COMPARATIVE PERFORMANCE OF POWER TILLERS AS AN ENTERPRISE: INDIVIDUAL VERSUS GROUP BUSINESS MODEL OPTIONS IN ARUSHA AND MANYARA REGIONS, TANZANIA.

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ABSTRACT

The aim of this study was to undertake a comparative analysis of the performance of a power tiller as an enterprise owned under individual and group ownership business models in Arusha and Manyara region. Specifically, the study aimed to i) undertake an inventory of 2WT and ownership distribution; ii) assess and compare the physical performance and iii) financial performance of 2WT under individual and group business models; and iv) evaluate the effect of ownership and other factors on the performance indicators of 2WT. The study involved a total of 47 individual owners and 34 group owners of power tillers from three districts Meru, Arusha rural in Arusha region and Babati district in Manyara region. Descriptive statistics, comparing means by hypothesis testing and regression analysis were used for data analysis. The study revealed that group owners of power tillers had higher annual net returns compared to individual owners, due to several factors including; group owners owned brand new power tillers with higher proposition of Kubota tractors which were the most efficient compared to other models of power tillers. Consequently, group owners had low maintenance cost compared to individual owners, in addition to that, high maintenance cost was a result of lack of trained and skilled mechanics who have knowledge on power tillers, and unavailability of spare parts. The most popular activity was transportation, however the highest significant paid activities were ploughing and tillage. It was recommended that individual owners should increase their share of ploughing and tillage in services provided. The government should facilitates individual owners as well as group owners to purchase brand new power tillers by promoting the use of Kubota power tillers. The government should widen the inputs fund so that individuals as well as groups can access credit for acquiring power tillers.

DECLARATION

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

_____ _____

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The above declaration is confirmed by;

_____ _____

Prof Aida C. Isinika Date

(Supervisor)

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DEDICATION

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LIST OF ABBREVIATIONS AND ACROYNMS

2WT	Two Wheel Tractors
4WT	Four Wheel Tractor
AGIFT	Agricultural Inputs Trust Fund
ASDS	Agricultural Sector Development Strategy
CAMATEC	Centre for Agricultural Mechanization and Rural Technology
DADP	District Agricultural Development Plans
DASIP	District Agricultural Sector Investment Project
FACASI	Farm Mechanization & Conservation Agriculture for Sustainable Intensification
FAO	Food and Agriculture Organisation
FFS	Farmer Field Schools
KATC	Kilimanjaro Agriculture Technical Collage
MAFC	Ministry of Agriculture, Food and Cooperatives
MDG	Millennium Development Goals
NSGRP	Strategy for Growth and Reduction of Poverty
RDS	Agricultural Rural Development Strategy
SDS	Sustainable Development Goals
SSA	Sub-Saharan Africa
TAMS	Tanzania Agro-mechanization Strategy
TDV	Tanzania Development Vision

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Agricultural mechanization has been an integral component of the agricultural transformation processes around the world. It embraces the use of tools, implements, and machines for a wide range of farm operations from land preparation to planting, harvesting, on-farm processing, storage, and marketing of products (Edeh *et al.*, 2014). In Tanzania, the history of post-independence mechanization experiences among smallholder farmers goes back to the 1960s where tractors were promoted, mainly on medium to large scale farms, which also provided hire services to smallholder farmers in their neighbourhoods (FACASI, 2014).

In the recent past years efforts to promote such technology were initiated by the Ministry of Agriculture, Food Security and Cooperatives (MAFC) during 2005, after developing the Tanzania Agro-mechanization Strategy (TAMS). The Government of Tanzania supports mechanization through empowering farmers to acquire farm machinery by facilitating different government programmes including the Agricultural Inputs Trust Fund (AGITF), District Agricultural Development Plans (DADPs) and the District Agricultural Sector Investment Project –DASIP. Further, an increase of power tillers in Tanzania has been attributed to the “Kilimo Kwanza” (Agriculture First) initiative; this is a national agenda of transforming agriculture through the introduction of new and innovative technologies so as to increase food production and agricultural exports (MAFSC, 2013).

By 2010/11, through different government agencies, about 4 571 power tillers had been imported and distributed to almost all districts in the country, priority being given to Farmer Field Schools (FFS), which were required to pay about 20% of the value for the 2WTs and ancillary equipment, thus receiving an 80% subsidy. Farmers found that 2WTs were easier to maintain and had higher field efficiency than oxen for conventional ploughing, cultivating 3-4 acres per hour compared to 1/4-1/2 acres per hour by oxen (FACASI, 2013).

Power tillers or two wheel tractors (2WT) are simple and more versatile machines that are efficient and can be easily diffused in developing countries, where they are used for a range of farm activities such as tillage, harrowing, pumping water and transportation. The simplicity, robustness, reliability and user safe features of 2WT make it a case of simple agricultural tools and commercial equipment that is highly desirable for smallholder farmers in developing countries (*ibid.*).

Power tillers in Tanzania have been used in various operations including; tillage (for maize, legumes, rice, and vegetables), transportation, shelling/threshing (maize and beans), water pumping for irrigation and maize milling. Such tools often serve a multipurpose function to smallholder farmers. They are often associated with small-scale agriculture cultivating 1-2 ha of land, with low farm mechanization, hence facing high labour drudgery and low yields). They are used as farm machinery for production but also as an enterprise for generating income through diverse hiring service (Diao *et al.*, 2016). While most farmers are aware of the benefits from mechanization most of them cannot afford to buy their own equipment such as 2WT and some cannot even afford to pay for rental services for the power tiller. The aim of this study was to compare the

performance of two wheel tractor under individual and group ownership business models based on physical and financial criteria.

1.2 Problem Statement

According to Food and Agriculture Organisation (FAO) report (2008) increased agricultural production and improved rural livelihoods cannot be achieved without the adoption and use of increased levels of farm power and mechanization. Lessons learnt from three stylized models based on experience from some Asian countries were smallholders farm mechanization dominate provide evidence of the accomplishment from mechanization in small scale agriculture. Diao *et al*. (2014) argued that for a successful sustainable adoption of mechanization, particularly involving tractors, it is important that the machinery be owned by farmers. However, investment in tractors by farmers can be more profitable when tractors are tailored to farmers' economic conditions, being used for multifunctional operations especially where the market for hiring service is easy to develop. FACASI (2014), estimated that by adopting 2WT-based technology farmers would increase income by as much as 50%, by widening the scope of using the tractors to include transport, threshing and shelling, which will increase their prior expected income by 20% or more.

In Arusha and Manyara regions, specifically in Arumeru and Mbulu districts, FACASI (2013) observed that the market for 2WT hiring service is well established both under individual and group ownership. However, running the 2WT has generated lower income than the potential. This has been a challenge to farmers especially among owners of unsubsidized 2WTs and ancillary equipment. Through training and workshops farmers have been provided with skills required for adopting and utilizing the agricultural machinery profitably. Nevertheless, the owner's returns tend to fall short of the predicted

income increase by FACASI. Even when farmers adopt 2WT under individual or group ownership, or when they run hiring services they also face other constraints related to limited ability to acquire other inputs such as fertilizer, agrochemical and high maintenance cost of the power tiller, which limits the potential for productivity improvement via mechanized technology adoption.

Hence, farmers often get low output and subsequent low demand for mechanization. All these feed into the vicious cycles of low productivity. These factors come up as constraints towards profit maximizations for owners of 2WT. This study presents a comparative analysis of how a 2WT performs (physically and financially) as an enterprise under individual and group ownership in Arusha District, Meru and Babati District Council. This study fills the knowledge gap in relation to the performance of 2WT in Tanzania, which has been strongly promoted by the government since 2005 as a solution to smallholder farmer's mechanization problems. However limited research has been conducted to verify the government's assertion. This analysis provides guidance regarding farmers' decision making process during the acquisition and ownership of 2WT, thereby contributing to future mechanization policy.

1.3 Objectives

1.3.1 Overall objective

The main objective of this study was to undertake a comparative analysis regarding the performance of two wheel tractor under two business models; individual and group ownership in Arusha and Manyara regions.

1.3.2 Specific objectives

In order to achieve the overall objective of this study four specific objectives were pursued as follows;

(i) To undertake an inventory of 2WT and ownership distribution in the study area during 2016.

(ii) To assess and compare the physical performance of 2WT under individual and group business models.

(iii) To assess and compare the financial performance of 2WT under individual and group business models.

(iv) To evaluate the effect of ownership and other factors on the performance indicators of 2WT.

1.4 Research Questions and Hypothesis

In order to address the first objective which aimed at developing an inventory of 2WT and access their spatial distribution following research questions were posed.

a) What is the number and proportion of 2WT owned and operated under individual ownership relative to those under group or cooperate ownership?

b) What is the range of activities performed by 2WT under each ownership regime?

c) What are the physical performance indicators of the 2WT adopted in the study area?

d) What are the financial performance indicators of the 2WT owned used or adopted in the study area?

The second objective set out to compare the physical performance of the 2WT under the two ownership regimes. The research question was designed to identify the type of tasks performed by 2WT as follows;

i. What type of tasks are performed by 2WT under individual and group ownership regimes?

This was followed by four hypotheses which were designed to assess 2WT physical performance indicators in relation to ploughing, tilling, threshing and transport. The null hypothesis and corresponding alternative hypothesis are as listed below;

i. H_0; the average area ploughed per year by 2WT under group owners is equal to average area ploughed by 2WT individual ownership.

Mathematically it is written as; H_0: $\overline{X_{1\iota}} = \overline{X_{1g}}$

Where; $\overline{X_{1\iota}}$ = average area ploughed per year by 2WT under group owners

$\overline{X_{1g}}$ = average area ploughed per year by 2WT individual ownership.

ii. H_0; the average area tilled per year by 2WT under group owners is equal to average area tilled per year by 2WT individual ownership.

Mathematically it is written as; H_0: $\overline{X_{2\iota}} = \overline{X_{2g}}$

Where; $\overline{X_{2\iota}}$ = average area tilled per year by 2WT under group owners

$\overline{X_{2g}}$ = average area tilled per year by 2WT individual ownership

iii. H_0; the average number of sacks threshed per year by 2WT in group ownership is equal to the average number of sacks threshed per year by 2WT under individual ownership

Mathematically it is written as; H_0: $\overline{X_{3\iota}} = \overline{X_{3g}}$

Where; $\overline{X_{3\iota}}$ = average number of sacks threshed per year by 2WT under group owners

$\overline{X_{3g}}$ = average number of sacks threshed per year by 2WT individual ownership

iv. H_0; the average number of sacks transported per year by 2WT in group ownership is equal to the average number of sacks transported per year by 2WT under individual ownership

Mathematically it is written as; H_0: $\overline{X_{4\iota}} = \overline{X_{4g}}$

Where; $\overline{X_{4\iota}}$ = average number of sacks transported per year by 2WT under group owners

$\overline{X_{4g}}$ = average number of sacks transported per year by 2WT individual ownership

The third objective set out to analyse economic performance indicators of the 2WT which were addressed by three research hypothesis as follows;

i. H_0; the average operating cost per 2WT incurred by group owners is equal to average operating cost per 2WT per year incurred by individual owners.

Mathematically it is written as; H_0: $\overline{C_\iota} = \overline{C_g}$

Where; $\overline{C_\iota}$ = average cost per 2WT per year obtained by Group owners

$\overline{C_g}$ = average cost per 2WT per year obtained by individual owners

ii. H_0; the average total revenue per 2WT per year obtained by Group owners is equal to average total revenue per 2WT per year obtained by individual owners

Mathematically it is written as; H_0: $\overline{R_\iota} = \overline{R_g}$

Where; $\overline{R_\iota}$ = average total revenue per 2WT per year obtained by Group owners

$\overline{R_g}$= average total revenue per 2WT per year obtained by individual owners

iii. H_0; the average compounded net return per 2WT per year obtained by Group owners is equal to average compounded net return per 2WT per year obtained by individual owners

Mathematically it is written as; H_0: $\overline{N_\iota} = \overline{N_g}$

Where; $\overline{N_\iota}$ = average compounded net income per 2WT per year obtained by Group owners

$\overline{N_g}$ = average compounded net income per 2WT per year obtained by individual owners

Under the forth specific objectives the influence of various factors on the variation of net profit was assessed using a regression model. The null hypothesis tested was;

i. H_0: the independent variables have no influence on the variation of the 2WT owner's net returns.

Mathematically this can be presented as; H_0: $B_{ij} = 0$

Where; B_{ij} is the coefficient of the j^{th} independent variables include; number of tasks performed by the 2wt, acres ploughed, acres tilled, number of sacks threshed, number of sacks transported, depreciation value, ownership type, tractor model, soil type and condition of the tractor brand new or used.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 History of Agricultural Mechanization

Agricultural mechanization refers to the application of tools, implements, and powered machinery as inputs to achieve agricultural production. Agricultural mechanization is often associated with tractorization that involves utilizing tractors and sophisticated agricultural machinery in agricultural production. Clarke (1997) points out that agricultural mechanization involves three sources of power which are used in agriculture; manual, animals, motorized; the latter involves fossil fuel and electric power. Mechanization is a core factor for agricultural development to farmers' wellbeing. Mechanization has increased productivity substantially, up to 500 times compared to manual labour and without chemical application (Mazoyer, 2001).

