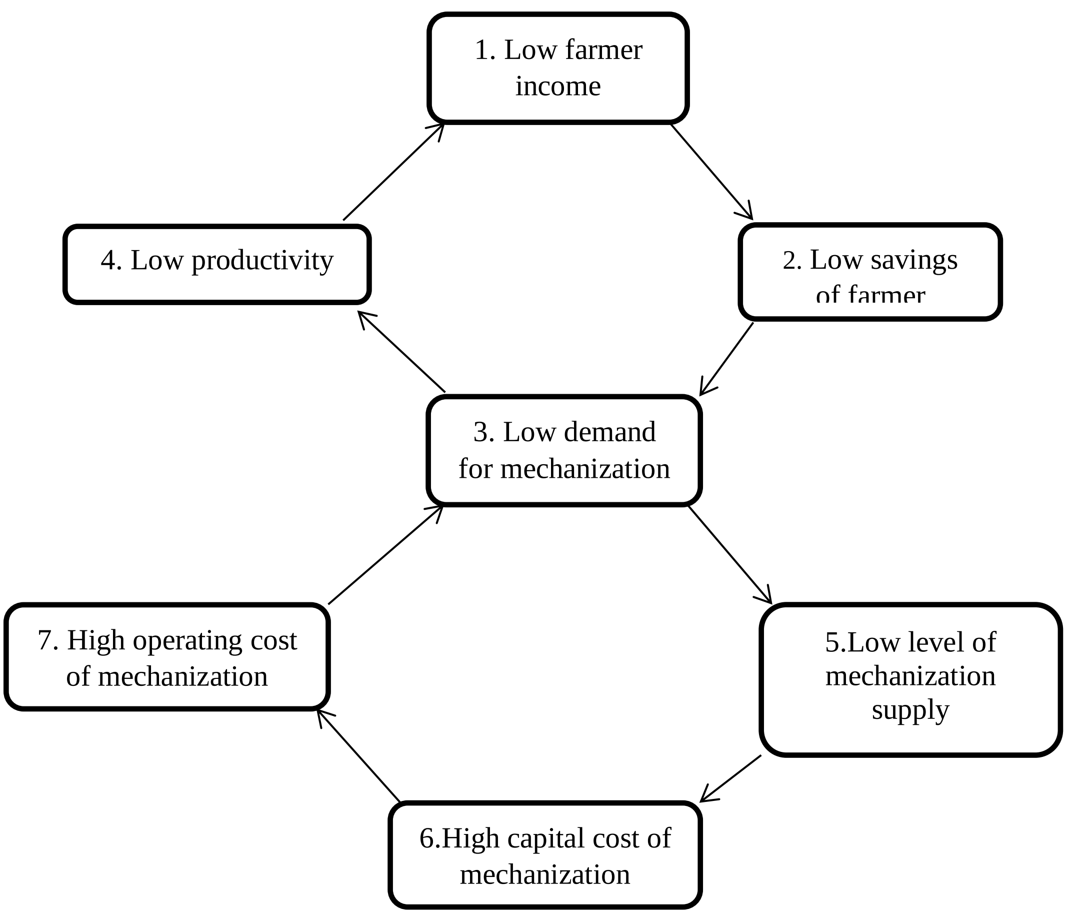

Figure 1: Vicious circle of agricultural mechanization

Source: Houmy *et al.,* (2013)

The conclusions of an Expert Group Meeting (EGM) jointly hosted by the UNIDO and the FAO, aimed to review situation and constraints of agricultural mechanization in Africa and to recommend ways through which these could be tackled in order to support sustainable economic growth and poverty reduction. Apart from other factors, the EGM considered pathways through which African farmers and rural communities can achieve higher intensities of agricultural production through investment in mechanization (Pingali, 2007).

According to FAO (2014), the shares of farming system based on agricultural mechanization from seven countries which were Bangladesh, Ethiopia, Kenya, Nepal, Nicaragua, Tanzania and Vietnam is indicated by Figure 2. It shows that Tanzania has lowest share of farming system based on agricultural mechanization during agricultural operation compared to other six countries.

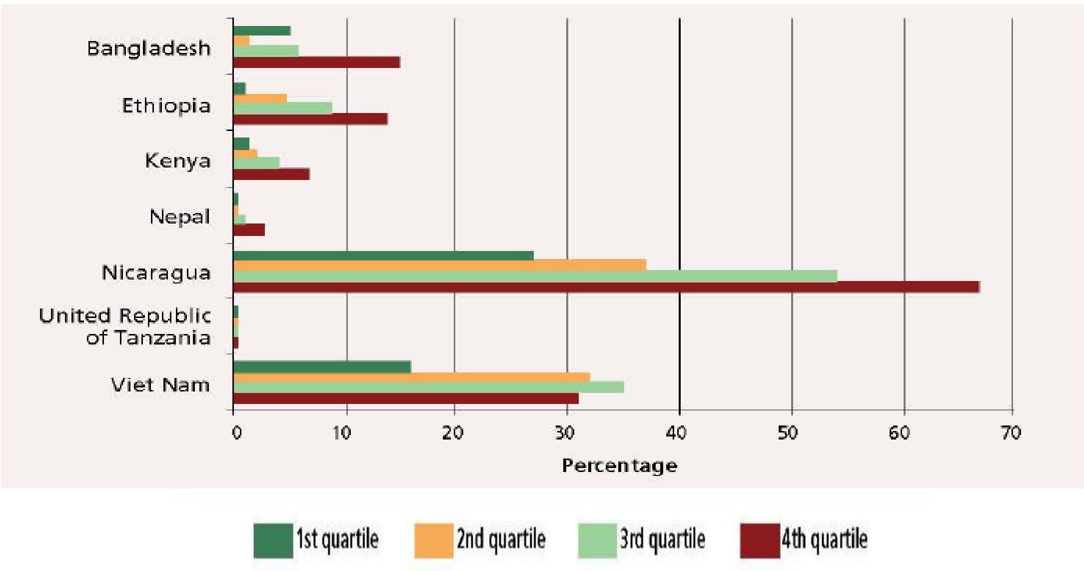

Figure 2: Shares of farms using mechanization
Source: FAO, 2014

The farmers in Tanzania need to improve their productivity so as to have drudgery free operations such as land preparation, planting, transplanting, weeding, pesticide application, harvesting, threshing and grain cleaning. This will raise the need of several machines including 2WTs which apart from doing several mentioned operations as they are imported, some locally made implements and equipment can be attached to them for specific agricultural operations.

A two-wheel tractor (2WT) is a small size, light-weight and good maneuverability multipurpose hand tractor designed primarily for rotary tilling and other operations on small farms. The 2WTs are presumed to be suitable to the level of mechanical knowledge and management in rural areas since its structure is simple and thus makes the operation, maintenance and repair easy (Fashola *et al.,* 2007). 2WT is focused and emphasized to be used as agricultural activities mostly practiced in rural areas with smallholder farmers who are considered to have low income and thus making them easy to purchase when compared to 4WTs.

1.2 Problem Statement and Justification

In Tanzania, the Government seeks to modernize and commercialize the agricultural sector by increasing the utilization of improved input from the current level of about 10 percent, to reach at least 50 percent of the requirement by 2017, and 80 percent by 2020 (URT, 2012). The government also seeks to raise the ratio of farm area prepared using tractors and animal-drawn ploughs from the current levels of 14 and 24 percent, respectively to reach at least 50 percent of the land mechanically prepared by 2020. This entails plans to increase the sale of new tractors to reach at least 900 units per year from estimated amount of 300 units supplied per year since 2005 (URT, 2012).

To achieve the goal, some 2WTs were imported in Tanzania under different government programs including Agricultural Inputs Trust Fund (AGITF) whereby loans were provided to input suppliers so as to ensure the sustainability supply of farm inputs to the farmers; District Agriculture Sector Investment Project (DASIP) which was a seven years project from 2006 to 2013 and cost about USD 84.2 Million aimed to ensure widespread of the agricultural technology, creating infrastructure and sustainable market systems so as to improve rural livelihoods. The total number of 2WTs imported by these programs in the year 2009/10 was found to be 2647 (Lyimo, 2011). Further, an increase of 2WTs in Tanzania has been attributed to "Kilimo Kwanza" Initiative; this is the national agenda of transforming agriculture through the introduction of new and innovative technologies so as to increase food production and agricultural exports. "Kilimo Kwanza initiative" for green revolution (KKIGR) has strengthened agricultural equipment basket fund for small scale farmers (Mwinama, 2013).

However, the development of mechanization in the country has been slow as it is hampered by several factors which include low purchasing power of most small scale farmers, low producer prices, high cost of agricultural machinery, lack of agricultural credit, lack of well-trained operators and mechanics for agricultural machinery, lack of suitable machinery packages for main agricultural operations, importation of tools and machinery of poor quality, weak private sector and general poor technical know-how, age and gender as most of African farmers are women or elderly people depends on muscle power.

One aspect of medium and smallholder farmers that is constantly mentioned by manufacturers and retailers is their limited ability to invest in agricultural equipment. When considering the group of farmers, the helpful provision of credit at moderate interest rates and advantages of sharing machinery ownership would also require further investigation. Whereas, individual ownership of a machine improves timeliness, equipment matching and maintenance assurance, there are also no costs for group management, which may be incurred in the sharing possibilities as a group of farmers (PrOpCom, 2012).

However, there is a need to sightsee the business model which could be sustainable in a Tanzania context such as Manyara. The business model should provide enough room for the private sector to develop the supply chain, including machinery imports and trade and link smallholders' demand for mechanized services to its supply, such that supply can further induce demand so that mechanization can take on a broader role in agricultural transformation.

The research output will be important to sector participants (manufacturer, importers, service providers and farmers) and government for commercial and public policies. The study is expected to inform future policy direction in the Tanzania Agricultural sector to increase agricultural machinery supply (2WTs) from demand driven to a broader farmer base and to enhance a more effective participation of manufacturer, farmers and other entrepreneurs in agricultural mechanization processes.

1.3 Objective

As regards to agricultural financing, most crop producers lack capital assets which is a crucial input like agricultural machinery for increasing agricultural production and productivity. Institutional finance for agriculture credit is controlled mainly by commercial banks as they contribute over ninety per cent while that of community banks (including cooperatives) contribute less than ten per cent. Short-term credit facilities account for more than 70 per cent of the total institutional lending to the agriculture sector, which means less access to credit for long-term investment projects. There is clear indication that commercial banks consider agriculture sector projects as of high risks with low returns and therefore, most households can neither save nor access loans from commercial banks and financial institutions

1.3.1 Overall objective

The objective of this study was to find out the most appropriate business models which will enhance adoption of farm machinery in Tanzania.