Agricultural mechanization, has been the greatest achievements of the 20th century (NAE, 2000), where the first engine-powered farm tractor using steam was introduced in 1868. Ried (2011) describes agricultural mechanization as a result of technology that created value in agricultural production practices through more efficient use of labour, the timeliness of operations, as well as more efficient input management that focus on sustainable, high-productivity systems. Historically, access to affordable machinery, which increased capability, standardization, measurably and improved productivity was a key enabler of agricultural mechanization in Europe and the United States of America (USA) as well as other developed countries (*ibid*.).

The demand for mechanization may be determined by various factors including farming systems, population density, and labour wages (Pingali, 2007). Given the heterogeneity of the agro-ecological environment and the diversity of socioeconomic characteristics

among farm households in Sub-Saharan Africa (SSA), farm mechanization plays diverse roles in agriculture development. For example, farm mechanization may be more effective at reducing labour costs than in expanding the area cultivated (Diao *et al.*, 2013).

Historically, tractor-based mechanization has enjoyed popular support among policymakers and the farming population in developing countries because it has a vital role in increasing production and relieving drudgery in agriculture (Ahmed, 2015). Since the 1940's many developing countries established state-run agricultural centres that subsidized tractor hire schemes for the purpose of extending tractor-based mechanization to small farmers as a means of helping farmers to increase their farm holdings and archive food production (Alabadan and Yusuf, 2010).

According to FAO reports (2013a, 2013b), in Asia, the number of tractors introduced among farmers' societies increased rapidly between the years 1961 until 1970, when the number of tractors rose from 120 000 to 600 000 units. By the year 2000, the number had increased 10 times to 6 million units. Since then numbers have continued to increase, especially in India, which had 2.6 million tractors in 2010 and China reached over 2 million units by 2008. Considering the significant increase in the number of tractors in Asia, the trend in SSA has been very low. In 1961 the number of tractors in use (in SSA) was higher than in both Asia and the Near East (at 172 000). However 2000 the number of tractors in SSA was only 251 209 compared to 6 million tractors in Asia (World Bank report, 2008).

Efforts reflecting the slow growth rate made by individual countries to promote agricultural mechanization had different results due to the form of economic systems in place. Evidence shows that socialist countries had experienced more difficulties in

advancing agricultural performance and that, these systems had slower agricultural growth compared to other countries. For example, socialist countries as China in 1930s under Mao Tse- Tung rule experienced declining agricultural production (Osterfeld, 1986).

However, attempts to mechanize agriculture in sub-Saharan Africa countries failed to induce sustained adoption of mechanization after the end of the initial government support (Pingali 2007). A major lesson is learnt from comparing Kenya, a capitalist state, and Tanzania, a socialist state, during the 1970s and 1980s. Kenya had an impressive performance in the agricultural sector while Tanzania's agricultural performance significantly declined due to economic mismanagement (Gabagambi, 2013). An FAO report (2011) observed that development of farm mechanization has rarely been successfully driven by the government's direct involvement in machinery supply, development, and financing, or offering mechanization hire services (FAO, 2011).

2.2 Position of Agricultural Mechanization in SSA

Agricultural mechanization levels, which entails the use of machinery in farming differs dramatically across the globe. Africa remains the most challenging region for mechanization. Farm power in African agriculture, especially in SSA, has high reliance on human muscle power. Such power, has limited bound in terms of energy, it also reduces efficiency in the farming process, costing more in terms of time and involving high labour cost. Land productivity in SSA is among the lowest in the world. Meanwhile, agricultural mechanization has either stagnated or retrogressed in recent years. Table 1 shows that over 60% of farm power is still provided by people's muscles, mostly women, the elderly and children; only 25% of farm power is provided by draught

animals and less than 20% of mechanization services are provided by engine power (FAO, 2008).

Table 1: Farm Power Source

	Farm Power Source (%)		
Region	**Hand**	**Animal**	**Engine**
SSA	65	25	10
3 Other developing regions*	25	25	50

* Asia, Near East and North Africa, Latin America and the Caribbean.

Source: FAO report, 2008.

Animal hire services are found in many communities in Eastern and Southern Africa. Between 30% to 60% of the farming communities in the region benefit from such hire services. An example is found in Sumbawanga district in Rukwa region, where 98% of rural households have been using oxen for ploughing, but only 30% of the households own oxen. Small-scale farmer hire service enterprises have emerged and they have recorded increases in farm income of more than 50% (Shetto *et al*., 1999).

Studies show that Sub-Saharan Africa remains the only region in the world with the lowest power usage (manual, animal and mechanical) and the lowest level of farm mechanization. Between 50 percent and 80 percent of the area under cultivation (Clarke, 1997) By 1996, in SSA the average number of tractors was about 28 tractors per 1000 ha whereas it was about 241 tractors per 1000 ha in other regions (Asia, Near East and North Africa, Latin America and the Caribbean). The use of manual power dominates in Central Africa whereas in Western and Eastern Africa more use is made of draught animals. In SSA, tractor usage is highest in Southern Africa (Houmy *et al*., 2013).

Table 2: Growth in tractor numbers between 1961 and 2000

Region	Increase %
Asia	500
Latin America and Caribbean	469
North Africa and Near East	1350
Sub-Saharan Africa	28

Source: FAO, 2004, Agricultural Mechanization in sub-Saharan Africa.

The growth of tractor increase in SSA is recorded to be far behind other regions. While in Asia the growth of tractor was 500% from 1961 to 2000 and that of North Africa and that of the Near East was 1350%, while SSA recorded only 28% corresponding growth. Table 2 shows greater advances in mechanization in other regions compared with SSA. This shows how far behind SSA is in the application of agricultural mechanization.

2.3 History of Power Tillers

The history of agricultural mechanization in Africa goes back to the 1900s as most countries started using more mechanized farm equipment's so as to increase production. Worldwide, the development of power tillers, which are also called single–axle tractors began in the early 20th century and for many decades it involved various people working independently to modify and improve the tools' work capacity. The first inventor of two-wheel drive (2WD) tractor was John Deere in 1968 under the Deere and Company (Shridar *et al.*, 2006).

Two-wheel tractors were designed to support small scale farmers' technical ability and productivity hence it was designed such that it has a lower price, more versatile nature and it could be driven by any family member since they are simple and easy to handle. Although labour productivity of two-wheel tractors is lower than that of four-wheel tractors, it is higher than that of animal-powered farming or manual labour. A farmer

can still benefit from faster and more timely completion of farm work with less labour force. The technology is therefore intended to help small-scale farmers shifting from animal-powered farming to engine powered farming (*ibid*.).

In their report, Sims *et al*. (2012) argued that most efforts to promote 2WT happened during the 1950s and early 1980s. Japan, where the first successful model of power tillers was designed in the year 1947, was the first country to use power tillers on a large scale. Thereafter, production of power tillers rapidly increased during the year 1950 up to 1965. The Japanese International Co-operation Agency-JICA highly promoted the Japanese 2WTs in Eastern Asia. This promotion enabled most Asian countries to import 2WT for the purpose of enabling their small scale farmers, especially in rice growing countries such as Nepal, China and Japan herself. When the Chinese power tillers were produced in 1961 most countries shifted from Japanese 2WT to Chinese because they were less expensive (Diao *et al*., 2016).

In addition to the 2WT ability to perform on-farm activities, it also functions well in other off-farm activities such as transportation and water pumping. Due to its multi-functions farmers and other rural entrepreneurs adopt two-wheel tractors as multipurpose productive investments to earn income. For example in Sri Lanka 2WTs are used in these multiple ways such that agricultural uses are just part of a mixture of operations involving services provided by the rural entrepreneurial activities of farmers and others in the rural and agricultural industries (Biggs *et al*., 1993).

2.4 Position of 2WT as Options for Mechanization

Farm power determines the total area under cultivation as well as the efficiency of accomplishing crop husbandry tasks. Increasing the usage of farm power for cultivation creates further demand for related agricultural machinery for weeding, spraying,

harvesting and storage. All these generate employment opportunities ranging from agricultural services to transportation. Diao *et al.* (2014) explains how utilizing power tillers are based on three stylized models that demonstrate the alternative relationships between demand for mechanization and supply of mechanization services. The three stylized models are named after three Asian countries, but they represent experiences from many other Asian countries as well.

The first is the Bangladesh model where small-scale farmers own the 2WT. In this model, there was a major increase in the import of Chinese two wheel tractors into Bangladesh began around the 1990s due to rapid mechanization as a result of major floods and cyclones that hit the country during the late 1980s (Justice and Biggs, 2010). By 2007, approximately 400 000 power tillers were in use in Bangladesh and nearly 62 000 units were being imported annually. A national survey showed that while only 2% of the farmers in Bangladesh owned power tillers, 72% of the farmers used the tools; an indication of a highly developed and well-functioning hiring market (Ahmed, 2013). Since farmers have extremely small farm landholdings, the use of power tillers for land preparation alone limits their utilization and hence profitability to their owners. To overcome such a limitation, farmers became innovative, using the power tiller as; (i) an engine in crop threshing (ii) water pumping for irrigation (iii) a vehicle to cart agricultural and non-agricultural products to local markets (iv) transport vehicle for people. Due to such diverse use of the tool, Singh and Roy (2008) showed that power tiller owners in Bangladesh can repay their investment within 1–2 years after the purchase.

Second is the India model, characterised by the presence of medium to larger farmers offering hire services to other farmers who do not own tractors. This model was critical

in expanding mechanization in India. Third, is the Chinese model comprising of professional service enterprises, which migrate from one region to another selling mechanization services. This model was highly driven by increased demand for specialized services such as harvesting and was characterized by the existence of seasonal difference in harvesting the same crop across the country. The Chinese Government played a facilitating role in providing information and coordination (Diao *et al*., 2014).

2.5 Agricultural Mechanization in Tanzania

Tanzania has an area of 945 239 sq. km. (94 million hectares of land), of which about 46.8% is classified suitable for agriculture. Agriculture is the leading sector of the economy as in the case of many other economies in Africa. Agriculture accounts for about 29% GDP and over 65% of its population live and earn their living in the rural areas with agriculture as the mainstay of their living. Smallholder farmers cultivate between 0.2 hectare and 2.0 hectares (MAFSC, 2015).

The level of mechanization in Tanzania is very low with the hand hoe dominating in all farming systems. Animal traction accounts for about 24% of the farm power, while mechanical power is estimated at 10% for 4 wheel tractors and 2 wheel tractors accounts for another 4%. Hence 62 % of the farmers in Tanzania still use hand hoes, cultivating only a few one hectare or less as shown in Figure 1 (Passtrust, 2013).

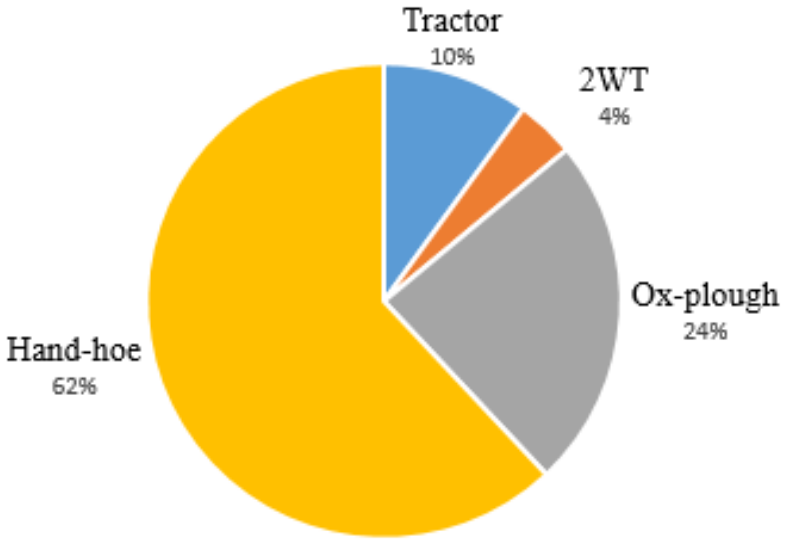

Figure 1: Level of mechanization

Source; MAFSC, 2012

Adoption of mechanized farm tool has faced a number of challenges even before independence. These includes; (i) low purchasing power of most small scale farmers (ii) low producer prices of farm produce, (iii) high cost of agricultural machinery (iv) limited access to agricultural credit (v) inadequate well-trained operators and mechanics for farm machinery maintenance (vi) lack of suitable machinery attachments for the main agricultural operations (vii) high cost for importation of tools (viii) equipment and machinery of poor quality and general poor technical know-how. All these factors pose constraints in the development of mechanization. Recognizing this limitation to agricultural development, the Government of Tanzania has overtime formulated sets of policies, strategies and initiatives to reorient and reinvigorate agriculture mechanisation and hence the national economy (Lyimo, 2011).

Since the mid-1990s, under the umbrella of the Millennium Development Goals (MDGs)[1] and the Tanzania Development Vision 2025 (TDV 2025), the MAFSC has formulated a number of strategies and national programme that support the fulfilment of the national goal of the agricultural sector. These strategies include the National Strategy for Growth and Reduction of Poverty (NSGRP) popularly known as MKUKUTA I (2000) and MKUKUTA II (2013), based on which a number of other programmes were established such as the Rural Development Strategy (RDS) in 2000. The Agricultural Sector Development Strategy (ASDS) was approved in 2001, followed by the first Agricultural Sector Development Programme (ASDP I) which was approved in 2005 and implemented from 2007 – 2013 (MAFSC, 2015).

The Tanzania agriculture mechanization strategy was formulated in 2005 with the aim of improving access and availability of mechanized inputs such as farm machinery, and by 2010, the government had imported about 7 823 tractors and 3 325 power tillers. The rate of importing tractors increased such that by 2014 it is estimated that the number had risen to 10 064 tractors and more than 9 000 power tillers operating in the country (MAFSC, 2015). Through sectorial strategies and programmes, the trend of equipment for farm mechanization has improved in every region within the country.

Despite all these initiatives to improve the performance of agriculture sector, by realizing the policy environment several setbacks have occurred in that process. Learning for example from other African countries such as Kenya and South Africa have managed to reduce the amount of farm machinery imported and instead they are manufacturing their own tools. In Tanzania such efforts have failed to be sustained. For example, after

[1] Since 2015, the MDGs have been replaced by the Sustainable Development Goals (SDGs)

independence the government constructed plants for manufacturing some agricultural tools, implements and machinery locally. Ubungo Farm Implements (UFI) factory and Zana Za Kilimo, Mbeya (ZZK) were established for this purpose. Both firms collapsed because of insufficient funds, unskilled personnel and lack of spare parts.

2.6 Introduction of Power tiller in Tanzania

The government's efforts to achieve the MDGs and Sustainable Development Goals (SDG's), and Tanzania development goals have been key to stimulating agricultural mechanization in Tanzania. Through ongoing national programme and initiatives such as Tanzania Agro-mechanisation Strategy (TAMS), Agriculture mechanisation development strategy-AMDS, Agriculture Sector Development Programme (ASDP) and Kilimo Kwanza, there has been a boost in the number of farm machinery imported and supplied to farmers. Zero rating the import duty on farm equipment has helped to accelerate importation and adoption, making tools affordable for many farmers (MAFSC, 2013).

Since the year 2005, the importation of farm machinery by the private sector and by the government started to increase. Examples of these agricultural mechanization equipment's are tractors, power tillers, trailers, planters, weeders, maize shellers, sugar cane forklift band and mechanical harvesters (PASS TRUST, 2013). The Mechanization Department of then Ministry of Agriculture, Food Security and Cooperatives (MAFC) estimated that in 2010, there were 7 823 tractors in use in Tanzania. Based on this estimate, there are about 7 tractors per 100 square km of arable land in Tanzania, which is very low compared to Kenya and South Africa with 27 tractors and 43 tractors per 100 sq. km, respectively (FACASI, 2014).

This increase in two wheel tractors use has been attributed to efforts of different government programme including the Agricultural Inputs Trust Fund (AITF) and District Agriculture Development Programme (DADPs) as well as the private sectors. The Agricultural Inputs Trust Fund (AITF) is a government institution established in 1994 to provide loans for farm inputs including machinery for the purpose of expanding farming areas and increase production. The interest rate for loan from the AIFT was 6% to 8% depending on the type of loan and a five years payback period. Other conditions include having a title deed of a house or land for individual farmers. The trust fund provides loans for fertilizers, insecticides, and pesticides loans, 4WTs and 2WTs, irrigation facilities and processing equipment (Lyimo, 2011). Another source of credit has been through the various development programme such as the District Agricultural Development programme (DADPs). Through such programmes it has been easier to distribute and increase the rate of utilization of 2WT as well as other inputs. The Government provided 2WT to Farmer's Field Schools which were given priority being required to pay about 20% of the value for the 2WTs and ancillary equipment, thus receiving an 80% subsidy and no additional interest rate charges (FACASI, 2014).

2.6.1 The Trend of 2WT in Tanzania

The government of Tanzania purchased 260 power-tillers for demonstration in 2006 and about 300 2WTs are estimated to have been supplied by private sector annually since 2005 (MAFC, 2006). The number of 2WT imported has been rising since then, increasing due to demand among small scale farmers, who need the equipment for different purposes. The Ministry of Agriculture estimates to have bought and distributed more than 6 348 2WTs between 2005 and 2012 excluding those imported by private importers in the country (MAFSC, 2015).

Figure 1 shows the annual number of imported 2WTs in Tanzania increased from 1 000 in 2 005 reaching a peak at 3 325 in 2010 due to government support for small farmers to access farm mechanisation tools. The number significantly declined in 2011 to 699 then recovered in the following year to 949, since then it has remained below 1000 2WT per year. This decline in the level of imports has been due to the fact that government support has been erratic government thus explaining the sharp drop in the number of 2WTs in the economy since 2011 (FACASI, 2014).

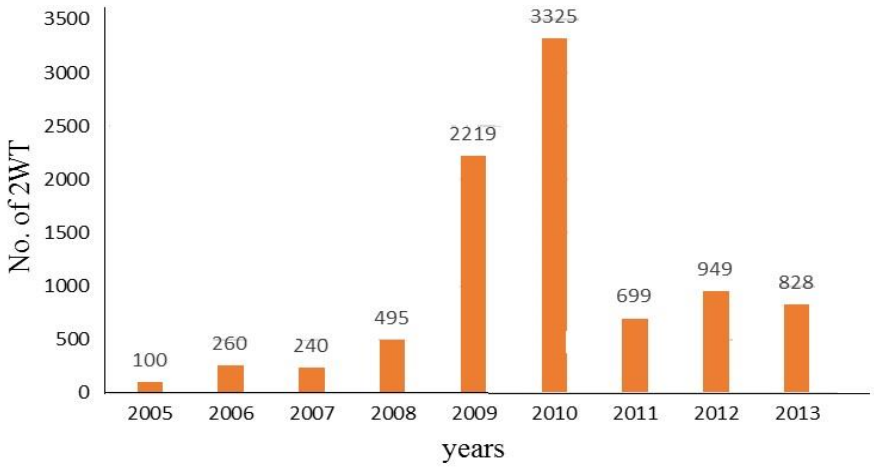

Figure 2: Trend of imported 2WT by the government and private sector in Tanzania

Source: FACASI report (2014)

The distribution of these power tillers varied from region to region. For example, by 2010, Mbeya region had the highest number of 2WT having 1 073 2WTs. Meanwhile in Arusha there were only 50 2WTs distributed. The reasons for such variations were; (i) economic wellbeing level of the community (ii) extent to which the region has commercial farming (iii) average land size of farmers (iv) production potential of the area either being medium or high production (v) value of crop grown (MAFC 2012, FACASI, 2014).

2.7 Analytical Issues

A number of studies have shown that small tractors have the advantage of size, being light-weight and having good manoeuvrability, which makes them favourable in most African agricultural condition. Mada and Mahai (2013), in Adamawa State Nigeria, observed that due to the low financial status of many smallholder farmers, their demand is highest for single axle (power tillers). However, multipurpose machines for pre-harvest and post-harvest operations generated more profit for small scale entrepreneurs. In their study (Mada and Mahai, 2013), used Benefit-Cost Analysis to determine the viability of the 2WT and they observed that low operating cost of 2WT has influenced increase in returns from the investment. Moreover, 2WT have proven to be a viable business model.

While a number of studies applied the Benefit-Cost analysis to test for the viability of 2WT, in their study Houssou *et al*. (2013) they used the Firm Investment Theory to assess the viability of the business model of power tillers operations under the Agricultural Mechanization Service Enterprise Center (AMSEC). The results signify the essential options for introducing lower-cost and smaller tractors into the Ghanaian market. According to Roy and Singh (2008) in a well-functioning market for tractor services, the owner may repay the investment in just 1-2 years after purchase.

The operations of 2WT and the mode of service provision is related to the mode of ownership. Under the study by Paman *et al*. (2010) observed that about 78% of the total annual use of the 2WT under farmers' cooperative ownership was on member's farms, providing tractor service primarily to group members. Meanwhile, individual owners of 2WT who are also farmers focused on tractor service for other farmers. Approximately 95% of the annual use of privately owned 2WT was for custom services and only about

5% were on owners' farms. This has been attributed to individual owners receiving higher profit than cooperative owners (ibid). The current study will be based on the analytical framework developed by Houssou *et al*. (2013) to assess the performance of 2WT in the study area according to the overall and specific objectives of the study as defined in earlier section.

2.8 Conceptual Framework

Factors that have a strong influence on the physical and financial performance of 2WT under the group and individual business models are derived from previous related studies regarding the viability of agriculture mechanization as summarized in Appendix 2. First, the decision to acquire a 2WT is influenced by financing mechanism and the type of ownership. Thereafter, depending on the ownership, the prospective owner must decide on the type of 2WT and its characteristics. After acquiring the 2WT, the owner will strive to operate it as efficiently as possible so that they get the highest stream of income, which will maximize their profit. Hence, farmers/owners use a number of physical and financial performance indicators to monitor the performance of the 2WT in order to prolong the lifespan of their investment.

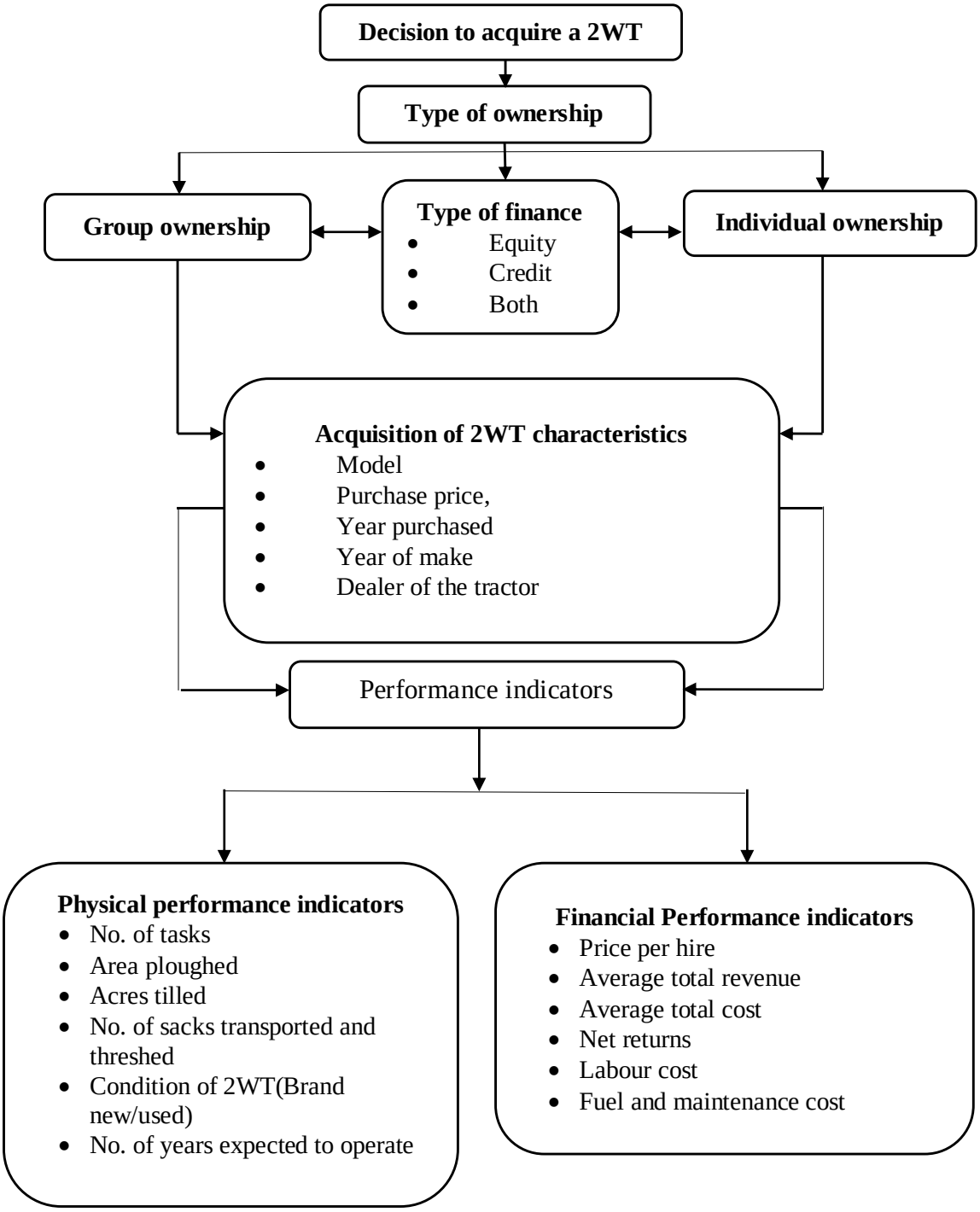

Figure 3: Conceptual framework

2.9 Theoretical Framework

The investment theory of agriculture mechanization was first developed by Diao, Yeldon, and Roe (1998), who adopted it from Barro and Salai-Martin (1995). The decision to invest is driven by the expectation whether the enterprise will result in net profit or loss after a given time. Baumol (1986) argues that an economy dominated by private enterprise has an automatic bias towards innovation, and it is always biased towards profit. This investment theory was further developed by Jones and Vollrath (2013) who presented a basic formulation of an investment problem, thus, deciding whether to or not to invest in an enterprise is basically dependent on the value of the business after being set up if revenue (profit) is larger than the cost of setting up the business such that the net value (profit) is positive assuming will occur. Again, modified Firm's investment theory is based on agricultural mechanization, a theory described by Diao *et al.* (1998), it says, evaluation of the feasibility of an investment (enterprise) depends on weighing between the net profits obtained or the cost incurred losses after a given time.