1.3.2 Specific objective

The specific objectives of this study were:

i. To assess the demand and supply of 2WTs in Tanzania
ii. To determine the socio-economic characteristics influence the purchasing of 2WTs
iii. To examine the profitability obtained by farm machinery suppliers from alternative business models for 2WTs

1.4 Hypothesis

i. Socio-economic characteristics have no significant influence on farmers decision to purchase of 2WTs

ii. There is no significant difference on profit obtained by farm machinery suppliers from business models for 2WTs

1.5 Organization of Dissertation

This study is structured into five chapters. Chapter one presents background information, problem statement and justification, objective of the study the overall objective and specific objectives, hypothesis and the organization of the dissertation. Chapter two presents literature review which reviewed the adoption theories, business models, empirical studies on agricultural mechanization, research and initiatives conducted in promoting farm machinery, factors influencing adoption of agricultural mechanization and lastly conceptualization of agricultural mechanization linked to business models for farm machinery supply. Chapter three presents methodology part which contains description and justification of the study area, research design, sampling procedure, data collection and processing. Chapter four presents results and discussion and the final chapter which is chapter five presents conclusion and recommendation.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical framework

2.1.1 Adoption Theories

2.1.1.1 Rostow growth stages

According to Rostow (1960), agricultural mechanization is integral to agricultural transformation. And apart from increase the power inputs to farming activities, also agricultural mechanization provides agriculture-led industrialization and thus markets for rural economic growth which is also supported by the second stage of development or economic growth also termed as the pre-condition for takeoff whose economy undergoes a process of change for building up of conditions for growth and takes off. Moreover, it was argued that, the stage in which agriculture is commercialized and mechanized to bring about technological advancement and growth in entrepreneurship activities and an important link in achievement of effective growth in production.

2.1.1.2 Diffusion model

Technology diffusion is the process of obtaining (new) technology adapted through practical use. The concept of diffusion in term of understanding how many farmers know and use of technology in the context of long-term technological forecasts, technology diffusion can be presented as a process of transition from invention to innovation. Innovation is the result of socio-economic and technological activities. It produces added value because of an uncommon way of doing business. Since new technologies enter the market and grow at logistic rates, only one technology is in the saturation period at any given time and declining technologies used fade away steadily at logistic rates uninfluenced by competition from new technologies.

Bass (1978) has presented a product growth model that has been successfully demonstrated in retail service, industrial technology, agriculture, and consumer-durables sectors. Implicit in most diffusion models currently used is the assumption that diffusion spreads through a static environment. But, because of the changing characteristics of the potential adopter population, technological changes, product modifications, pricing changes, general economic conditions, and other exogenous and endogenous factors, then we have to consider the dynamic environment which is likely to change over time (Bass, 1978). With increasing interest in the development and use of models for technological innovation, it is imperative that models be developed that capture the dynamic nature of the diffusion environment. The feedback approaches provide one avenue to developing such structures for innovation diffusion models. These approaches, however, are not without limitations (Hemes, 1976).

Fisher-Pry transform addressed and discussed the issue when there is no or scarce data for emerging technologies, causal and naïve methods for long-term forecasting were employed. The causal method was applied to adopt quantitative models while naïve method was applied to adopt qualitative models, both for predicting the diffusion of new technologies. A significant achievement was accomplished by Fisher and Pry (1971) in formulating the model for binary technological switch and provides clear and suggestive outputs for supporting medium- and long-term forecasting of technology change.

2.1.2 Agricultural Development Theory

2.1.2.1 Schultz agricultural development theory

According to Schultz (1960), based on Agricultural Development Theories, the High-Payoff Input Model is found to attempt explaining the forces in society and the economy that lead to agricultural change as there were inadequacy of policies based on the conservation, urban-industrial impact, and diffusion models led for transforming a traditional agricultural sector into a productive source of economic growth in investment, designed to make modern, high-payoff inputs available to farmers in poor countries. The model was characterized by the ability to develop new technical knowledge, new technical inputs and efficient use new knowledge and use new inputs. He insisted that farmers in traditional societies remained poor because there were only limited technical and economic opportunities to which they could respond.

It is targeted that by 2025, the country will have agricultural productivity transformation to a semi-industrialized country, based on modernized and highly productive agricultural activities which are effectively integrated. The Agricultural Sector Development Strategy (ASDS) was prepared to achieve an agricultural sector that is modernized, commercial, and highly productive and which utilizes natural resources in a sustainable manner during 2025. The program was focused on increasing productivity and profitability and thus reducing income poverty. Apart from that, the Kilimo Kwanza initiative program was launched in 2009 as a Public-Private Partnership initiative to promote a transformation of Tanzanian agriculture so as to improve economic growth and poverty reduction and emphasizing on agricultural machinery (URT, 2012).

Nevertheless, in response to the disappointing performance of agriculture, the resolve attempts to address the issues of extremely low utilisation of improved seed, fertilizer, and as well as very limited value-addition/agro-processing. Kilimo Kwanza is a national resolve to accelerate agricultural transformation, applying a general approach, involving all sectors and all producers, small, medium and large. It is not a new strategy but a catalyst for the implementation of ASDP, with additional features (FAO, 2014).

2.1.2.2 Investment-specific technology

Greenwood *et al.*, (2000) focused on the attention of economists on the role of investment-specific technological change as a main driving force behind economic growth and business cycle fluctuations. The relative price of business equipment in terms of consumption goods has fallen in nearly every year since the 1950s. The fall in the relative price of capital is faster during expansions than during recessions. Models of investment-specific technological change have also being successfully used to account for the evolution of the skill premium or the cyclical behavior of hours and productivity among several other applications (Fisher, 2003).

2.1.2.3 Mechanization and productivity

Agricultural productivity refers to the output produced by a given level of input or inputs in the agricultural sector of a given economy; also it can be referred as the ratio of the value of total farm outputs to the value of total inputs used in farm production (Fulginiti and Perrin, 1998). As agricultural productivity mostly depends on agricultural technology, particularly in farm mechanization and thus underinvestment in agricultural machinery will hinder sector productivity and results to low returns from agriculture, especially compared with those from the rest of the economy.

2.1.3 Business models

A business model is the blueprint of how a company does business. The model represents the architecture of the business and its network of partners to create market and deliver value to generate profitable and sustainable revenue streams. There are various definitions of business models, depending on how to categorize in different fields of application has to emphasize the design of the transactions of a firm in creating value (Amit *et al*., 2011); to blend the value stream for buyers and partners, the revenue stream, and the logical stream (Mahadevan, 2000); and the firm's core logic for creating value (Linder and Cantrell, 2001). According to Magretta (2002), a good business model is essential to every firm, whether it is a new venture or an established player because it positions the firm within its value network, shows how it transacts with customers and suppliers, and highlights the products that are exchanged.

2.1.3.1 Bangladesh model

According to Roy and Singh (2008), the individual business model is a sustainable supply model in which the private sector plays the leading role throughout the entire mechanization supply chain. When importation and the domestic market are operated by the private sector, profitability guides traders to import the right machines that are affordable to individual famers. When local fabricators developed equipment that could attach to 2WTs, multifunctional operations became possible for the owners of 2WTs and thus made investment in 2WTs profitable for small farmers. Nevertheless, as profitability is a general rule for any business model, the individual business model emphasizes the versatile use of 2WTs beyond the initial demand for mechanized power-intensive agricultural operations and for small farmers to individually own agricultural equipment if this equipment is well tailored to small farmers' economic conditions.

2.1.3.2 India model

According to Gupta and Kumar (2001), the use of individually owned 2WTs for power-intensive operations such as plowing remains dominant and has similarities to the individual business model. However, when mechanization diversifies to include control-intensive operations, individual ownership of agricultural machinery in such operations becomes impossible. Individual farmers are unlikely to purchase such machines for their own use on their small piece of land or for serving neighboring farmers in the same location but farmers cluster together and form a group for easy purchasing of agricultural machinery. The group business model emphasizes the scale needed in order to allow relatively expensive and specialized agricultural machinery to be fully and efficiently used and become a profitable investment.

2.1.3.3 China model

According to Yang *et al*., (2013), the China model is used to represent the pattern of specialized service provision for control-intensive farming activities. When mechanization advances to include control-intensive operations, group of farmers and individual farmers, including most medium- and larger-scale farmers, are unlikely to own such specialized machinery. Specialized businesses of service provision for control-intensive operations started to develop, which we refer to as the China model. In this model, non-farmer entrepreneurs provide professional services to farmers. Service provision through migration is a necessary condition for this model to be viable. Indeed, with China's vast farmland across different agro-ecologies, the same crop can be harvested at different times which allow service providers to be able to operate up to eight months per year through migration.

2.2 Empirical studies

The Mechanization Department of the Ministry of Agriculture, Food Security and Cooperatives (MAFSC) estimated that in 2010, there were 8,466 tractors in use in Tanzania, in a country with 11.5 million hectares of arable land. Based on this estimate, there are some 7 tractors per 100 sq km of arable land in Tanzania. These figures could be compared to Kenya and South Africa with 27 tractors and 43 tractors per 100 sq. km, respectively. Thus, 92 percent of Tanzanian farmers still use hand hoes and cultivate a few acres of land, with just 5 percent of farming households using tractors. From 2009, there has been an upward trend in the number of tractors being imported. In the mechanization sector, the Government has disengaged itself from direct commercial activities, opening doors for the private sector to import and distribute tractors. The level of mechanization is low with the hand hoe dominating farming systems. The use of animal traction is estimated at 24% and the mechanical power is estimated at 14% (fig 3). Examples of agricultural mechanization equipment are tractors, power tillers, trailers, planters, weeders, maize shellers, sugar cane forklift band and mechanical harvesters (PASSTRUST, 2013).

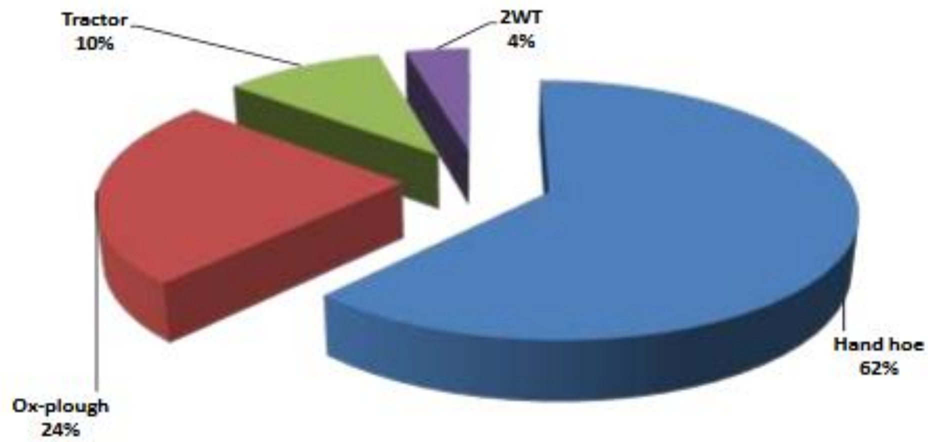

Figure 3: Level of mechanization in Tanzania:

Source: MAFSC, 2012

Studies on efficiency such as that of Msuya *et al.*, (2008) and Temu *et al.*, (2005), and adoption studies such as Fleisher *et al.*, (2000) in Tanzania provide a logical flow of various technical issues and agree that the current lack of farm machinery is creating a critical bottleneck, because investing in quality seeds and fertilizer will not be sufficient to produce benefits unless seedbeds are prepared properly and crops are harvested in a timely manner.