Under this theory providing mechanization service is considered a business that is run by a farmer or any other owner, whose goal is to maximize net return (profit = π). Such profits are a function of providing the technology; market prices for the service provided, fuel cost, repair and maintenance cost and the cost of other inputs. This model is accompanied by a number of assumptions; first, we do not consider inflation in the discount and interest rate, thus rates are constant over time since the lifespan of 5 years, representing the repayment period is considered short. Whether owned by individuals or groups, both accommodate owner's use and hire services for other farmers. After 5 years, the old 2WT may be replaced by a new one. The cost of which is covered by accumulated depreciation cost, set aside as a part of profit set aside for investment.

Based on the firm's investment theory as stated above, the study adopts the analytical framework by Houssou *et al*. (2013). Mathematically, this firm's investment decision during the 5 years' duration can be modelled as maximizing discounted profit using the following equation:

$$\pi = \sum_{i=1}^{5} R_t Y_t - I \quad \ldots\ldots (1)$$

$$R_t = \frac{1}{(1+r)^t} \quad \ldots\ldots (2)$$

Where π is the total discounted net profit over 5 years, Rt is the annual discount factor, r is the annual interest rate, and I is the tractor purchase cost. Yt is the net return acquired by the firm during the year *t* (that is, annual service provision revenue minus costs).

$$Y_t = P_t * Q_t - TC_t \quad \ldots\ldots (3)$$

$$Q = f(AC, D, No.of\ tasks) \quad \ldots\ldots (4)$$

$$C = f(m, L, T, F, Lb) \quad \ldots\ldots (5)$$

Where; P = price, Ac = acres cultivated in different tasks, F = total costs of fuel, Lb = total cost of lubrication, L = labour cost per acre, m = maintenance cost and fixed cost per year, T = taxes and license, D = distance covered, No. of tasks 2WT performs, Q = quantity, C = cost and TC = total cost.

Taking into consideration capital depreciation yields the following non-arbitrage condition:

$$Y_t - \delta I_t = rI_t \quad \ldots\ldots (6)$$

Where; δ is the annual capital depreciation rate. Equation 4 indicates that the net returns *Y* minus the annual depreciation cost of the tractor investment equals the interest earned from saving the same capital at a bank; hence r is the savings interest rate. Thus, to invest on a tractor the profits must be higher than the returns (interest) from saving the capital (tractor investment cost) at a bank in each year. Hence the annual net profit from investing in a tractor is given as;

$$N = P*A - \text{TC} - (r+\delta)\, I \quad \text{……..…………………………………….……… (7)}$$

From the above N= net profit equation, a model and other analytical tools were developed to evaluate the performance indicators on the net profit of 2WT.

$$N = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 D_{1i} + \beta_{10} D_{2i} + \beta_{11} D_{3i} + \beta_{12} D_{4i} + \beta_{13} D_{5i} + \beta_{14} D_{6i} + \beta_{15} D_{7i} + \beta_{16} Z_{1i} + \beta_{15} Z_{2i} + \varepsilon \quad \text{……………………………………………………….………………............ (8)}$$

Where; N= Net profit, X = independent variables, D= dummy variables, Z= annual total cost and annual total revenue, β’s are coefficients. Each variable is described in Appendix 1.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Description of the Study Area

The study covers two regions, Arusha and Manyara. Arusha is one among 31 administrative regions in Tanzania Mainland. Arusha region is located in the north-eastern corner of Tanzania. It is situated between latitudes 2º and 6º south, and longitudinally between 35º and 38º East of Greenwich. According to the 2012, Tanzania National Census, the population of Arusha Region was 1 694 310 households. The total area of Arusha region is 82 428.5 square kilometre, and it has 7 districts, Arusha rural district, Ngorongoro, Longido, Monduli, Karatu, Meru and Arusha city (Arusha Regional report, 2012). The second study region was Manyara, which has a population of 198 513 agricultural households. Out of 193 288 households in the region about 132 677 (67%) were involved in crops as well as livestock production, 60 611 (30%) were involved in growing crops only, and (3%) were involved in rearing livestock only. Manyara region has 5 districts Babati, Hanang, Mbulu, Simanjiro and Kiteto. Selection of Arusha and Manyara regions for the study has been influenced by the presence of a high proportion of power tillers due to efforts of various agencies to increase agricultural mechanization in their respective districts. In the next section I have presented specific information of each district relevant for agro-mechanization.

Meru District Council

Meru District Council is among two councils that form Arumeru district. Meru District Council was established under Government gazette No. 353 of 2007, following the government decision to split Arumeru district and introduce two Councils; Meru and Arusha. Administratively Meru District Council is divided into 3 divisions, 17 wards and

69 villages. The economy of Meru district like many other districts depends on subsistence agriculture and livestock production. The main type of agriculture products are coffee, bananas, vegetables, tomatoes, onions, cabbage, carrots, avocado, paddy, millet, cassava, irish potatoes, sweet potatoes and french beans. Farmers practice traditional farming system, using traditional farm yard manure (Meru District report, 2007).

Arusha District Council

Arusha District Council is the second council that forms Arumeru district. Administratively it is divided into 3 divisions, 20 wards, 75 villages, 294 hamlets with a total of 64 339 households. The council occupies 1547.6 square kilometres. The Council currently has about 355 892 people being 171 511 males and 184 381 females (Tanzania National Census, 2012). Agriculture and Livestock production are the main economic activities. The District has arable land covering 78 350 ha. Land under cultivation is 36 802 (53 %). A number of crops are grown in the district both for cash income and for food. Cash crops include Coffee, flowers, Artemisia and Pyrethrum while banana, potatoes, maize, pigeon peas, sorghum, fruits and vegetables are grown for food as well as for cash income and market purpose on a small scale per farmer. Coffee and flower are produced by large scale farmers who own big plantations. Livestock are kept in the district include cows and goats, indigenous cattle, chicken, goats and sheep (Arusha DC report, 2008).

Babati District

Babati District is found within Manyara region and Babati town is located 172 km south of Arusha. The district covers an area of 6 069 km^2 (2,343 square miles).

Administratively Babati district consists of four divisions, 21 wards and 82 villages. The main economic activities are crop production and livestock keeping (URT report, 2013).

In Babati district, the increase in the number of 2WT was brought by the increase in demand for farm transport where the district office had supported farmer's groups by providing 2WT as a loan with 20% subsidy, hence it influenced farmers to acquire more 2WT for individual as well as group use. In Arusha, a number of projects have influenced the adoption of new technology of using 2WT; these include; 'Selian Agriculture Research Institute 'and FACASI project. Selian Agriculture Research Institute, which operates in the outskirts of Arusha, has had a major influence in convincing local farmers in the Northern Zone to stop cultivating their lands using the hand hoe and adopt more mechanized methods of farming instead. Several initiatives have been implemented to promote 2WT usage. They include the 'Tanzania Agro-Business Expo 2013', organized by the East African Grain Council in 2013.

Tanzania Agro-processing Expro 2013 and FACASI concentrated its project activities around Arusha as one site to improve access to mechanization, reduce labour drudgery, and minimize biomass trade-offs in Eastern and Southern Africa, through accelerated delivery in order to enhance the adoption of 2WT-based technologies by smallholders. The project under Selian and FACASI both focused on farmer groups as well individual farmers who were already using some mechanization services from individual or groups of service providers. It was, therefore, possible to select respondents from both individual and group business models for comparative analysis according to the study objectives.

3.2 Research Design

The study employed a cross-sectional survey design whereby data were collected from selected villages in the study area at a single point in time. The sample of 2WT owners was selected to represent the population from which it was drawn (Bailey, 1994; Babbie, 2007). The design was suitable as it enabled the researcher to investigate if there was any association between the business models and performance indicators. The analysis also compared the outcome of investment in 2WT in terms of operating and maintenance cost as well as net profit.

3.3 Analytical Tools

For the first study objective, descriptive statistics were used to present the inventory of 2WT operating in study area. The inventory of the power tiller was described in terms of; number of power tillers owned by individuals and groups, type of finance, characteristics of 2WT, ownership pattern and type of use, socio-economic factors and classification of hiring services. Each variable is listed and explained in Appendix 1.

In order to address the second objective, descriptive analysis was used. This included; comparing the mean value of physical indicators as described in Appendix 3 for both individual and group ownership business models. The t-test was then used to test the hypothesis whether there was a significant difference in the mean value between individual and group ownership as presented in section 1.3.3. The first null hypothesis under this specific objective tested whether the average area ploughed per year by 2WT under group ownership was equal to average area. The second null hypothesis tested whether the average area tilled per year by 2WT under group owners was equal to average area tilled per year by 2WT individual ownership. A third related null hypothesis tested whether the average number of sacks threshed per year by 2WT under group

ownership was equal to the average number of sacks threshed per year by 2WT under individual ownership. The last null hypothesis tested whether the average number of sacks transported per year by 2WT under group ownership was equal to the average number of sacks transported per year by 2WT under individual ownership.

The third objective was analysed using descriptive statistics comparing the average values of financial indicators under group ownership and individual ownership. The t-test was then applied to test the hypothesis as stated in section 1.3.3. The first null hypothesis under this specific objective tested whether the average operating cost per 2WT incurred by group owners was equal to the average operating cost per 2WT per year incurred by individual owners. The second null hypothesis tested whether the average total revenue per 2WT per year obtained by group owners was equal to the average total revenue per 2WT per year obtained by individual owners. The third null hypothesis tested whether the average compounded net return per 2WT per year obtained by group owners was equal to average compounded net return per 2WT per year obtained by individual owners.

To evaluate the effect of ownership as well as other factors on the physical and financial performance of the 2WT, a linear regression model was used where the net profit was the regressed against a number of independent variables. Dummy variables were introduced in the equation to capture the effects of qualitative variables in the model including a dummy distinguishing two business models, individual and group business models.

$$N = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 D_{1i} + \beta_{10} D_{2i} + \beta_{11} D_{3i} + \beta_{12} D_{4i} + \beta_{13} D_{5i} + \beta_{14} D_{6i} + \beta_{15} D_{7i} + \beta_{16} Z_{1i} + \beta_{15} Z_{2i} + \varepsilon \quad \text{..... (8)}$$

Where; N= Net profit, X = independent variables, D= dummy variables. Each variable is described in Appendix 1.

Under the forth specific objectives the null hypothesis which was tested states that;

> The independent variables have no influence on the variation of the owner's net returns from 2WT. Mathematically; H_0: $B_{ij} = 0$

Where; B_{ij} is the coefficient of the j^{th} independent variable. The variables includes; number of tasks performed by the 2WT, acres ploughed, acres tilled, number of sacks threshed, number of sacks transported, depreciation value, ownership type, tractor model, soil type and condition of the tractor brand new or used.

3.4 Sampling

3.4.1 Sampling procedures

The target population for this study was the whole population located in the selected District Council, including Arusha, Meru and Babati. The population for the study consisted of all farmers in these districts. The sampling frame covered all farmers in the selected districts who owns power tillers as individuals or as groups. The groups were treated as a business entity. The mode of ownership formed the basis for stratification to facilitate comparative analysis.

In the first category involving individual owners, the sampling unit was the head of the household where a power tiller is owned. In the second category involving groups or cooperatives, a group was defined as a group of people who collectively own an agricultural asset or assets such that each member participates in the acquisition of the asset economically through shareholding. The institutional management arrangement also allows running cost and benefit to be shared among members. There is as well collective decision making regarding the asset often guided by a constitution or some

guidelines. For the purpose of data collection only representative of the group were interviewed.

Non-probability and probability sampling techniques were used, namely purposive and simple random sampling designs respectively. A Multistage sampling procedure was adopted. In the first stage, Arusha DC, Meru and Babati districts were purposively selected because this area has the highest number of 2WTs. The second stage of sampling involved purposive selection of villages where ownership of 2WT under individual and group systems were present. A total of 11 villages were sampled as presented in Table 3.

Table 3: The list of villages selected

Region	District	Village	2WT owned by individuals	2WT owned by groups	Total 2WT owned
Arusha	Meru	7	26	20	46
	Arusha DC	2	7	9	16
Manyara	Babati	2	14	5	19
Total		**11**	**47**	**34**	**81**

Within each village that was selected, the list of 2WT owners under each stratum was prepared to form the sampling frame. The third stage involved selecting individual farmers and groups that own 2WTs by using simple random sampling from 11 villages. Out of 134 2WT owners a total of 50 individual farmers and 40 groups were selected. However the actual number of respondent fell because some of the owners had sold their power tillers, while others had migrated to other districts. Hence the sample comprised of 81 respondents, 47 individual farmers and 34 groups that were interviewed.