2.3 Conceptual Framework

As population is growing faster than food production in SSA, food security, increase employment and improvement of rural livelihood have to be put under consideration so as to avoid rising number of undernourished people and reducing dependence on food import by producing more which requires more power too. Mechanization is a key input in any farming system as it increases productivity per unit area due to improved timeliness of farm operations (land preparations) and an expansion of the area under cultivation where land is available.

The Government of Tanzania has developed an Agricultural Sector Development Strategy (ASDS) that aims to achieve sustained agricultural growth by transforming the sector from subsistence to commercial agriculture. The strategy was prepared with a premise that private sector will play a leading role in providing a range of demand-driven support services to smallholders. Agriculture mechanization is included as one of the key priority areas of the strategy which proposes, among other things, to: encourage private sector investments to set up mechanization centers that provide tractors and equipment hire services to smallholder farmers; provide financial incentives to the Institute of Rural Technology to design and develop appropriate farm tools and machinery suitable for Tanzanian farms; and provide training and demonstrations on the use of new agricultural technologies at the district level.

On the regulatory side, the Center for Agriculture Mechanization and Rural Technology (CAMARTEC) based in Arusha is assigned with testing imported tractors to determine the suitability of the machinery to soil conditions in Tanzania. The Center is also supposed to be involved in research and development of local technology. Private importers are required to get approval from CAMARTEC prior to introducing new tractors into the market (CAMARTEC, 2010).

On the supply side, the major importers of tractors in Tanzania, the private companies set up distributorships of various machinery brands. Distributors are based in the capital, though a few have distribution centers in various districts. Their main clientele are individual farmers or farmer groups or savings and credit cooperatives that have access to subsidized financing from public banks or donor financed programs. Based on profitability criterion, distributors have to decide either selling machinery to individual farmers or to farmer groups. Individual farmers or farmer groups to purchase machinery is determined by several factors such as; age, sex, gender, education, co-operative experience, management scale and user fee. The relationship between government, distributors and individual farmers or farmer groups is illustrated in Figure 4. The direction of the arrows illustrates the cause-effect relationship.

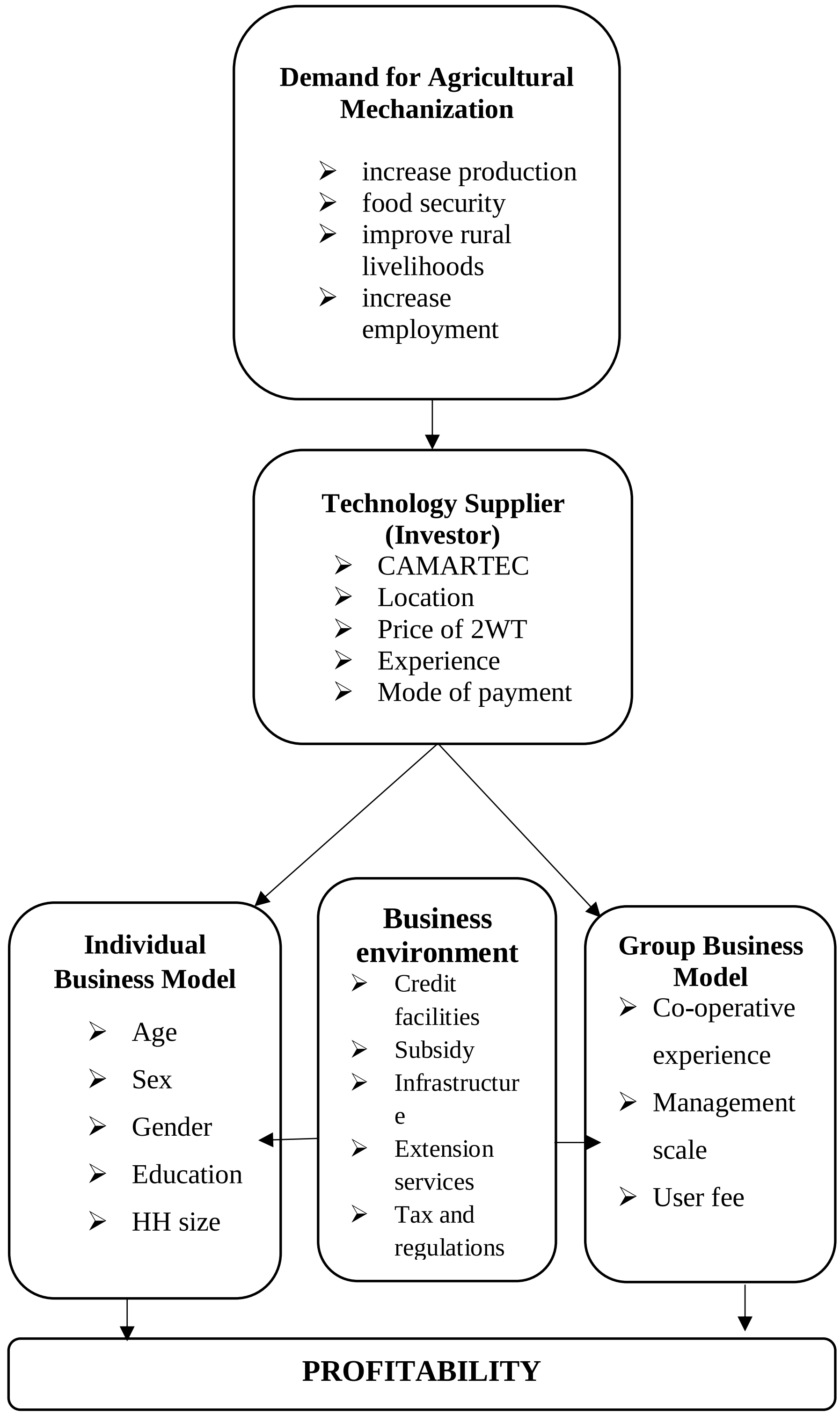

Figure 4: Conceptual Framework

Source: Own observation

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study area

3.1.1 Description

Manyara region was purposely selected as the case study area since was already involved with innovation platforms, adoption of conservation agriculture practices and mechanized maize shelling and threshing of legumes. Also in 2002, Manyara Region had a GDP of Tshs. 332 617 million and per capita income of Tshs 319 682. By the year 2011 the Regional GDP was Tshs 1 267 337 million and per capita income was Tshs 879 014, which indicated that there is potential returns to investments (FAOStat, 2012/13).

3.1.2 Location

Manyara Region was formed from the former Arusha region in 2002. The formation of this new region was announced in the *Official Gazett* No. 367 on 27th July 2002. The Regional headquarters is located in Babati town which is 167 kilometers from Arusha, 157 kilometer from Singida and 248 kilometers from Dodoma. There are five administrative districts with six Local Government Authorities, namely: Babati Town, Babati, Hanang', Kiteto, Mbulu and Simanjiro District Councils, with 29 Divisions, 123 Wards, 393 Villages and 1 540 Hamlets. Babati is divided into Babati Town with total are of 461 km^2, 2 division, 8 wards and 13 villages, and Babati district has an area of 5 608 km^2, 4 divisions, 21 wards and 95 villages.

The Region is bordering Arusha region to the north, Kilimanjaro and Tanga regions to the east, Dodoma region to the south and Singida and Shinyanga regions to the west. The region lies between latitudes 3^0 40' and 6^0 0' S and longitudes 33^0 and 38^0 E. It has an area of 50 921 square kilometers, which include 49 576 square kilometers of dry land and 1 260 kilometers covered with water. Manyara Region has three major agro-ecological zones which are; the rift valley highlands, the semi-arid midlands and the bushed Maasai steppe (ISPMR, 2013).

3.1.3 Economic activities

The main economic activities in Manyara Region are agricultural production includes maize, food beans, pigeon peas, sunflower, onions, garlic, coffee, paddy and finger millet and commercial crop which are wheat at Basuto in Hanang and pigeon pea in Babati and Hanang. They also practice livestock keeping and mining include tanzanite, ruby, green garnet, green tourmaline and rhodolite, tsavorite and tremolite and Recently, gold has been discovered in more than three areas in Mbulu district.

3.1.3 Map of study area

Map of Manyara region showing its districts

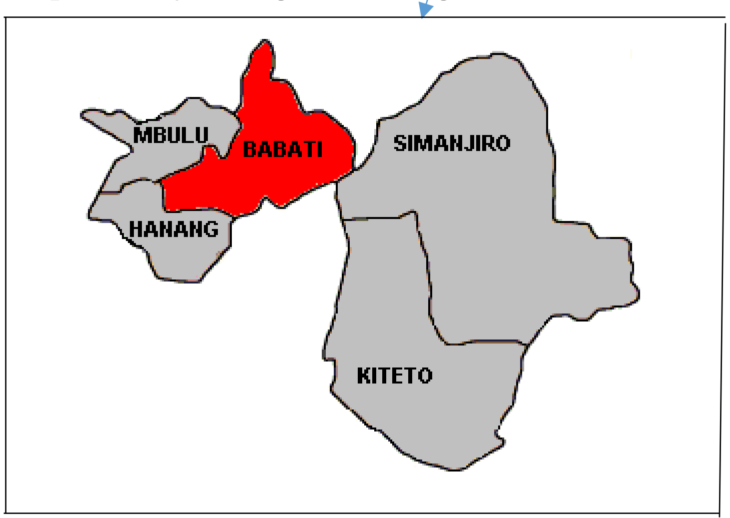

Figure 5: Map of the Study area

3.2 Research Design

The study used a cross sectional survey design and a cross-sectional micro data were collected from the individual farmer and group of farmers in charge of agricultural machinery purchases. The design allowed data to be collected once at single point time that can be in descriptive analysis and for determination of relationship between variables. The set of data focused on the characteristics of individual farmer and group of farmers on purchasing 2WTs whereas for individual famer, personal and household characteristics such as age, education and household size, income were considered while for a group of farmers, characteristics such as management, financial status and size of group were considered too (Bailey, 1998).