3.5 Type and Source of Data

Data for this study was collected in order to address the objective of this study as stated in chapter one. The type of data collected was guided by the analytical framework as presented in the preceding section (Section 3.3). In order to get reliable information about the cost and returns for the operations of 2WTs the study adopted triangulation whereby several methods were to collect the same piece of information (Sabina and khan, 2012). These methods include, face to face interviews, Key informants interview, Focus Group Discussions as Primary sources of information, complimented with secondary data.

3.5.1 Primary data collection

Primary data was collected directly from the respondents, in relation to each study objective. This included; socio-economic and demographic characteristics of respondents, various data on the physical performance of 2WT, data on financial records and characteristics, as well as open ended questions to gauge the respondents views regarding the performance of power tillers. In the case of 2WT under group's ownership, in addition to the information regarding the power tiller, questions regarding the organization, membership and leadership pattern of the group were included. Face to face interviews were conducted to collect relevant information using two structured questionnaires, one for individual 2WT owners and the other for group owners. In addition three Focus Group Discussion (FGD) meetings were conducted. Each session composing of at least 5 power tillers owners (both individuals' owners and group members) and an extension officer. The discussion within FGD was guided by a checklist of questions presented in Appendix 8.

3.5.2 Secondary data collection

Secondary data were used to furnish additional information on various aspects of the study and provide a basis for comparison and triangulation. Most of the secondary information was drawn from reviewing the literature, which included books, journal articles, theses and various electronic sources. Documents related to power tillers importation trend and other related statistics were obtained from the Ministry of Agriculture Livestock and Fisheries, Arusha Regional Secretariat, Manyara Regional Secretariat, as well as district offices, FACASI office also provided journals and research reports which were used to complement the primary data.

3.6 Data Analysis

Primary data were organized, coded and cleared using SPSS software. Thereafter, the data were analysed using the same SPSS as well as Excel and STATA. The data was analysed based on analytical tools as stated in section 3.3 of this chapter. Descriptive statistics was employed in the presentation of quantitative data. Frequencies and percentages analysis were used to indicate the relative strength and distribution of respondents based on various variables.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents the empirical findings and discussion based on the data analysis and observations from the field survey. The chapter is organized into four sections. The first section presents socio-economic characteristics of the owners of the power tiller under individual and group ownership; the second section presents results of the physical performance of 2WTs in the two region; the third section presents results of the financial performance characteristics of the 2WT while the forth section presents the effects of ownership and the other factors on the performance indicators of the 2WT used in this study.

4.1 Socio-economic Characteristics of the Respondents

A summary of socio-economic characteristics of the respondents in the study area is presented under two categories, individual and group ownership business model. This section is divided into 3 parts. Part 1 presents the summary of individual respondents' characteristics while part 2 show group owned characteristics. The third part covers characteristics that are observed under both business models.

4.1.1 Characteristics of Individual owners

Table 4: Characteristics of individual owners of 2WTs disaggregated by location

		Arusha		Manyara		Whole sample	
Category	**Variable**	**Freq (n=33)**	**%**	**Freq (n=14)**	**%**	**n**	**%**
Gender	Male	31	94	14	100	45	95.7
	Female	2	6	0	0	2	4.3
Age group	20 to 40	8	24	5	36	13	27.6
	41 to 60	23	70	8	57	31	65
	61 and above	2	6	1	7	3	6.4
Education level	No formal education	5	15	1	7	6	12.7
	Primary education	21	64	10	71	31	66
	Secondary education	7	21	3	21	10	21.3
Main occupation	Crop farming	7	21	1	7	8	17.0
	Livestock + crop farming	20	61	7	50	27	57.4
	Business + crop farming	6	18	4	29	10	21.3
	Livestock + farming + business	0	0	2	14	2	4.3
Years of Farming experience	1-10	7	21	4	29	11	23.4
	11-20	15	45	8	57	23	49.0
	21-30	8	24	1	7	9	19.1
	More than 30	3	9	1	7	4	8.5

Results in Table 4 show gender imbalance on the ownership of the power tiller. Only 2 (4.3%) of the 33 respondents in Arusha were females while there were no female 2WT owners in Manyara region, For the whole sample 95.7% of the respondents were male

while only 4.3% were female. These results suggest there is gender imbalance on the ownership of power tillers, very few women are engaged in mechanized agriculture as owners of farm machinery. Moreover, numbers of studies support the argument that women in most part of Tanzania are underrepresented in the ownership of assets especially agricultural properties such as land and farm machinery such as tractors, power tillers (Anderson and Leavan, 2011). The dominance of male ownership of individually owned power tillers is also consisted with 85% of the respondents being married, hence the husbands being reported as the owners of the 2WT as opposed to their wives.

The results show further that 70% of individual owners in Arusha region were between the age group of 41-60 years, followed by those who were 20-40 years old representing 24% of the respondents being similar to the distribution in Manyara region where 57% of the individual owners were between 41-60 years followed by 36% of the respondents having 20 to 40 years old. Very few individual owners of power tiller in Arusha (6%) and Manyara (7%) were above 61 years old. These results therefore reveal that, many individuals power tiller owners were in the active age group between 40 and 60 years old representing 66% of the whole sample.

In term of education, the majority of the individual owners in Arusha (64%) and Manyara (71%) had primary education followed by 21 % who had secondary education in both regions. A small proportion (15% in Arusha and 7% in Manyara) did not have any formal education. Thus the sample was dominated by primary school graduates (66%) while 21.3% had secondary education and 12.7% had no formal education. Using farm tools such as power tiller requires the owner to follow some technical instruction

during initial operation of the machine. Having education helps the farmer to follow such instruction.

The majority (61%) of the individual owners in Arusha) and about half (50%) in Manyara were actively engaged in agriculture combining crop and livestock production. About one fifth (21%) of the individual owners in Arusha engaged in crop production and agriculture related business; whereas in Manyara region the corresponding figure was 29%. Thus, the sample is dominated by owners who combine crop and livestock production (57%). Approximately one third (27%) of the respondents combined farming with other business. More than three quarter (76.4%) of the respondents had been farming for eleven years or more. Only 23.4% had ten or less years of farming experience.

4.1.2 Group composition

Characteristics of the group ownership

According to the results presented in Table 5, out of 34 groups whose representative members were interviewed 29 groups were found in Arusha region and 5 groups in Babati- Manyara region. The minimum number of female members was 3 in Arusha region and the maximum was 29. In contrast, the minimum number of female members in Manyara region was 6 and the maximum was 16.

Table 5: Group Composition by gender

Variable of Central Tendency	Arusha Region		Manyara Region		Sample Total	
	Female	Male	Female	Male	Female	Male
Minimum	3	1	6	8	3	1
Maximum	29	22	16	19	29	22
Mean	11	10	11	12	11	10
Total	**340**	**304**	**55**	**64**	**395**	**368**

Comparing the proportion of male members in the groups shows on average 10 male members within the groups in Arusha compared to 12 in Manyara while for female members on average they were 11 in both Arusha and Manyara. All this shows the heterogeneity of groups with some groups being inclined toward a higher proportion of female members.

4.1.3 Group governance

Good governance is an important characteristic for the survival of group activities. In this study I have presented information regarding the group leadership and the frequency of election for group leaders as indicators of the group governance.

Table 6: Group governance distribution

Variable	Frequency	Arusha		Manyara		Sample Total	
		No.	%	No.	%	No.	%
Number of leaders	2	21	61.7	2	5.8	10	29.4
	3	6	17.6	3	8.8	20	58.8
	4	2	5.8	0	0	4	11.8
Numbers of election	Once in 3 years	16	47	1	2.9	27	79.4
	Twice in 3 years	11	32.3	4	11.7	7	20.6

According to the results presented in Table 6, majority (58.6%) of the 34 groups had 3 leaders namely a chairperson, secretary and a treasurer. About one third of the groups (29.4%) had only two leaders; a chairperson and a secretary who often serves as a treasurer. A smaller percent of the groups (11.8%) had four leaders; a chairperson, co-chairperson, secretary and treasurer. Most of the groups (79.4%) held election once every three years while the remaining 20.6% held election twice in 3 years.

Table 7: Gender and leadership distribution in the 34 groups

Number of leaders	Gender					
	Chairman		Secretary		Treasurer	
	Male	Female	Male	Females	Males	Females
2	6	4	4	6	3	7
3	11	9	8	12	9	11
4	4	0	0	4	2	2
Total	**21**	**13**	**12**	**22**	**14**	**20**
	(61.8%)	**(38.2%)**	**(35.3%)**	**(64.7%)**	**(41.2%)**	**(58.8%)**

From Table 7 above the results show the gender distribution of the leaders in the group. For the position of a chairperson, 21 groups (61.8%) were headed by male members as chairperson while 13 groups (38.2%) were headed by female chairpersons. For the position of secretary 12 groups (34.5%) had male secretaries and in 22 group (64.2%0 females held the position of group secretary. Then in 14 groups (41.1%) male members held the position of a treasurer compared to 20 groups (58.8%) where female members were the treasures. The result shows some gender equality. Gender is taken into consideration in the leadership of the groups with women leading in position that require trust (treasurer) and dedication (secretary). Men however lead as chairpersons, a position that is considered critical in guiding decision making.

4.1.4 Sources of information

From the field survey, knowledge about power tiller has been provided via many sources. Farmers have been educated through a number of government programmes and private organization. The results presented in Table 8 show that extension officers were the most important source of information about power tillers both for individual and group owners as stated by 46.8% and 55.9% of the individual and group respondents respectively.

Table 8: Sources of information about 2WT

Information source	Type of ownership by region							
	Arusha		Manyara		Sample Total			
	Individual	Group	Individual	Group	Individual		Group	
	%	%	%	%	No.	%	No.	%
FACASI	3	28	0	0	1	0.02	8	23.5
Ext. officer	58	55	21	60	22	46.8	19	55.8
Fellow farmers	12	0	36	0	9	19.1	0	-
Selian	15	0	0	0	5	10.6	0	-
CAMARTEC	6	0	0	0	2	4.3	0	-
KATC	6	0	0	0	2	4.3	0	-
SACCOS	0	17	43	40	6	12.8	7	20.6
Total	**100**	**100**	**100**	**100**	**47**	**100**	**34**	**100**

Two other sources provided information to group owners; FACASI officers (23.5%), Extension officers (55.8%) and SACCOS members (20.6%). Individual owners had more diverse sources of information including fellow farmers (19.1%), SACCOS members (12.8%) and researchers from Selian institute (10.6%). FACASI officers were mentioned by the lowest proportion of the individual members (2.1%) as sources of information.

Other sources were Center for Agricultural Mechanization and Rural Technology-CAMARTEC and Kilimanjaro Agriculture Technical Collage (KATC) officers mentioned by 4.3% of the respondents.

4.2 Physical performance of the 2WT

The physical performance of 2WT analysed in this study are presented in table 10.

Table 9: Descriptive statistics of physical performance of 2WT

Tractor model	Indicator	Ownership type		Average price (*000 TZS*)	t-test
		Individual	Group		
Kubota	New	4	14	11 725	6.52
	Used	12	0	6270	
Toyo	New	7	6	8500	3.87
	Used	17	0	3800	
DH-Changchai	New	0	6	7550	2.55
	Used	2	0	5450	
Amek	New	2	8	9400	2.88
	Used	3	0	4150	
Total	New	13	34	9293	3.16
	Used	34	0	4917	

Corresponding with the sampled respondents, 47 of the power tillers were owned by individuals and 34 were owned by groups, constituting a total of 81 power tillers. Out of the 47 2WT owned by individuals 13 (27.7%) of the power tillers were brand new while 34 (72.3%) were used. Arusha region had 10 (21.2%) of brand new 2WT that were individually owned compared to 3 (6%) in Manyara. All 34 2WT (100%) of the 2WT owned by groups were brand new; 29 (85.3%) being located in Arusha region and 5 (14.7%) being in Manyara.

The individual and groups owned four different brands of 2WT. The kubota is a Japanese model while the Amek is made in India, the DH-Changchai and Toyo are made in China. The groups could afford to buy new tractors because most of them had been supported to acquire brand new tractors through various developing projects by the government as well as non-government organizations (NGO) including private sector actors such as FACASI and cooperatives especially SACCOS. In order to compare the relatives cost of purchasing different brands of the power tillers, the purchase price for each tractor was compounded to the present value. According to the results presented in Table 9, a brand new kubota power tiller was the most expensive having a sample mean compounded price of 11 725 000 TZS. Compared to 9 400 000 TZS for the Amek brand which came second follows by Toyo model which was 8 500 000 TZS and the lowest compound price was for DH-Changchai that was 7 550 000 TZS. Meanwhile, the prices for the used power tillers were significantly lower for each brand but the used Kubota power tillers were relative more expensive (6 270 000TZS) followed by DH-Changchai (5 450 TZS), Amek (4 150 TZS) and lowest for Toyo (3 800 TZS).