3.2.1 Sampling procedures and sample size

Multi-stage sampling involving two stages was employed. The first stage involved the purposive selection of one district (Babati) out of five districts (Babati, Hanang, Kiteto, Mbulu and Simanjiro) in Manyara region due to involvement with innovation platforms, adoption of conservation agriculture practices and mechanized maize shelling and threshing of legumes. The second stage involved selection of sample households within the selected district using systematic random sampling techniques. According to the 2012 Population and Housing Census, Babati district had a total of 405 500 households (NBS, 2013) but total population owning 2WTs were found to be 78.

Using the formula of sample size determination described by Yamane (1967), this population gives a representative sample of 78 households which were interviewed as shown below;

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

Whereby n is sample size, N is total population in the study area (77) who own 2WTs, x is the level of Precision (1%). Applying the formula in (3) above we have;

$$n = \frac{78}{1+78*(0.01)^2} \text{...Eq (3)}$$

n = 77.396≈78 households

3.2.2 Data Collection Method

Data were collected using structured questionnaires consisting of both closed and open-ended questions and from other market players for mechanization demand-driven using interview. The study involved formal survey. Main issues included in the questionnaire were data/information on inventory turnover for agricultural machinery (2WTs), socio-economic and institutional factors that were likely to influence the choice to purchase 2WTs.

3.2.3 Data analysis

3.2.3.1 Objective I: Supply – Demand Gap Analysis

The annual-wise supply of agricultural machinery was assessed by considering the available agricultural machinery in the country (secondary data) and average agricultural machinery delivered in a year by each district (primary data). The annual-wise demand for agricultural machinery was assessed by considering National Agricultural policies and Millennium Developments Goal's requirement for various operations to be carried out in each year or in every specified periods of targeted time like putting up mechanization interventions that aim to increase profitability of agriculture and other investment in the supply, processing and marketing side. Estimates were obtained by availing both primary and secondary data.

3.2.3.2 Objective II: Binary-Logit model

Farmer's decision to adopt agricultural technology depends on household's socio-economic, institutional and environment factors (CIMMYT, 1993). However, there is no firm economic theory that dictates the choices of specific independent variables in adoption studies. They could vary from context to context. As a result, the explanatory variables assumed in this model are those included in the baseline survey questionnaire.

Binary logit model was used to determine the factors affecting farmers' purchase decision of 2WTs in agricultural operations at household level. Adoption and purchasing of 2WTs and relationship with some other factors at farm level has been considered to explain ownership of 2WTs at farm level which is a dependent variable (0, 1), where 1 means the ownership of 2WT and 0 means non ownership of 2WT. The model used was written as;

$$Y = XB + e \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad Eq(1)$$

Whereby: Y is dependent variable;

X is the matrix of independent variables;

B is the vector of parameters representing the partial effect of each of the independent variables;

e is the error vector which represents the amount of variable unaccounted for the independent variables

Binary Logit Model for the decision to purchase and own 2WTs was specified as:

$Y_i = \beta_0 + \beta_1 AGe + \beta_2 Gend + \beta_3 Educ + \beta_4 HH\_Size + \beta_5\ Farm\_Size\ +$
$\beta_6 Cred + \beta_7 Knowl + \beta_8 Spares + \beta_9 Drght + \beta_{10} Ext\_Servc + \varepsilon_i$...........Eq (4)

The factors that are believed to determine ownership of 2WT at farm level are identified, which are:

X_1=Age of the head of the household;

The age related dummy variables were coded ‘0’ for age with less than 30 years of age, ‘1’ for the age between 31-50 years, ‘2’ for the age between 51-70 years and ‘3’ for those older than 70 years. Age was expected to have a positive relationship with ownership of 2WTs, since older farmers may be more experienced in production activities with agricultural mechanization. Fleischer (2001), argues that age reflects managerial and experience of the farmer as it increases production and farm profit. Therefore, age category as a dummy variable was included in the model to show its influence on the dependent variable. Thus, the coefficient was expected to be positive in the ownership decision for 2WTs.

X_2=Sex;

The dummy variables for gender were coded ‘0’ for female household and ‘1’ for male household. Gender of the household was included in the model to show its influence on ownership of 2WTs. Women have limitation of accessing productive resources such as land, they may also be excluded in extension and training as men may attend these trainings. In addition, male members of the household were expected to participate more in farming activities and in long working hours compared to women. The coefficient was expected to have a positive sign on ownership decision of 2WTs (IFPRI, 2010).

X_3=Educational level;

It was constructed from the number of years a farmer spent in school. Education availability allows farmers to participate better in production and able to adopt new technologies effectively and efficiently (Gbetibouo, 2009) and thus it has a positive relationship with ownership decision of 2WTs. As number of years spent in school increase further, the respondents' exposure to education will increase the farmers' ability to utilize information in order to improve production and profit. Therefore, the coefficient was expected to have a positive sign on ownership decision to 2WTs.

X_4=Family size/Group size;

Household size expressed as the number of the people living in each household. Size of the household was expected negatively related to ownership decision of 2WTs. Therefore, as the household size increases, then labour force may increase in the family, hence decrease mechanized farm power. Thus, the coefficient was expected to have a negative sign.

X_5=Farm size (ha);

One determinant of the use of agricultural machinery is farm size. Economies of size suggest that machinery will only be used if there is a large enough farm area to spread its cost over the asset's useful life in a cost competitive way. The size of the farm was positively related to production. The variable farm size was measured in hectares. The respondents with large farm size tend to realize increased production and likely to use improved technologies thus increasing production and profit (Hassan and Nhemachena, 2008). Hence, the variable was expected to have a positive sign in the two models as farmers with large farm size seems to be more willingly to own 2WTs.

X_6=Credit accessibility;

The dummy variable for credit was included in the model to show the influence of credits on the dependent variables (productivity and profitability). The variable was ‘1’ for those who had access and ‘0’ for those who did not have access to credits. Credit was expected to have a positive relationship with ownership of 2WTs. Credit is a useful input in any production activity as it helps farmers to purchase the necessary agricultural inputs and technology for production. Most of the farmers who have access to credits are expected to improve their production and farm income (Thapa, 2010). Therefore, the coefficient was expected to have a positive sign on decision to purchase 2WTs

X_7= Knowledge on how to operate and repair 2WTs;

Lack of knowledge and skill by farmers about suitable equipment and how to operate such equipment (Ashburner and Kienzle, 2011) has been something to consider. Where machines are used, the lack of both farmer knowledge and skills leads to misuse and mismanagement of machinery. Regardless, farmers have a great deal of traditional knowledge and experience accumulated over generations but access to new knowledge remains largely limited. Mostly the level of training for farmers is relatively low and the opportunities for further training are limited. Therefore, the coefficient was expected to have a positive sign on decision to purchase 2WTs

X_8=Availability of spare parts;

Critical lack of spare parts can be improved by the standardization of spare parts, and thus facilitating inter-changeability between tools/spares sourced from different manufacturers. Availability of equipment for motorized farm machinery particularly for 2WTs may influence the decision on ownership of 2WTs (Ashburner and Kienzle, 2011). Therefore, the coefficient was expected to have a positive sign on decision to purchase 2WTs.

X_9= Number of draught animals;

Developed countries have been replacing draught animals by mechanical power. Farmers in developing countries depend on draught animal power for small-scale agricultural operations and rural transportation. Although mechanization will continue but adoption to mechanical power may take many years as some farmers will remain dependent on draught animals. Therefore, the coefficient was expected to have a negative sign on decision to purchase 2WTs

X_{10}=Access to extension services

The dummy variable for extension service was included in the model to show the influence of extension services on the dependent variables. The dummy variable was coded with the value of '1' for those who had access and '0' for those who did not have access to extension services during the production period. Extension services were expected to have a positive relationship with productivity likelihood of farmers to participate effectively in agriculture production (FAO, 2008). Therefore, the coefficient was expected to have a positive effect on both production and profitability.

3.2.3.3 Objective III: Cost-Benefit Analysis

Cost-benefit analysis is an economic approach for measuring economic viability of the investment or project by comparing the benefits against the costs. It helps in identifying the streams of benefits and costs over time for every investment and bringing back to present values by the means of discounting at a selected interest rate. According to Stern (2007), the discounting rate proposed was 1.4%, while Cline (1992) proposed 1.5%. The higher the discount rates, the more the future impacts are discounted. In the case of infrastructure, also higher interest rates have the effect of postponing action on climate change, as future benefits are more heavily discounted. The time horizon is mainly determined by the life of the investment in the case of infrastructures such as irrigation.

Furthermore, the cost-benefit analysis has the following advantages: (i) it help in decisions on programme options by weighing up costs and benefits of different interventions; (ii) it acts as a decision support tool for demonstrations and a powerful tool for economic investment, in risk reduction that maximizes benefit for every dollar of investment spent; (iii) it is useful in assessing larger scale infrastructure and public investments projects and its use at community or local level; (iv) it helps in decision making as it provides important information to decision makers (UNFCCC, 2009).

Notwithstanding its usefulness the model has the following disadvantages: (i) Costs and benefits of adaptation have to be presented on a range of values and not a single value; (ii) it ignores the distribution of the costs and benefits of adaptation options and fails to account for those costs and benefits that cannot be reflected in monetary terms; (iii) data limitations cause substantial challenges, specifically, if there is uncertainty over data gathered or no resource to collect primary data.

Profitability analysis of business models is done by using simple costs and return analysis considering the individual and group business models. Benefit-cost ratio (BCR) and internal rate or return (IRR) was employed.

Benefit-Cost ratio is mathematically expressed as;

$$BCR = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}} \quad \text{...Eq (5)}$$

Where; B_t=benefits derived from the uses of business model (individual/group)

C_t=costs incurred in each year from employment of business model (individual/group)

t= 1,2,3,…,n

i= interest rate

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Demand and supply of 2WTs in Tanzania

Total 2WTs in the country is almost about 6,000 units (MAFSC, 2014). In Tanzania, the number of 2WTs has kept on increasing since 2005. According to Mwinama (2013), the Tanzania government purchased 260 2WTs for demonstration in 2006 and about 300 2WTs are estimated to have been supplied by private sector annually since 2005 from Table 1. Some of power tillers were imported by private sectors and some of them have been distributed through different government programs including Agricultural Inputs Trust Fund (AGITF) and District Agriculture Development Plans (DADPs) (Lyimo, 2011).

Agricultural Inputs Trust Fund is a government institute established to provide loans for farm inputs including machineries for the purpose of expanding farming areas and increase production. Interest rate for the loan is 6 to 8 percent depending on the type of loan, payback period is 5 years, conditions; title deed of a house or land for individual customers.