The average working life of each 2WT model was highly correlated with their purchase price. For the brand new power tillers, the kubota model, which was the most expensive also had the longest average life span at 11 years followed by Amek 8.2 years, DH-Changchai 7.5 years old. The Toyo had the shorter life span 6.2 years on average. These results correlated to the average working life of the used power tillers (Table 10).

4.2.1 Activities performed by Power Tiller

The Power tiller is farm machinery that performs multi-functional activities, including ploughing, threshing/shelling, tilling, harrowing, transport, milling, pumping water, weeding or ripping. However, in the study area only four functions were identified;

ploughing, tillage, transportation and threshing. From Figure 3 results shows the share activities (%) performed by the power tillers in the sample while figures 4 distinguishes the activities by types of ownership.

According to Figure 3, transportation is the most dominant activity performed by 41% of the 81 power tillers in the sample. This is followed by ploughing (34%) tilling (21%) and threshing which is performed by only 4% of the power tillers in the sample.

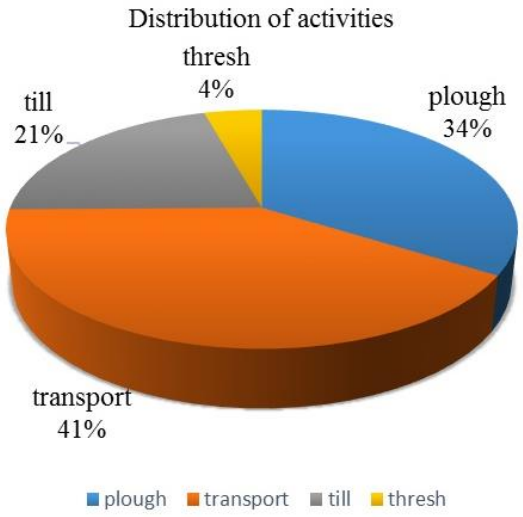

Figure 4: Activities performed by all power tillers

When the power tillers are stratified by ownership type transportation remains the dominant activity both under individual and group ownership being performed by all 47 and 34 of the individual and group power tillers respectively. Ploughing followed, being performed by 39 (83%) of the individually owned and 32 (94.1%) of the group owned power tillers. Tilling comes next being done by 51% and 55.9% of the individually and group owned power tiller respectively. About 10.6% of the individually owned power tillers were used for threshing compared to 5.9% of power tillers owned by groups.

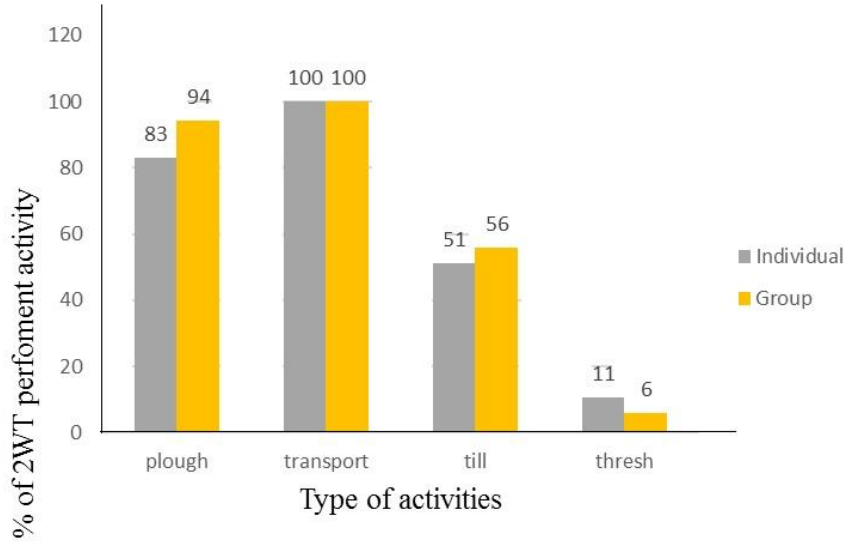

Figure 5: Percentage Distribution of activities performed by the business models

Table 10: Comparison of selected physical activities of power tiller

Activities	Mean		t value	Minimum		Maximum	
	Individual	Group		Individual	Group	Individual	Group
Acres ploughed	14.2	22.3	-3.84	8	8	35	40
No. of sacks transported	74.25	86.8	-1.64	30	10	200	150
Acres tilled	7.1	7	0.106	8	3	27	30
No. of sacks threshed	3	6.4	-0.69	50	100	100	120

Table 10 present the mean, minimum and maximum of physical performance indicators of power tillers in the study area. These results show that on average group power tillers cultivated a significantly higher area per annum (22.3 acres) compared to only 14.2 acres under individual ownership (t=-3.84 significant at p=0.01). The performance was also significantly difference in terms of the number of sacks transported per annum being higher under group ownership (86.8) compared to 74.25 under individual ownership (t=1.64). Since there was a larger number of individuals owned power tillers in the

sample (47) compared to those under group ownership (34) it was expected that the latter would have a larger load in case of number of sack threshed. However, as shown in Table 10, the average number of sack threshed annually by individual owner's power (3) tillers had no significant difference compared to the average number of sacks threshed by the group owned (6.4) power tillers. Also the number of acres tilled showed no significant difference between the two business models.

Table 11: Comparison of mean physical performance for brand new power tillers

Variables		Acres ploughed	Acres tilled	No. of sack transported	No. of sack threshed
Arusha	Individual	14.4	4.9	76	0
	Group	23.79	6.4	85.9	7.58
	T value	-2.52	-0.676	-2.94	-1.83
Manyara	Individual	11.3	9	173	0
	Group	14.2	10	92	0
	T value	-0.45	-0.14	3.42	0
Sample	Individual	13.69	5.8	98.46	0
mean	Group	22.3	7	86.8	6.4
	T value	-2.69	-0.51	3.01	-0.87

As it was shown in Table 4.2 that 13 of the individuals owned brand new tractors, henceforth this comparison was made by comparing the performance of these 13 tractors owned by individual and the 34 brand new 2WT owned by groups. Table 11 shows the comparison of activities performed by the brand new power tillers by the individual owners versus the group owners. The result shows a significant difference of the average acres ploughed between the two business models in Arusha region. This suggests that the average acres ploughed by group owners (23.8 acres) of brand new power tillers was high relative to acres ploughed by individual owners (14.4 acres). However the average number of sacks transported by brand new power tillers owned by group (85.9)

significantly exceeded that of individual owners (76). Similar to number of sacks transported, the average number of sack threshed showed significant difference between the two business models operating in Arusha region. Meanwhile, in Manyara region the only activity that showed significant difference between the owners of brand new power tiller was the average number of sack transported (173), whereas individual owners had more number of sacks transported compared to group owners (92). For the whole sample comparison of the activities showed a significant difference in the average number of acres ploughed by the group owners (22.3 acres) which exceeds that of individual owners (13.7) by more than 9 acres of land ploughed. However, the individually owned brand new power tillers performed significantly better for the mean number of sacks transported, being 98.5 compared to 86 sacks for group owned ones (Table 11). Comparison could not be done for used 2WT since none of the groups owned such tractors.

4.3 Financial Performance Indicators of the 2WT

In this section, financial analysis is done to compare indicators of the power tillers performance under the two business models. The financial performance indicators of the 2WT covered in this study included the price of 2WT, total income, from annual operating cost and the total cost of running the power tiller per year.

In order to compute all these indicators the prices of the various services provided were sought and analysed by comparing the mean, minimum, maximum and standard deviation under each business model. It should be noted that the service prices do not depend on the tractor type or the condition of the tractor (new or used). A customer hires the services as long as the machinery is operating.

Table 12: Price analysis of the activities

Indicator	Mean (Tshs)		T	Minimum		Maximum	
	Individual	Group	Value	Individual	Group	Individual	Group
Plough	32 600	30 800	0.84	28 000	28 000	40 000	35 000
Till	80 000	118 000	-6.29	60 000	100 000	100 000	130 000
Transport	1 900	1 600	1.08	1 000	1 000	3000	2 000
Thresh	1 500	-	-	1 500	-	1500	-
Mean price per service charged in Manyara region							
Plough	34 600	29 100	5.21	25 000	25 000	40 000	35 000
Till	115 000	116 200	-0.18	70 000	100 000	140 000	130 000
Transport	1 380	1 600	-3.01	1 000	1 000	2 000	2 500
Thresh	1 500	1 220	4.6	1 500	1 500	1 500	1 500
Mean price per service charged in Arusha region							
Plough	34 000	30 000	4.976	25 000	25 000	40 000	35 000
Till	104 900	116 470	-2.63	60 000	100 000	140 000	130 000
Transport	1 540	1 650	-0.96	1 000	1 000	3 000	2 500
Thresh	1 500	1 250	2.63	1 500	1500	1 500	1 500

Mean price per service charged of the sample

The results in Table 12 show the difference in the mean price charged among the two business model in Arusha and Manyara, as well as the overall sample mean prices. It was observed that in Manyara region, among the four physical activities performed by the power tiller, the mean price of tillage per acre was significant different between the two models, depicting higher mean price charged by the group of 118 000 TZS per acre while individual owners charged 80 000 TZS per acre. On the contrary, in Arusha region, all the activities (plough, transport and thresh) but tillage had a significant difference between the individual owners and group owners of power tillers. Both the mean price of ploughing (34 600 TZS) and threshing (1 500 TZS) charged by the individual was

relatively higher than mean price charged by group owners (29 100 TZS and 1 220 TZS respectively).

Also results in Table 12 show that group owners' charged lower prices compared to individual owners, however group charge a higher prices on tilling 116 470 TZS per acre compared to 104 900 TZS and the difference between them is significant (t = -2.63). Group owners also charge a higher average price for transport (1 650 TZS) compared to individuals (1 540 TZS), but the difference is not significant (t = -0.96).

For ploughing and threshing individual owners charged significantly higher prices. The individual owners price is higher (1 500 TZS) compared to that of group owned power tiller which was 1 250 TZS (t = 2.63). For individual owners the mean price per acre of ploughing was 34 000 TZS while the price for group owners was 30 000 TZS (t = 4.976). However there was no significant difference between the mean price charged for a bag/sack transported by power tiller under individual ownership and group ownership of power tiller.

4.3.1 Average annual total revenue per power tiller

Based on the price and the physical indicators for the price the average annual total revenue per service was computed for each respondent adding up across services.

Table 13: Distribution of average total revenue per annum from 2WT activities (TZS)

Activities	Individual owner		Group owner	Whole Sample	
	New	used	New	Individual	Group
TR-Plough	456 923.1	348 852.9	652 735.3	378 744.7	652 735.3
TR-Transport	156 538.5	105 205.9	146 382.4	119 404.3	146 382.4
TR-Till	478 461.5	608 235.3	859 705.9	572 340.4	859 705.9
TR-Thresh	0	6 617.647	7941.176	4 787.2	7941.1
TR	1 091 923	1 068 912	1 666 765	1 075 277	1 666 765

From Table 13 results show that the average total revenue obtained by tilling are the highest under both models. This has been attributed to the high price charged for tilling compared to other activities. Comparing the revenue collected, group owners have higher average total revenue per power tiller in all the activities on ploughing, tilling, transport and threshing. Hence giving the annual average total revenue per power tiller for individuals 1 075 200 TZS while the annual average total revenue for the group owners was 1 666 700 TZS. It is therefore plausible to conclude that the group business models obtains higher average total revenue per power tiller per annum compared to individual owners. Moreover the result show that the new power tillers owned by the groups had higher returns, an average of 1 666 765 TZS for each power tiller compared to 1 091 923 TZS earned by the individual owners. This is contributed by group owners of brand new power tillers had higher average returns from tillage (859 705 TZS) compared to in the difference between the new power tillers individual owned (478 461 TZS).Also the similar results is also seen in the annual mean total revenue collected from ploughing, were groups owners of brand new 2WT had an average of 652 735.3 TZS per tractor, while individual owners had an average 456 923.1 TZS per tractor.

4.3.2 Comparison of selected Cost indicators between Individual ownership and group ownership of 2WT

This analysis of cost distribution in running the power tiller was computed by summing up the variable cost across all power tillers for group owners and individual owners. Whereby, the variable cost was considered to include the cost of fuel, maintenance cost and labour cost.

Table 14: Annual total Cost summary of fuel, cost and maintenance for 2WT

Activities	Individual owner		Group owner	Whole Sample total	
	New	used	New	Individual	Group
TC-fuel	18 653.8	19 385.24	16 802.9	845 200	627 800
TC-Labour	59 615.38	58 676.47	67 205.88	2 883 000	2 172 200
TC-Maintenance	376 923.1	420 588.2	327 058.8	16 420 000	13 900 000

The results in Table 14 show that maintenance cost are very high compared to fuel and labour cost. The field data showed that 80% of power tillers required maintenance in terms of repairs damaged parts and buying spares for replacement at least 3 times a year. This has contributed to very high cost of maintenance which the total maintenance cost for all the individual owners was 16.4 million TZS, while that of group owners was 13.9 million TZS. High fuel cost is the results of more trips (including off farm activities) the power tiller make under individual owners compared to group own. The results shows that individual models incur more cost per power tiller per annum in all the three areas, fuel 845 000 TZS, labour 2.8 million TZS and maintenance 16.4 million TZS. This suggest that individual owners undertake more frequent maintenance since they own more of used 2WT (72%). Hence they face more dysfunction, hence more frequent repair to address damages and dysfunctions of 2WT leading to incurring more cost for maintenance.