Table 1: Supply of 2WTs in Tanzania

s/n	Agricultural Machinery	2005	2008	2010	2011	2012	2013
1	Two wheel tractors	-	290	3325	699	949	828
2	Four wheel tractors	115	569	1960	3183	782	916
3	Plough(Ox-drawn)	-	82, 112	4	3	349	1078
4	Hand hoe	3,056,189	2,159,094	-	-	7,923,375	1,108,700

Source: MAFSC, 2014

Demand of 2WTs in Tanzania

Tractors, draft animal power implements and hand tools are imported mainly from Europe, China, India, South Africa and Kenya. Local manufacturing of tools, implements and machinery is very low after the collapse of the Ubungo Farm Implements (UFI) and Zana Za Kilimo, Mbeya (ZZK).On the average 2,000,000 hand hoes, 20,000 animals drawn ploughs and between 200 and 300 tractors were imported annually. The country demands between 30,000 to 40,000 animal drawn ploughs, 1,500 to 1,800 for two axle tractors and implements and for single axle tractor is 1500 to 2000 annually in order to cater for farm power needs for satisfactory agricultural growth (PASStrust, 2013).

4.2 Socio-economic Characteristics of the Respondents

4.2.1 Age of the respondents

The age of farmers was categorized into four categories for both owners and non – owners of the 2WTs. From Table 2, the findings show that about 63.6% of the respondents aged 31-50 owned 2WTs while 11.4% in the same age category did not own. It was also found that 53.4% of respondents for both owner and non-owner of

2WTs were in the age category of 51-70. Furthermore none of the respondent aged less to 30 years owned a 2WTs while 2.3% of the respondents found not to own 2WTs in the same age category and consisting about 1.1% of the total respondents not owning 2WTs. This implies that farmers who owned 2WTs were adults found in age category of 31-70, this group is responsible in decision- making on technology adoption of mechanization and thus age of the farmer can positively influence the decision of farmers to adopt and own 2WTs. These results are similar to the study of Harford (2009) who argued that with an increase in age farmers tend to reject new farming practices for less demanding cropping systems with low transactional cost associated with them. Furthermore, older farmers tend to be risk adverse and may avoid innovations in an attempt to avoid risk associated with the initiative. Rukuni *et al.* (2006) argued that being older creates a conservative feeling among farmers and hence resistance to change.

Table 2: Ownership of 2WTs by household head's age

	Category of household member's age			
	<30	31-50	51-70	>70
Ownership of 2WTs (%)		63.6	31.8	4.6
Household head’s age (%)		64.8	29.8	5.4

4.2.2 Sex of the respondents

From Table 3, the findings show that 90.9% of 2WTs owners were male while female were 9.1% while non-owners male were 40.9% and female were 59.1%. This implies that males were more willing to purchase and own 2WTs than female and thus, there is gender imbalance between male and female in adopting agricultural mechanization. Also it was found that female farmers who did not own 2WTs were many compared to male farmers who own 2WTs. These results are similar with those of (Matlon, 1994) who argued that men are more willing to participate in mechanization and conservation agriculture than women as a result of gender based wealth differences. This result however proves positive since women in the African countries forms big portion of the population undertaking farming activities, though they face socially conditioned inequities in the access, use and the control of household resources (Adesina *et al*., 2000).

Table 3: Ownership of 2WTs by household head's sex

	Household member sex	
	Female	Male
Ownership of 2WTs (%)	9.1	90.9
Household head's sex (%)	31.0	69.0

4.2.3 Household size of the respondents

The results in Table 4, categorized the household size categorized into three groups which were less to 6 members, 6-10 members and greater to 10 members. Farmers with less than 6 household members were found to be 4.5%, 5-10 members were 43.2% and greater to 10 members in the household were 52.3% for the farmers who did not own 2WTs. 90.9% of farmers who owned 2WTs were in a group of 6-10 members of the household, and about 6.8% were in a group of greater to 10 members of the household and only 2.3% were in a group of less 6 members. The findings show that among farmers who did not 2WTs, majority were found in third group of greater to 10 members. It implies that the number of family members of the household might influence farmers' decision on adopting agricultural mechanization. Ayuya *et al*., (2011), made an argument that the larger households have the capacity to relax the labour constraints required during the agricultural production activities.

Table 4: Ownership of 2WTs by household size

	Category of the Household size		
	<6	6-10	>10
Ownership of 2WTs (%)	2.3	90.9	6.8
Household size (%)	3.3	67.8	28.9

4.2.4 Marital status of the respondents

It was found that the majority 75% of respondents who did not own 2WTs were married, 6.8% were single, 11.4% were widowed and 6.8% were divorced. For 2WTs owners, 90.9% were married, 4.5% widowed, 2.3% divorced and about 2.3% were single (Table 5). Similar results were discussed by Mtama (1997) and found that marriage has an effect in production process as it increases labour availability in the household and be more willingly to adopt new agricultural technology.

Table 5: Ownership of 2WTs by marital status

	Marital status			
	Single	Married	Widowed	Divorced
Ownership of 2WTs (%)	2.3	90.9	4.5	2.3
Marital status (%)	25.0	54.8	18.6	1.6

4.2.5 Awareness/Knowledge

When considering awareness/knowledge in terms of operating the agricultural machinery as per Table 6, it was found that 81.8% of farmers who owned 2WTs had knowledge on operating the 2WTs while 31.8% of farmers were aware too on 2WTs but did not own it due to other reasons. About 68.2% of famers who did not own 2WTs were not aware on operating it while 18.2% of famers who owned 2WTs were not aware too on operating the machine.

Table 6: Ownership of 2WTs by awareness on 2WTs

	Awareness on 2WTs	
	No	Yes
Ownership of 2WTs (%)	18.2	81.8
Awareness on 2WTs (%)	21.1	78.9

4.2.6 Information spread on 2WTs

From Table 7, the findings show that 70.5% of farmers who own 2WTs were well informed on the 2WTs before purchasing it. Farmers who were fairly badly informed on 2WTs were 4.5% while none of the farmer who had very bad information on 2WTs attempted to purchase and own it. Observation from early adopters and owners of 2WTs acted as role models and therefore many farmers owned 2WTs after seen the benefits that early owners get. If there are visible benefits most of farmers will adopt and willing to own the technology in early stage.

Table 7: Ownership of 2WTs by information on 2WTs

	Information on 2WTs			
	Very well	Fairly well	Fairly badly	Very bad
Ownership of 2WTs (%)	70.5	25.0	4.5	
Information on 2WTs (%)	47.9	36.7	15.4	

4.2.7 Level of education of the respondents

From Table 8, the findings showed that 52.3% of respondents who did not own 2WTs were illiterate and 34.1% had attained primary level of education while 4.5% and 59.1% of respondents found to own 2WTs in the same education category respectively. Also respondents not owned 2WTs attained education level were 11.4% while 20.5% of respondents were found at same educational level category. Furthermore, 2.3% and 13.6% of respondents were found to attain college level of education for non-owners and owners of 2WTs respectively. The numbers were found decreasing as education level increasing for both owners and non-owners of 2WTs. It implies that farmers' education may significantly influence decision to own 2WTs with more years in schooling probability of participating decreases. Same results found by Perservance *et al.* (2012) in the study of adoption and efficiency of selected farming technologies found that educated people tend to reject agriculture activities.

Table 8: Ownership of 2WTs by level of Education attained

	Highest level of education attained				
	Illiterate	Primary	Secondary	College	No formal
Ownership of 2WTs (%)	4.5	59.1	20.5	13.6	2.3
Level of education attained (%)	8.0	33.4	24.3	5.7	28.6

4.2.8 Source of labour

From Table 8, the findings show that 56.8% of farmers who own 2WTs hired labour, while 40.9% owners of 2WTs used family labour and 2.3% of 2WTs owners involved in both hired labour and family labour. Labour is a key factor known that hinder adoption of new agricultural technologies more especially those which are labour intensive. Hicks and Johnson (1974) argued that higher rural labour will slow down the purchasing of 2WTs while shortage of family labor explains willingness to adopt and own agricultural machinery

Table 9: Ownership of 2WTs by source of labour

	Labour source		
	Self	Paid laborer	Both
Ownership of 2WTs (%)	40.9	56.8	2.3
Labour source (%)	47.1	50.4	2.5

4.2.9 Land size

The findings show that majority of farmers who had 2WTs owns land which is more than 16 acres while for famers who did not own 2WTs was found to fall on acreage between 6-10 acres (Table 10). For 2WTs owners, about 4.5% own land between 6-10 acres while 47.7% of non-owners fall in the same agricultural size category, none of 2WTs owner and 2.3% of farmers not owning 2WTss own less to 5 acres. Also those who own 11-15 acres are 38.6% for 2WTs owners and 27.3% for farmers who did not own 2WTs, while 11.4% owner of 2WTs and 68.2% of farmers who did not own 2WTs have greater than or equal to 16 acres of land size. This implies that there is a relationship in size of land possessed by farmers and that influences on purchasing 2WTs. 2WTs owners tend to have large amount of land compared to the farmers who did not own 2WTs. These results are similar with those Just *et al.* (1980) who claimed that adoption of an innovation will tend to take place earlier on larger farms than smaller farmers. Large scale farmers are more likely to adopt a technology than small holders CIMMYT (1993).

Table 10: Ownership of 2WTs by land size

	Agricultural production size			
	1-5	6-10	11-15	>=16
Ownership of 2WTs (%)		4.5	27.3	68.2
Agricultural size (%)		8.7	5.6	85.7

4.2.10 Market access

From Table 11, the findings show that 75% of the farmers who own 2WTs said that market accessibility was the reason for them to refuse purchasing that agricultural machinery while 81.8% of farmers were influenced with market accessibility to purchase 2WTs. Market access in the study area plays a great role in determines agricultural mechanization adoption of 2WTs. Howley *et al.,* (2011), argued that the market accessibility with interventions such as price supports speed up the adoption of the new technology.

Table 11: Ownership of 2WTs by Market access

	Market accessibility	
	Available	Not available
Ownership of 2WTs (%)	81.8	18.2
Market accessibility (%)	76.6	23.4

4.2.11 Reason for farmers to own 2WTs

From Table 12, the findings show that 36.4% of the respondents decided to adopt mechanization through purchase and ownership of 2WTs because they wanted to increase crop production, 20.52% of the respondents reasoned on labour scarcity while 43.2% of the respondents mentioned cost efficient to be the reason for owning 2WTs. Shetto and Owenya (2007) claimed that agricultural mechanization helped to increase crops yield in Manyara region.