4.3.3 Revenue and cost comparison between individuals and groups models

The average total revenue (ATR) and average total cost (ATC) are calculated using the following formulas.

1. Revenue, TR= $R_1 + R_2$
    a. Revenue from the services (plough, till, thresh, transport)

        R_1= Qi *Pi

        Where Q1 = acres tilled, Q2= acres ploughed, Q3=sacks transported and Q4= sacks threshed.

        P1=price per acre tilled, P2= price per acre ploughed, P3= price per sack transported, P4= price per sack threshed.

    b. Salvage value = 10% of the initial cost = R_2

2. Cost, TC= $C_1 + C_2$
    a. Fixed cost= (initial cost + depreciation+ taxes + insurance+ housing/storage) = C_1
    b. Variable cost = (Fuel cost + Repair and maintenance cost+ lubricating oil cost+ labour cost)= C_2

3. Net return = TR - TC

Table 15: Average total revenue, average total cost and net returns of power tiller

Variable	Whole Sample average		
	Individual.	Group	t value
ATR	1 585 280	2 297 650	-4.7
ATC	442 470	509 900	-1.8
Net returns	1 142 810	1 787 750	-4.1

Variable	Sample for Brand new 2WT		
	Individual.	Group	t value
ATR	1 091 923	1 666 765	-3.2
ATC	452 230	491 1170	-0.64
Net returns	629 320.7	1 165 418	-2.8

The average total revenue and average total cost presented in Table 15 show the comparison of the annual net returns received between two models. The results show that average total revenue gained by the group owners (2.3 million TZS) was significantly higher than average total revenue received by individual owners (1.7 million TZS). Also for a brand new power tiller, an individual owner earns an average of 629 320 TZS per annum while group owner earned an average of 1 165 418 TZS per power tiller. This results shows significance difference (-3.2) between the average annual revenue received by individual owned power tiller with average annual revenue earned by group owners of brand new power tillers. This conforms to prior results on how group owners performed better in managing the power tiller than the individual owners, given that there was a significant difference in the net return received by the two models. Hence the overall conclusion obtained from this results show that owners of power tiller under group business model earned higher net returns than individual business model. In the next

section results of the analysis to assess the effect of ownership and other factors have on the performance of 2WT.

4.4 Effect of Ownership and Other Factors on the Performance Indicators of 2WT

Regression Analysis

A Multiple Linear Regression analysis was done to address the forth objective of this study which was to evaluate the effect of ownership and other factors on the physical and financial performance indicators. The analysis was done according to the empirical model derived under the methodology, in section 3.4, equation 8 which is repeated here for convenience. However two variables were dropped in order to reduce the effect of collineality between the independent variable (Net profit), Z1 and Z2 which are annual total revenue and annual total cost respectively of the power tiller.

$$N = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 D_{1i} + \beta_{10} D_{2i} + \beta_{11} D_{3i} + \beta_{12} D_{4i} + \beta_{13} D_{5i} + \beta_{14} D_{6i} + \beta_{15} D_{7i} + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Where; all variables are as previously defined in chapter two and three.

This model was run using the STATA analytical tool pack. The model was tested for heteroskedasticity using the Breusch-pagan/Cook-Weisbert test. Results of the tests showed presence of heteroskedasticity since the Chi^2 value was 34.96 (p=0.000). This problem was corrected by running the model using a robust multiple regression model. Multicollineality was tested using the Variance Inflation Factor (VIF) who's computed value was 3.63; being less than the upper limit of 10; hence, multicollineality does not pose a problem. The Breusch Godfrey LM test was used to test for autocorrelation. The results showed no presence of serial autocorrelation since the Chi^2 value was 0.414 (p=0.501). These outcome of these tests are presented in the Appendix 6.

Table 16: Effect of ownership and selected performance indicators on net profit

Variable	Expected sign	Coefficient	Std. error	T value	P > | t |
Constant		65024.5	54930	1.18	0.241
Acres_ploughed	+	21953.1	8279.2	2.65	0.010
Acres_tilled	+	77530.7	9126.8	8.49	0.000
Sacks_threshed	+	680.20	2744.3	0.25	0.805
Sacks_transported	+	1979.9	2058.8	0.96	0.340
Clay soil	-	-10125.2	18688.3	-0.54	0.590
Loam soil	+	22223.8	13371.8	1.02	0.310
D1Individual	+	-2791.5	1961	-1.42	0.101
Brand_new	+	3338.9	2395.2	1.26	0.211
Kubota	+	23701.6	2180	10.8	0.000
Amek	+	7886	2007.46	0.39	0.696
DH-Changchai	+	17080	21539.9	0.79	0.431
Credit	-	-226045.4	178648.1	-1.27	0.210
Equity	+	198.9	384	0.52	0.606
Interest rate	-	-18366.14	37348.64	-0.49	0.625
Depreciated value	-	-22676.11	117337.51	-1.93	0.058
Dependent variable =	Net profit				
No. of obs =	81		R^2 Adjusted		= 0.5950
F(15,65) =	12.22				
Prob > F =	0.0000		Root MSE		= 4.7e+05
VIF =	3.63				

The regression results in Table 16 show that the entire model was significant at 5% level of significance and the variation in the dependent variable were explained by 59.5% by the variation from all the independent variables. The regression results show that the amount of acres ploughing and acres tilling have a highly significant effect on the net profit at 1% level of significance. This conforms to the expected sign and thus an increase of a one acre ploughed, on average, net profit will increase by 21 953 TZS ,

Again an increase of one acres tilled by the power tiller on average net profit will increases by 77 530 TZS. Hence for farmers to increase their gains, it will be beneficial for them to take advantage of these two activities (ploughing and tilling).

As these regression results show, the kind of power tiller purchased has an impact on the performance of the power tiller and thus the net profits gained from it. There were four models of power tiller owned by the farmers, Kubota, Amek, DH-Changchai and Toyo. The regression results show that the Kubota model had a significant positive effects on net profits gained over Toyo, which was used as the reference or base. However there was no significance impact of the other kinds of power tillers. From the analysis it was observed that Toyo power tillers had the lowest net profits obtained among the other models of power tillers. The results conform to earlier descriptive results on the performance of these four kinds of power tillers. The most durable and longer life time, also raise the earnings of Kubota power tillers. Hence it is more feasible for farmers to buy Kubota power tillers than the other kinds.

The regression results also show that the depreciated value of the power tiller has a negative effect on the net profit and the relationship is statistically significant at 10% level of significance. This conforms to the expected sign. A unit increase in depreciation value would, on average, decrease the annual net profit by 22 676 TZS. This results has a larger effects on net profits because depreciation value means the wear and tear of the power tiller. Hence the farmer incurs more cost for repair and maintenance of the power tiller as it ages. Although the interest rate on loan was not significant but it negatively affected the net profit, which conforms to the expected sign that higher interest rate affects loan repayments especially for smallholder farmers whose only source of income is by selling agricultural products and hiring services. High rates may lead to longer

period to break even for the farmer due to fluctuations in income therefore they fails to recover the cost of production and repayments of the loan in the working lifetime of the power tiller. Also interest rates have an impact on farmer's ability to secure funding. High interest rates reduce overall individual or corporate earnings, hindering the ability of business to expand or grow.

From Table 16, the results show that there is a significant influence of relationship on net profit gained. The variable D1 represented the dummy for type of ownership whereas D1 was 1 if individual ownership and D1 was 0 if group ownership. The result in Table 16 show that, the type of ownership has a positive significantly affects the net profit at 10% level of significance. However, expected results assumed that individual owners would have more profit than group owners. From the results it shows that, net profit gained under the individual business model is lower by 2791.5 TZS compared to that gained by group ownership business model.

Also in Table 16, the results shows that there is strong evidence to reject the null hypothesis at 1% level of significance that the mean net profit obtained in the individual model is statistically significantly lower than the mean net profit gained by the group model. Hence our results led to conclude that based on average net returns, new group owned power tillers perform better under group ownership than under individual ownership.

The results from this study suggest that among the two ownership models (group owners had higher returns due to the fact that they all owned of brand new power tillers with a higher proposition of Kubota tractors which were the most efficient compared to other models. Consequently, group owners had low maintenance cost compared to individual

owners. Meanwhile the most popular activities were transportation, ploughing and tillage. Tillage had the highest net returns (26.6 million TZS for individual owners and 29million TZS for group owners). This implies, increasing the area tilled and ploughed would raise net return, especially for individual owners who are currently providing more transport services than tilling and ploughing.

4.5 Other Findings

Power tillers were observed to be difficult to operate, requiring more muscular energy. The operation of power tiller often required more manpower, to which only men are able to pull or push and operate the power tiller during farm operations. The tool is tedious, energy absorbing, requires muscle to pull and one becomes tired after a few acres of tillage because it is heavy and hard to push. The power tillers require even more energy to pull out of a clay soil when it is stuck in the mud. This excludes owner from performing most of the operations.

The high cost of maintenance is attributed to lack of trained and skilled mechanics who have knowledge about power tillers. Such mechanics would know the exact problem when breakdown occurs and the appropriate spare part. Currently mechanical services being provided to power tiller owners are not specialized for 2WT. Rather they are local mechanics who are trained for general maintenance of motor vehicles. When such mechanics make the wrong diagnosis the owner incurs higher maintenance cost and increase in depreciation of the power tiller.

Within groups, ownership of a single power tiller has been observed to be insufficient for delivering required services to all the members. During farm preparation and harvesting, it has been observed, in groups of 30 members, that most likely, less than half the

members don't get to prepare their farm by the power tiller. Hence it is impossible for the power tiller to provide services to each member for timely farm operations. Other members who fall behind in the que are forced to find alternative means to prepare their farms on time at the beginning of the farming season. Such problems raise grievances among group members which may overbore group harmony and sustainability.

Nevertheless, some benefits were observed and reported during the group discussions. They include members get some services quickly especially, transport when it is required. For example, transportation of farm harvest to the house or to the storage unit. The 2WT also assist in carrying coffins, during funerals within society. It also helps in carrying blocks for building, water and many other functions. Another benefit is that group members are able to pay in instalments.

This study aimed at doing a comparative analysis on the performance of power tillers under the individual and group ownership business models. The main findings observed in this study are as follows; among the two models, group owners had higher returns due to several factors. First, they all owned brand new power tillers with a higher proportion of Kubota tractors which were the most efficient compared to other models of power tillers. Consequently, group owners had lower maintenance cost compared to individual owners. The higher maintenance cost among individual owners which was compounded by owning old (used) tractors. Shortage of trained and skilled mechanics who have the right knowledge on power tillers, and unavailability of spare parts. Also the most popular activity was transportation, however the most rewarding activities were ploughing and tillage which were performed less by individual owners. Hence this resulted to group owners earning higher returns compared to individual owners.

In the next chapter the conclusions drawn from this study are presented, based on which policy recommendations a made to improve the management of power tillers under individual and group business models.

CHAPTER FIVE

5.0 CONCLUSIONS AND POLICY RECOMMENDATIONS

The main objective of the study was to perform a comparative analysis of the performance of two wheel tractor under individual and group ownership business models. The study identified the power tillers found in the study areas in Arusha and Manyara regions (Meru, Arusha Rural and Babati districts), classify them under individual or group ownership. The study also assessed and compared the physical and financial performance of the power tillers under both models. The last objective was to evaluate the effect of ownership and performance indicators on the net profit of the power tillers.

5.1 Conclusions

Generally, the findings show that 56.8% of the owners were located in Meru district, while Arusha DC had 19.8% and Babati had 23.4% of the individual and group respondents interviewed. The findings show further that gender balance applies more within the group since only 2 (4.2%) out of 47 individual owners were women. The study established that extension officers are by far the most important source of information about power tiller utilization, especially under group ownership. About 55.9% of group owners obtained knowledge from this source compared to 46.8% for individual owners.

Among the different kinds of power tillers, Toyo and Kubota brands were most commonly owned. Toyo 2WT had the lowest ranking in terms of durability and performance in all the activities. Meanwhile the Kubota 2WT were the strongest, however they are relatively expensive. A high proportion of brand new Kubota power

tillers being owned by group owners, mostly because these were bought under a subsidy from the government or facilitating NGOs.

In terms of activities undertaken, transportation being the most common service provided by all the owners. However, ploughing and tillage had the highest net returns. Increase in land ploughed and tilled significantly increased net return, individual owners led to perform less of these services.

In relation to the third objective it was observed that, the prices charged for each service were much higher by individuals than those charged by the group business model. This implies that group owners were able to undertake a higher number of the services provided, which contributed to higher total returns. Consequently, group business model had higher average total returns compared to individuals and also had lower average total cost compared to individual model. Hence group business model obtained higher net income compared to individual owners. Both total revenue and total cost were statistically different between the two models.