Table 12: Reason for farmers to own 2WTs

	Reason to purchase 2WTs		
	Cost efficient	Labour scarcity	Increase production
Ownership of 2WTs (%)	43.2	20.5	36.4
Reason to purchase 2WTs (%)	34.0	52.1	13.9

4.3 Inferential Statistical Analysis

In this study binary logistic regression model was developed to analyze factors affecting adoption and ownership of 2WTs. The dependent variable was a decision of a farmer or group of farmer weather to adopted and own a 2WTs or not. Logistic regression is used to predict a categorical (usually dichotomous) variable from a set of predictor variables. With a categorical dependent variable, discriminant function analysis is usually employed if all of the predictors are continuous and nicely distributed; logit analysis is usually employed if all of the predictors are categorical; and logistic regression is often chosen if the predictor variables are a mix of continuous and categorical variables and/or if they are not nicely distributed (logistic regression makes no assumptions about the distributions of the predictor variables).

The results shows that, factors which were significantly affect the purchasing and ownership of a 2WTs were sex of the farmer/gender ($p<0.05$), land size allocated for crop production ($p<0.01$), age of the famer including experience on farming ($p<0.05$) and household size of the respondent ($p=0.05$) but other variable factors were found not to be significant (Table 13).

Table 13: Factors influencing ownership of 2WTs

Variable	B	S.E.	Wald	Sig.	Exp(B)
Gender	3.166	1.431	4.896	.027**	23.723
Family Size	-0.557	.284	3.838	.050**	.573
Land Size	0.413	.135	9.378	.002***	1.511
Age	-1.526	.777	3.859	.049**	.217
Education level	-0.627	.591	5.518	.623	.534
Credit availability	0.773	1.83	2.921	.154	2.166
Knowledge/Operation	2.678	.815	6.003	.702	14.556
Spares availability	0.632	.277	1.813	.173	1.881
Number of draught available	-4.034	.418	8.211	.210	.0177
Availability of extension services	2.711	.647	7.069	.722	15.044
Constant	0.393	3.616	.012	.913	1.482

Nagelkerke R square= 0.627, Cox & Snell R square= 0.835, -2log likelihood= 35.309

Notes: *, **, *** indicate significance at 10 percent, 5 percent and 1 percent level, respectively.

Wald Chi-Square statistic tests the unique contribution of each predictor, in the context of the other predictors that is holding constant the other predictors and eliminating any overlap between predictors. The Wald $\chi 2$ has been criticized for being too conservative, that is lacking adequate power and an alternative would be to test the significance of each predictor by eliminating it from the full model and testing the significance of the increase in the -2 log likelihood statistic for the reduced model.

The likelihood is the probability the data given the parameter estimates. The goal of a model is to find values for the parameters (coefficients) that maximize value of the likelihood function, that is, to find the set of parameter estimates that make the data most likely. Many procedures use the log of the likelihood, rather than the likelihood itself, because it is easier to work with. The log likelihood (i.e., the log of the likelihood) will always be negative, with higher values (closer to zero) indicating a better fitting model.

Under Model Summary we see that the -2 Log Likelihood statistic is 35.309. This statistic measures how poorly the model predicts the decisions, the smaller the statistic the better the model. SPSS does not give us this statistic for the model that had only the intercept. The Cox & Snell R^2 can be interpreted like R^2 in a multiple regression, but cannot reach a maximum value of 1. The Nagelkerke R^2 can reach a maximum of 1.

4.3.1 Gender

Sex of farmer was found to be a positively significant ($p<0.05$) affect the ownership of 2WTs as shown in the Table 13 above. In the study area showed that male household are the ones who owned 2WTs more than female household with the variable for gender is 3.166 and female household coded “0” while male household coded “1”. Semgalawe (1997) argued that gender of the household head determines access to technical information provided by extension agents. Due to social barriers, male extension agents tend to address male-headed households. Also, female-headed households, who are mainly widows, divorcees and unmarried women, have limited access to production resources such as land.

4.3.2 Land size

Land size was highly statistically significant ($p<0.01$) and is positively related to the ownership and purchasing of 2WTs. Farmers who own large sized land have a great chance to purchase a 2WTs compared to those who own small sized land. This is due to the reason that most of farmers who own 2WTs have land size greater to 15 acres while farmers who do not own 2WTs have a land sized to 10 acres or less (Table 13). Makundi (2008) observed that land ownership and land size are the factors that influence a farmer to adopt a new technology.

4.3.3 Family size

From Table 13, number of household members was negative statistically significant at 5%. It is found that farmers with low numbers of members (coded as “0”) in the household are likely to adopt and own 2WTs compared to farmers with high number of household members (coded as “1”) because farmers with low population size in the household may be willing to hire more labour during the cultivation process and thus exposed easily to the new agricultural technology. The same results was found by Makundi (2008), who argued that high population size in the household constrains farmers to adopt methods of agricultural technology, also a study by Serman and Filson (1999) claimed that low population size in the household improves the desire to adopt agricultural innovations as they have the necessary need to start the innovation due to labour scarcity. It is expected that a larger household size will influence the decision of technology rejection because of the availability of labour required during the agricultural process.

4.3.4 Age

From Table 13, the findings show that age of the farmer is statistically significant ($p<0.05$) and is negatively related to the adoption and ownership of 2WTs. Farmers who aged greater than 50 years had less chance to adopt and purchase 2WTs compared to those who aged between 31-50 years. Baudron and Gerard (2012), found that chances of participation in mechanized farming increased with age because youths have appreciation on the importance of agricultural activities in most rural set ups and will take marginal effort to expand these activities while decreased with age as older has little appreciation on it as they tend to be risk adverse. Therefore there is a relationship between age of the farmer and adoption of 2WTs.

4.4 Costs-Benefit Analysis

To make a decision on whether to supply 2WTs to individual farmers or group of farmers, the calculation of break-even points for the business models were employed. The viability of 2WT mechanization was assessed from the perspective of the individual farmer and group of farmers. Net Present Value (NPV) and Benefit-Cost ratio (BCR) were used for measuring the profitability of individual or group business models for 2WT mechanization investments over times. Information was collected from individual farmers and group of farmers owning 2WTs and dealers/suppliers of 2WTs. A review of the demand and supply of 2WTs was undertaken to determine the extent of use, management and willingness to purchase 2WTs in the area. Information collected included: Machinery work rates; Timing of field and post production operations; Gross margins per hectare from individual and group of farmers owning 2WT; Investment costs on 2WTs and implements; Maintenance, running costs and general management; Crop production and its prices.

The cost-benefit analysis looks at the profitability of business models in agricultural mechanization investments and the financial incentives to individual farmers/group of farmers to purchase 2WT. By undertaking the financial analysis we can see whether the business models for mechanization interventions are profitable for the individual farmer or group of farmers and create an appropriate incentives scheme to ensure that the technological package is attractive to either business models and is likely to be sustained.

In conducting the financial analysis the following underlying assumptions were considered: Constant working hours of is 8hrs per day; A time horizon of 3 years was taken for the analysis to capture the full benefits of 2WTs business models; A discount rate of 23% was taken for the financial analysis reflecting the opportunity cost of capital in Tanzania; Working life of 2WT be 4 years/4000 hours (Titus *at el.*, 2014).

Business models information in per hectare costs and returns were prepared for each of the major cropping patterns found in the area. The budgets were derived from individual farmers and group of farmers own 2WTs and collaborated by technical experts in the Babati district. The economic analysis of the mechanization options was conducted for two business models which are the individual farmer owning a 2WT, employing on his/ her farm operations and providing services to neighbors and nearby villages; and the group of farmers owning 2WT, use it on their farms and providing services to neighbors and nearby villages.

4.4.1 Mechanization operations

Since 2WTs can perform several farm operations, a summary of the estimated purchase price, working life, utilization and work output for different implements are tabulated below (Table 14).

Table 14: Summary of the estimated purchase price, working life, utilization and work output for different implements.

Implement	*2WT*	*Trailer*
Purchase price ($)	2,700	950
Working life (hrs.)	4,000	10000
Crop	Multi use	Multi-use
Work rate (hrs./ ha)		2.0 tons per day
Available hrs. of operations		1000

4.4.2 Implement and maintenance costs

Most of the farmers remembered the price of the implements and the time they were bought. But also different local dealers/suppliers were visited to verify and establish the current prices. Using a straight-line depreciation method, annual depreciation values for the expected life of each implement was determined as shown in Table 15. Most farmers' service their equipment by buying spares parts from local importers and maintenance cost taken from Agricultural machinery shops.

Table 15: Annual depreciation values for the expected life of each implement

Equipment	*Purchase price ($)*	*Maintenance costs ($)*	*Working life estimated (years)*	*Annual depreciation ($)*
2WT	2,700	112	5	320
Trailer	950	64	10	112

4.4.3 Labour and 2WTs operators' costs

In Babati district, all farmers were not relying on permanent laborers rather on casual labour only if family labour was scarce to assist in farm operations. Casual labours were only employed during peak seasons for activities such as planting, weeding, harvesting, and after harvest processes and wage rated $3 and $5 per day.

4.4.4 Gross margin analysis

The average yields and production costs for maize and legumes were estimated and a summary of gross margins for these crops on a per hectare basis are shown in the tables.

4.4.4.1 Group Business Model

The results from the calculations showed that farmers generated a positive gross margin when using either hired or owned 2WTs. Although the value of production was assumed to remain constant with mechanization for both hired and owned 2WTs from Group BM, there were considerable input and cost savings. From table 16, with hired 2WTs, mechanization increases the cost of production of maize by 1% and legumes by 20% respectively but with an increase in gross margins. From Table 17, with own mechanization; production costs for maize reduced by 41% but gross margins increase by 12.8% and production costs for legumes decreased by 52.8% but with decrease by 4.36% in gross margin. Farm income analysis was conducted to determine the profitability of using 2WT for group of farmers.

Table 16: Yields, production costs and gross margins analysis (Without 2WT)

Crop	Yield/ha (ton)	Value of prod ($) /ha	Variable cost($)/ha	Gross margin($)/ha
Maize	2.0	504	269.28	209.52
Legumes	1.5	852	233.55	599.85

Table 17: Yields, production costs and gross margins analysis (With hired 2WT)

Crop	Yield/ha (tons)	Value of prod ($) /ha	Variable cost ($) /ha	Gross margin ($) /ha
Maize	5	1200	272.04	867.96
Legumes	2	1136	280.36	827.24

Table 18: Yields, production costs and gross margins analysis (With their Own 2WT)

Crop	Yield/ha (tons)	Value of prod ($) /ha	Variable cost ($) /ha	Gross margin ($) /ha
Maize	5	1200	160.48	979.52
Legumes	2	947.2	132.32	791.2

4.4.4.2 Individual Business Model

The results from the calculations showed that farmers still generate a positive gross margin when using the 2WTs as individual owner. Also, the value of production was assumed to remain constant with hired and owned 2WTs with respect production without mechanization. From Table 19, with hired 2WTs, mechanization increases the cost of production of maize by 5.16% and legumes 33.8% respectively but also with increase in gross margins. From table 20, with own mechanization; maize the costs reduced by 40.5% but increase by 52.6% in gross margins and production costs for legumes decreased by 52.8% but with an increase of 23%. Farm income analysis was conducted to determine the profitability of using 2WT for individual farmers.

Table 19: Yields, production costs and gross margins analysis (Without 2WT)

Crop	Yield/ha (tons)	Value of prod ($)/ha	Variable cost ($)/ha	Gross margin ($)/ha
Maize	1.5	457.5	327.7	102.35
Legumes	1.5	888	261.94	581.66

Table 20: Yields, production costs and gross margins analysis (With hired 2WT)

Crop	Yield/ha (tons)	Value of prod ($)/ha	Variable cost($)/ha	Gross margin($)/ha
Maize	3	642	344.61	265.29
Legumes	2	1184	350.45	803.95

Table 21: Yields, production costs and gross margins analysis (With own 2WTs)

Crop	Yield/ha (tons)	Value of prod ($) /ha	Variable cost ($) /ha	Gross margin ($) /ha
Maize	3	642	205.1	404.8
Legumes	2	1184	165.4	989

4.4.5 Mechanization services

Mechanization services to neighboring farmers and nearby village(s) were provided by individual farmers and group of farmers owning 2WT. Attention was given to collect data on custom hiring charges for mechanization service provision. The figures were based on interviews with ten individual 2WT service providers and four groups service providers located in Babati district. The market rate charges set by service providers are listed in the Table 22.

Table 22: Hiring charges for various services

	Hiring charges for service provisions	
Name of operation	*Market rate ($)*	*Hiring charge ($)/ hr.*
Ploughing	42.68/ ha	7.11
Sheller (2WT transported)	5.2/ton;	3.48
Water lifting	9.6/ ha.	4.26
Transportation (to market)	0.8/ bag	2.72

4.4.6 Cost-benefit analysis

A cost benefit analysis of the mechanization investments was conducted from the perspective of the individual farmer and the group of farmers. The analysis conducted in the view of calculation of the break-even point to decide whether for individual farmers or group of farmers to purchase the machinery and ensure that the business of providing mechanization services is viable

4.4.7 Business Models Analysis

Besides, the two business models were analyzed with consideration to mechanization service provision though was found to be limited in financial viability with the low number of customers. In either business model which did not provide services to neighboring farmers and nearby villages, proved to be clearly unviable meaning that in each business model, had to provide mechanization service to others. The net benefit stream was assumed to increase by 5 percent annually after year 3, as the demand for mechanization services expands. The results are summarized in Table 23:

Table 23: Cost benefit analysis for a business models not providing services to other farmers

Indicators	**Individual BM**	**Group BM**
	Basic model	
NPV ($)	-7963.3	-5788.7
B/C ratio	0.06	0.1
IRR (%)	-12	-25
	***Increase in costs** (10%)*	
NPV ($)	-8769.2	-6412.2
IRR (%)	-13	0

The analysis covers a three year period taking into account the incremental net benefits and investment schedule. The mechanization investments were phased in over a period of three years. The results for Individual BM show that purchase of

2WTs and its implements is not viable from the perspective of the group-owner operator, generating a negative net present value of $7963.3 at a 23% discount rate. The IRR was calculated at negative 12% which is well below the discount rate. The B/C ratio is 0.06. The investment costs were seen to be sensitive to cost variations. A 10 percent increase in the cost of machinery/ equipment and operating costs resulted in a reduction in the IRR and NPV (-13% and -8769.2 respectively). The results for group BM are somewhat attractive but not indicating viability. A negative NPV of $5788.7 is attained with a B/C ratio of 0.1 and negative 25% of IRR. The individual BM is also sensitive to a 10% increase in costs leading to the negative $6412.2 NPV and 0% IRR.

Based on this analysis; these results show that 2WTs can be attractive as investments for individual smallholder farmers if they can provide services to neighboring farmers and to other nearby villages based at commercial rates.

4.4.8 Mechanization service provision analysis

The analysis conducted based on the mechanization service provider perspective operating on a full time basis in both districts. The results for the two districts suggest that both individual BM and Group BM have attractive business opportunity. The results are summarized in Table 24:

Table 24: Cost benefit analysis for a business models providing services to other farmers

Indicators	Individual BM	Group BM
	Basic model	
NPV ($)	5419.7	3607.8
B/C ratio	2.59	1.47
IRR (%)	36%	38%
	Increase in costs (10%)	
NPV ($)	3748.7	2085
IRR (%)	32%	31%

From individual BM, the findings were extremely better; at 23% discount rate NPV is 5419.7 and IRR is 36%. A B/C ratio of 2.59 was also produced while for group BM the findings were also attractive; with NPV 3607.8, IRR 38% and B/C ratio of 1.47 was also produced. Both models proved not to be sensitive to changes in costs.

The market potential for hiring services depends on, or will vary with the purchasing power of its customers which in-turn will depend on productivity trends, price fluctuations, proper business management practices, availability of simple soft loans and off-farm income.

4.4.9 Comparative analysis.

The economic analysis results for the two models suggest that the rate of return on investment as represented by the IRR is attractive in the case of a full-time service provider. This is the case where a service provider provides mechanization services to other farmers around the location and nearby villages. The lower net income level for the group BM when not combined with own farm and provision services can be attributed to the failure to provide services to other farmers though the demand is there. The revenues from individual BM make the service providers business to be viable and profitable with positive NPV compared to group BM.

CHAPTER FIVE

5.0 CONCLUSION, RECOMMENDATION, AREAS FOR FURTHER RESEARCH AND STUDY LIMITATIONS

5.1 Conclusion

The demand for agricultural machinery in Tanzania is growing. Much of this growth is driven by the Government of Tanzania (GOT) and its desire to increase rural incomes and agricultural efficiency. The GOT also pursues these objectives as a way to increase political stability and national food security.

Sex of the farmer was found to influence the ownership decision of 2WTs. Results showed that male headed households are the ones who owned 2WTs more than female headed households due to accessibility of technical information provided by extension agents. Most of women do not access to technical training since they are busy with household chores and caring of children and may happen to have no time to attend the training/awareness creation seminars.

Also, land size was found to influence the ownership decision of 2WTs farmers who owned large sized land greater to 15acres have a great chance and more willing to purchase a 2WTs compared to the farmers who owned less than 10 acres as land can act as collateral for credit accessibility.

Family size was found to influence the ownership decision on 2WTs as household with low numbers of members in the household are likely to adopt and own 2WTs compared to household with greater number of members because farmers with low population size in the household may be willing to hire more labour during the cultivation process.

Age was found to influence the ownership decision of 2WTs as youth farmers were more willing to adopt compared to young and older farmers years because youths have appreciation on the importance of agricultural activities in most rural set ups. Lastly, ownership of 2WTs has helped farmers (Individual/Group) to increase their agricultural productivity especially on maize and legumes. Yields from the own mechanization was greater compared to hired mechanized services and yield without mechanization.

Cooperative ownership may appear to be the solution for easily purchasing of 2WTs in the short term and as many African farmers are already used to working in associations or cooperatives, so this should not be a problem. Local credit organizations have started working with cooperatives and governments now see mechanization as the way forward but in long term consideration, sole ownership of a machine improves timeliness, equipment matching and maintenance assurance, there are also lower the cost of management, which may be incurred in the sharing possibilities.

5.2 Recommendation

This research also has implications for agricultural machinery dealers because it provides them with a broader picture of what is occurring throughout Tanzania. Even though this research focuses on the Babati district agricultural machinery market, many of the challenges of meeting market demands that have been identified will be similar to those found in other centrally controlled countries. However, future research must be done in these economies to determine the relevance of these findings to agricultural machinery markets in other nations.

Apart from looking at delivering 2WT-based technologies to smallholders through government and/or entrepreneurs, but ownership of machinery by farmers is important for the successful and sustainable adoption of mechanization particularly for 2WTs. Investment in 2WTs by farmers can be made profitable when; 2WTs tailored to farmers' economic conditions; Multifunctional operations being feasible; Hiring service market easy to develop demand-driven.

There is need for communication and a feedback mechanism. Mechanization developments, adaption and transfer based on problems identified by the farmer in farm level are likely to be more effective in producing technology acceptable to farmers. However, the personal characteristics of researcher/extension worker such as credibility have good relationship with farmers, intelligence, ability to communicate with farmers and development orientation.

The private sector generally has a positive view of the policy environment for agribusinesses in Tanzania. Incentives for agriculture investors that include zero-rated duty on farm inputs including fertilizer, seeds, tractors and zero rated VAT on agricultural exports are encouraging. Tanzania is a signatory of the CAADP compact that calls for the Government to allocate at least 10 percent of the total annual budget to agricultural development. Tanzania has not met this target so far but over the years, the agriculture budget has been growing both in nominal and real terms.

The private sector should engage also in importation and the market interaction of machinery supply and demand will suitable and affordable machinery be brought into the country and ensure availability of spare parts.

To have a successful BM, it needs strengthening of services like information and agricultural training embedded in the price of the product and improved efficiency and profitability by creating transparency, understanding and trust. The business model approach for the commercialization of 2WT, there is a need to shift in approach paradigm a supply-side approach to a demand-side approach also from a public sector-focus to a more private sector-focus so as to provide more for agricultural machinery investors.

For standardization and quality, private importers need to be guided as they tend to be general traders with no specialist knowledge or experience of farm machinery. It is usual for these companies to import a batch of machines and once they are sold there is no further obligation to provide either spare parts or service for them. The next batches of machines to be sold might well come from a different manufacturer. The farmers who purchase from these companies are mostly inexperienced and often do not realize that there may be later problems with spare parts and repair services.

5.3 Further Research

Because of the time and resource limitations to this research, only one individual and one group business models were studied deeply. Multiple-case study of several business models in the Tanzania agricultural machinery industry would bring additional insight into how businesses have successfully met Tanzania agricultural machinery demand. If multiple business models have dealt with the same challenges in the Tanzania market that this research has identified, then increased validity and generalizability would result.

Gathering large amounts of primary data by surveying Tanzania farmers and their reasons for purchasing agricultural machinery and their general situation in the agricultural industry would have been helpful additions to the research of this topic. These data could have been analyzed to discover the weight of each factor in the average Tanzanian farmer's decision to purchase agricultural machinery. Since climate, policies, and the agricultural industry vary by location, these surveys could be done in multiple provinces to obtain an even more accurate observation of the Tanzanian agricultural machinery market.

5.4 Study limitations

Most of the information from the department of mechanization was difficult to get because are not well documented so being difficult to capture, especially for the previous and current mechanization data. Also studies conducted by the Ministry on the impact of mechanization in farming are not documented and it was difficult to share with the project.

Unwillingness of farm machinery dealer's or importer's to share information. It was difficult real to get information from them fearing leakage of information and competitions. To some extent enough information on farm machinery trend and business in general were not shared as expected.

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APPENDICES

Appendix 1: Description of the variables used in Binary Logit model and their expected signs

Variable	symbol	Unit	Expected sign	Description
Age	Age	Years	+/-	Age of HHHs either positively or negatively influences adoption.
Age dummy				
Less to 30 years	AGE1	Dummy	-	Age of HHH either positively or negatively influences adoption.
31-70 years	AGE2	Dummy	+	Age of HHH either positively or negatively influences adoption.
Greater to 70 years	AGE4	Dummy	-	Age of HHH either positively or negatively influences adoption
Gender	Gend	Dummy	+	Male are expected to be better adopters and more willingly to own 2WTs.
Marital status	Mar_st	Dummy	+	Married HHHs are expected to adopt.
Education	Educ	Dummy	+	Educated HHHs are expected to adopt.
Family size	HH_Size	Number	-	A larger family size is expected to negatively influence adoption.
Farm size	Farm_Size	Number	+	A larger farm size used for agricultural operation is expected to positively influence adoption
Credit services	Cred	Dummy	+	Getting credit services is expected to positively influence adoption.
Availability of spare parts	Spares	Dummy	+	Availability of spare parts will influence the willingness to 2WTs ownership
Knowledge	Knowl	Dummy	+	Knowledge on how to operate and repair
Extension services	Ext_Servc	Dummy	+	The access to extension services is expected to positively influence adoption.

Appendix 2: Questionnaire

A COMPARATIVE ANALYSIS OF BUSINESS MODELS OF 2WTs IN BABATI, MANYARA

HOUSEHOLD QUESTIONNAIRE

Household Information and Characteristics

Date: ………………………….. Respondent name: ………………………………………….…….

Name of Household head: …………..………..…………………. District: …………………….

Village name: ……………………….…….…. Sub village name: ………..……………………..

Ward name: ……………………………….

S/N	Name of Household member	Sex 1.Male 2.Female	Age	Relationship with household head 1.Head 2. Husband 3.Wife 4. Wife in polygamous relation 4. Child 5. Brother 6. Sister 7. Grandchild 8.Mother/father in-law 7.Other relation	Marital Status 1. Married 2.Single 3.Widowed 4.Separated/Divorced	Highest education attained 1. Illiterate 2.Primary 3.Secondary 4. College 5.University 6.Adult education 7.No formal education	Occupations of adults 1.Crop production 2.Lvestock keeping **3**.Fishing **4.**Mining **5.**Casual labour **6.** Salaried job **7.** Artisan **8.**Own business **9.**Other (specify)	Participation on Farming activities 1.Full time 2.For a short period 3. public holiday 4.Ceremony 5.Others(specify)
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
11.								
12.								

Ethnicity, Language and Nativity

Was the household head born here? [ ] 1= Yes, 2= No;

If No, where did he/she migrate from? ____________ (District) _______________ (Region);

Is the spouse a native of this place? [ ] 1= Yes, 2= No

When did the household head arrive in this village? _________ Year

Why did the household head migrate to this place? [ ] 1= seek arable land, 2= seek irrigable land, 3= marriage, 4= good access to market, 5= seeking casual job, 6= migrate to follow parents 7 = search for water, 8 = other (specify) _______________________

What is the first language used in this household? _______________

What is the main language used in this community _______________

Which ethnic group do the household head and spouse belong to?
__________________ (head) ____________________ (spouse)

Labour availability and workforce

Age (years)							
	Total	Disabled/dependents (younger children, challenged, aged, permanently sick)	Able but jobless (not willing to work)	Working off-farm always	Working on-farm always	Working on-farm partly	Total
Up to 6							
7 --- 12							
13 ---17							
18 --- 40							
41 --- 60							
More than 60							

Knowledge on 2WTs and availability

Are you aware that 2WTs is used in farming activities?

a) Yes ( ) b) No ( ) c) Don't know ( )

From where have you heard about 2WTs? (Tick as appropriate)

a. Own observation ( ) g. NGO working in our area ( )
b. Newspapers ( ) h. Researchers ( )
c. Village meetings ( ) j. Radio ( )
d. Neighbors, friends or family ( )
e. Input suppliers ( ) l. Others (specify) ( )
f. Television ( )

When did you hear about powertiller?

a) Recently ( )
b) Long ago ( )
c) None of the above ( )

How well have you been informed about 2WTs and its uses on farming activities?

a) Very well ( )

b) Fairly well ( )

c) Fairly badly ( )

d) Badly ( )

What kind of 2WTs related problems/shocks occur/have occurred in your area?

a) ………………………………………………………………………………

b) ………………………………………………………………………………

c) ………………………………………………………………………………

d) ………………………………………………………………………………

What kind of coping mechanism you have been employed in solving the above identified problems?

a) ………………………………………………………………………………

b) ………………………………………………………………………………

c) ………………………………………………………………………………

d) ………………………………………………………………………………

To determine the factors which influence the purchasing of 2WTs

How many times in a year did you till your land?

a) once ( ) b) twice ( ) c) three times ( ) d) three times and more ( )

Do you cultivate land yourself?

a) Yes ( ) b) No ( )

How did you till your land?

a) Hand hoe ( ) b) 2WTs ( ) c) Tractor ( ) d) Ox-cart ( ) e) Oxen plow ( ) f) Donkey ( )

Among of the tools mentioned above which one is mostly frequently used per season? Rank in order of importance

a)………………………………………………..

b)………………………………………………..

c)………………………………………………..

d)………………………………………………..

How do you know about the use 2WTs?

a) TV/ radio (   )   b) neighbor (   )   c) magazine (   )
d) research and extension officer (   )   e) inputs shop (   ) f) Others (specify) …………………………

When did you purchase your 2WTs? Year………….

What is the reason of purchase 2WTs?

a) Price of 2WTs (   )   b) income level (   )   c) Labour scarcity (   )
d) cost efficient   (   )   e) business purpose (   )   f) self-employment (   )

What is the initial price of 2WTs? …………..

Tillage by 2WTs per hour (ha/hour)……………….

What is the fuel consumption per hour……………

Repair and maintain cost per season?

Do other people hire your 2WTs?
a)   Yes (   )   b) No (   )
If yes in question no… above, for what purpose do they tend to hire 2WTs?

a)farm activity (   ) b) off- farm activity (   )

Who drives your 2WTs, yourself or paid labour?

If paid labour, what is his monthly/daily based salary (Tsh)…………

If other people hire your motor how much they pay for an hour (Tsh)………

Did your 2WTs perform any other operations other than tillage?

Total working days of 2WTs in a season/month, number of days………..

What is your annual income (Tsh) from 2WTs? …………..………….

Economic performance of 2WTs

	Individual 2WTs		**Group 2WTs**	
Activities	**Maize**	**Wheat**	**Maize**	**Wheat**
Total revenue				
Variable cost				
Land preparation				
Sowing				
1st fertilizer application				
2nd fertilizer application				
1st weeding				
2nd weeding				
Seed cost (Tsh/ha)				
Fertilizer cost (Tsh/ha)				
Harvesting				
Threshing				
De husking				
Total variable cost				
Gross margin(TR-TVC)				
Net revenue				
BCR				

Approximation of household incomes from farm, off-farm and non-farm activities for the last twelve months

Item	Quantity sold/year	No. of unit sold/year	Total Value/year(Tsh)
Crop			
Livestock			
Others (specify)			

Did you participate in non-farm activities/off-employment? 1= Yes 2= No
If your answer above is yes, how much did you receive as income from your activities?

Type of Activity	Self-employment (Tsh)	Off farm employment (Tsh)	Total income/year (Tsh)

What are the main constraints for increased income and output and improved livelihood in your area? (Agricultural and livestock) (Please rank them in the order of importance

Constraint	**1. Yes 2.No**	**Priority (e.g put 1, 2, 3, etc)**
Unavailability of improved seeds		
Unavailability of inorganic fertilizers		
Unavailability of Organic fertilizers		
Weeds		
Salinization		
Inadequate extension services		
Unavailability of insecticides		
Prolonged drought		
Floods		
Poor market access		
Low market prices of crops/livestock		
Wildlife related shocks		
Local conflicts		
Labor shortage		
Soil problems		
Fire		
Theft		
Livestock diseases		
Inadequate extension services (crop and livestock)		
Unavailability of veterinary drugs		

LHS.4. In the past one year did you borrow (get money from others on loan) or lent (give out money on loan)?	Activities	No. of times
	Borrow money	
	Lent money	

If your HH wanted to borrow money, who would you approach first? And how difficult is it to borrow money from them?	Source	Tick	Easy	Difficult
	Relatives			
	Friends			
	Community fund			
	Rural credit cooperative			
	Local private money lender			

Extension services

Have you ever received any extension/information/knowledge from the following sources?

a)Government Agents ( ) b) Researchers ( )

c) NGOs ( ) d) Private sector (e.g. stockists, tractor hirer) ( )

How many times per cropping season do you receive the extension services? ……..

Appendix 3: Group Business Model

Purchase price						2700
Selling price after		4	years			1120
Average value						1528
Interest		23	% rate			281.2
Annual depreciation						316
Insurance and road license		5	%			7108
Storage cost		2	%			43.2
Total annual fixed costs						598.7
Hours or hectares worked annually						1000
Fixed costs per hour or hectare						*0.59868*
Operating cost per hour						
Labour		Operator	60	$/month	6.8355	1.14
Fuel		0.38	Litre/hr.	1.0	$/litre	0.38
Spares and repairs						0.19
Total operating costs						1.71
Mark-up		30	%			0.69
Total cost per hour or hectare		Mark up 25-50%				***3.0***

Appendix 4: Individual Business Model

Purchase price						2700
Selling price after		4	years			1120
Average value						1528
Interest		23	% rate			281.2
Annual depreciation						316
Insurance and road license		5	%			7108
Storage cost		2	%			43.2
Total annual fixed costs						598.7
Hours or hectares worked annually						1000
Fixed costs per hour or hectare						*0.9855*
Operating cost per hour						
Labour		Operator	60	$/month	2.5	0.31
Fuel		0.38	litre per hr.	1.0	$/litre	0.38
Spares and repairs						0.19
Total operating costs						0.88
Mark-up		20	%			0.30
Total cost per hour or hectare		Mark up 25-50%				***1.78***