Under the final objective of the regression analysis showed that a number of variables influence the variation in net profit obtained from the two business models. Variable that had a positive effect on the net profit include the number of acres ploughed and tilled and owning a Kubota power tiller. Also variables that negatively affected the net profit were purchasing price and depreciation rate. The results also show that the ownership option has a significant effect on the net return, increasing if the owner was a group.

5.2 Policy Recommendations

Comparative performance analysis of power tillers found that among the two business models, group owners had higher net returns due to several factors. First, they all

owned brand new power tillers with higher proposition of Kubota tractors which were the most efficient compared to other models of power tillers. Consequently, group owners had low maintenance cost compared to individual owners. Second, while the most popular activity was transportation, ploughing and tillage had highest net returns. On average individual owners provided more transportation services while group owners provided more services for ploughing and tilling, which significantly increased their net return.

Based on these findings the following recommendations are made towards improving the performance of power tiller on individual and group business models. First, if a buyer is planning to provide more ploughing and tillage services, they should acquire brand new tractors preferably Kubota model.

Second, the government through the Agricultural Input Fund and other agencies should facilitate individual owners as well as group owners to purchase brand new power tillers. By doing so it will help farmers to have efficient usage of the power tiller for a longer working life and incur lower maintenance cost.

The government should promote the use of Kubota power tillers, by encouraging private sector and government agencies to import more Kubota power tillers than other models, since they have been observed to be the strongest and most durable compared to other kind of power tillers. However other types of power tillers such as Amek, and DH-Changchai can at least come second to Kubota. Field results show great evidence of discouraging the use of Toyo power tiller due to its vulnerable nature and frequent damage. Other factors to consider would be the type of power tiller and the range of

activities they expect to perform, land size considered (preferably not more than 10 acres).

Also, the government through its agriculture agencies and technical experts, should establish a network that involves providing information and connect with well-established farm mechanics within the country. Such a network will enable farmers to purchase spare parts of tractors and power tillers at lower cost. The system should involve networking farmers across Tanzania and mechanical centres for exchange of spare parts and even trade of agricultural mechanical equipment's within the country.

The government should continue support farmers group by giving 80% subsidy on power tillers but they should widen the inputs fund so that individuals can access credit for acquiring power tillers. However the remaining loaned out part (20%) should come with lose restrictions and that longer grace period for loan repayment would help farmers to return the payment considering the vulnerability of the equipment and fluctuation of returns.

Finally, although the study shows the need to invest in farmers groups, the study acknowledges that individual farmers also provides more hiring services to an even larger portion of community members than group owners. So in confirming with Kilimo Kwanza individual owners should also be supported to acquire power tillers.

5.3 Limitation of the Study and Area for Further Research

Data collection on variables such as cost and return of the power tiller had to rely on farmer's ability to recall data some which may have had a high margin of error. Hence,

future extension services should train farmers to keep records so that the performance of their farm tools and enterprises can be analysed based on accurate farm records.

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APPENDICES

Appendix 1: Description of physical and financial performance variables

Symbol	Variable	Description	Expected sign
N	Net profit	A dependent variable	
X1	Number of tasks	Ploughing, tilling, sowing, pumping water, transportation, milling, threshing /shelling.	+
X2	Acres ploughing	Number of acres ploughed per year	+
X3	Acres tilled	Number of acres per year	+
X4	Number of sacks threshed	Number of sacks threshed per year	+
X5	Number of sacks transported	Number of sacks transported per year	+
X6	Savings interest rate	Annual Savings interest rate (%)	-
X7	Depreciated value	2WT depreciated value	-
X8	Purchasing price	Initial cost of the 2WT (TZS)	-
Z1	Annual total revenue	Annual total revenue	+
Z2	Annual total cost	Annual total cost	-
D1	Dummy for ownership	1= individual, 0= if group	+
D2	Dummy for credit financing	1 = Credit 0 = Otherwise	-
D3	Dummy for equity financing	1 = Equity 0 = Both	+
D4	Dummy for type of power tiller	1 = kubota 0 = Otherwise (Amek)	+
D5	Dummy for type of power tiller	1 = Toyo 0 = Otherwise (Amek)	+
D6	Dummy for type of power tillers	1 = DH-Changchai 0 = Otherwise (Amek)	+
D7	Dummy for type of soil	1 = Clay 0 = Otherwise (loam)	-
D8	Dummy for type of soil	1 = Sandy 0 = Otherwise (loam)	+
D9	Dummy for a Brand new	1 = Brand new power tiller 0 = Used power tiller	+
β's, α & θ	Parameters		

Appendix 2: Description of variable on spatial distribution and inventory of power tillers

Categories	**Variables**
Ownership pattern	Individual
	Group
Geographical location	Arusha DC
	Meru District
	Babati district
2WT characteristics	Model
	Purchase price
	Year purchased
	Dealer of the tractor
	No. of year expected to operate
Type of use	Tilling
	ploughing
	Transporting
	Threshing/ shelling
Social-economic factors	Gender
	Farmer education
	Group size and gender distribution
	Group leadership

Appendix 3: Description of physical performance indicators

Indicator	Description of the indicator	Unit of measurement
Model	The model of make of the 2WT. They were 4 models found; Kubota, Amek, Toyo and DH-Changchai	Type of model
Purchase price	This is the purchase price of a 2WT either brand new or used. Also without inclusion of subsidy.	Real price in Tshs
Year purchased	Year to which it was bought by the current owner	Year
Condition of 2WT	Condition of the 2WT whether a brand new or used	Brand new or used
Working life time	This is the expected working life time of the 2WT	Number of years
Type of activities		
Ploughing	The 2WT had a plough as an attachment	Number of acres ploughed
Tilling	The 2WT had a rotavator for tilling the land	Number of acres tilled
Transportation	The 2WT had a trailer for transportation of goods	Number of sacks (100kg) transported per year
Threshing/shelling	The 2WT had a thresher as an attachment	Number of sacks (100kg) threshed/shelled

Appendix 4: Description of financial performance indicators

Indicator	Description of the indicator	Unit of measurement
Fuel cost	Total cost of fuel = Price of fuel per liter x liters used per week	Price in Tshs
Labour cost	Total wage paid to labour(driver/operator) per month = Wa(ploughed) + Wb(till)+ Wc(transport)+ Wd(thresh)	Price in Tshs
Maintenance cost	Cost for maintenance in a year	Price in tshs
Price based on type of activities		
Ploughing price	Price for ploughing per acre of land	Price in Tshs
Tilling price	Price for tilling per acre of land	Price in Tshs
Transportation price	Price for transport per sack of good	Price in Tshs
Threshing/shelling price	Price for thresh per sack of good	Price in Tshs
Total income of an activity	Total income= price x quantity in a year	Price in tshs
Total cost	Total cost= labour cost + fuel cost + maintenance cost	Price in tshs

Appendix 5: Test results for Heteroskedasticity, multicollinearity and autocorrelation

Breusch -pagan/ Cook-Weisberg test for heteroskedasticity	
Ho;	Constant variance
Variables;	fitted values of net profit
Chi2(1)	= 34.96
Prob > chi2	= 0.0000
Tolerance and variance inflation factor test for multicollinearity	
Mean VIF	3.63
Breusch-Godfrey LM test for autocorrelation	
Chi2	= 0.414
Prob > Chi2	= 0.5201

Appendix 6: Focus group discussion questions

1. Which ownership model is better and why?

2. Which model is better for service provision to other farmers?

3. Which model is better for maintain and longer life of the machine?

4. Which model can easily access credit to purchase a 2WT and why?

5. How can the management of 2WT be improved under each model?

Appendix 7: Key informants questions

Name of the respondent……..

Name of enumerator…….……

Date of interview ……...

Division …… District ……..……..

Village …… Ward ……..……

Questions

1. What is the number of farmers in your district?

……

2. What the amount of land under cultivation

   a. For hand hoes = ……

   b. Draught animal = ……

   c. 2WT = ……

   d. 4WT = ……

3. What is the number of agricultural implements in your area?

   a. 4WT = ……

   b. 2WT = ……

   c. Seeder = ……

   d. Thresher = ……

   e. Sheller = ……..

   f. other specify= …….

4. What is the trend in the number of 2WTs in the district in relation to other farm implements?
5. How many groups have acquired subsidized farm machinery during the last 3 years?
    a. Tractors = ……
    b. 2WT = ……
    c. Ox-plough = ……
    d. Threshers = ……
6. How many individuals have acquired subsidized farm machinery during the last 3 years?
    a. Tractors = …..…….
    b. 2WT = …….
    c. Ox-plough = ……
    d. Threshers = ……..
7. Who are dealers of farm machineries in your district or nearby district/town?
8. What are the ownership models for 2WT in your district? 2WTs business models existing in your District?
9. Have there been any agricultural mechanization related programs, projects and other interventions implemented or planned in your area during the last 3 years or before? Please describe
10. In your opinions, what are the strengths and weaknesses of 2WTs industry/business in Arusha?
11. What are the key successes that your office can show regarding farm mechanization?

Appendix 8: Individual power tillers owners questionnaire

Name of the respondent……..…
Name of enumerator……
Date of interview …….
Division …… District ……..……..
Village …… Ward ……..……
Time started ……..…….. Time finished..…….……

Variable code	Question or variable	Response	Coding key	Skip rule
A: PERSONAL CHARACTERISTICS				
A001	Name of the respondent		…… …… …… ….....	
A002	Sex of respondent		1= Male 2= Female	
A003	Age		1=20 to 40 years ( ) 2= 41 to 60 years ( ) 3= 61 and above years ( )	
A004	Education		1= Not gone to school ( ) 2= Adult education ( ) 3=Primary Education ( ) 4=Secondary education ( ) 5= College education ( ) 6=University education ( )	
A005	Marital status		1 = Married 2 = Cohabiting 3 = Single never married 4 = Widow 5 = Divorced 6 = Other Specify ……..	
A006	Number of dependents		…… ….....	
A007	What is your major activity?		1= Crop farming 2= Livestock keeping 3= Business 4= Employment 5= Others Specify……	
A009	How many years of farming experience do you have?		…… ……	
A010	When did you start farming?		…… ……	
A010	What is the average cost of farming in a year?		……..	

<table>
<tr><th>Variable code</th><th>Question or variable</th><th>Response</th><th>Coding key</th><th>Skip rule</th></tr>
<tr><td>A011</td><td>How much revenue do you get from selling agriculture produce in a year?</td><td></td><td>…….. .....</td><td></td></tr>
<tr><td colspan="5">B: ASSET OWNERSHIP AND FINANCES</td></tr>
<tr><td>B001</td><td>Do you own a power tiller?</td><td></td><td>1= Yes 2= No</td><td></td></tr>
<tr><td>B002</td><td>How many power tillers do you own?</td><td></td><td>1= 1 2= 2
3= more than two</td><td></td></tr>
<tr><td>B003</td><td>Do you share the ownership of the power you have with anyone else?</td><td></td><td>1= yes
2= no</td><td></td></tr>
<tr><td>B004</td><td>If yes who is your co-owner?</td><td></td><td>1=group
2=family members
3=cooperate members
4=partner(s)</td><td></td></tr>
<tr><td>B005</td><td>When did you acquire your first power tiller?</td><td></td><td>…… …….</td><td></td></tr>
<tr><td>B006</td><td>When did you acquire your second power tiller?</td><td></td><td>…… …….</td><td></td></tr>
<tr><td>B007</td><td>Do you hire services?</td><td></td><td>1= yes
2=no</td><td></td></tr>
<tr><td>B008</td><td colspan="4">What other farm power assert do you own?
<table>
<tr><th>B0081; Name of asset</th><th>B00822; Yes/no</th></tr>
<tr><td>B00811; Tractor</td><td></td></tr>
<tr><td>B00812; Ox-plough</td><td></td></tr>
<tr><td>B00813;Ox-cart</td><td></td></tr>
<tr><td>B00814;Sickle</td><td></td></tr>
<tr><td>B00815;Panga knife</td><td></td></tr>
<tr><td>B00816;Axe</td><td></td></tr>
<tr><td>B00817;Spade/shovel</td><td></td></tr>
<tr><td>B00818;Hand hoe</td><td></td></tr>
<tr><td>B00819;Sprayer/water pump (electric)</td><td></td></tr>
<tr><td>B00820;Sprinkler set/ drip irrigation</td><td></td></tr>
<tr><td>B00821;Harvester/ thresher/Sheller</td><td></td></tr>
</table></td></tr>
<tr><td>B009</td><td>How did you come across the knowledge of the power tiller?</td><td></td><td>1= Extension officer
2= FACASI officers
3= Fellow farmers
4= Selian officers
5= other specify……</td><td></td></tr>
</table>

Variable code	Question or variable	Response	Coding key	Skip rule
Please provide information based on the newer power tiller you acquired last.				
B010	How did you obtain the capital for acquiring the 2WT?		1= Equity 2= Credit 3= Both	
B011	If credit, where did you get the credit from?		1= Bank 2= Microfinance banks 3= Farmers cooperatives banks 4= Saccos groups 5= Other specify……	
B012	If credit, what was the exact amount obtained?		…… …..	
B013	If credit, what was the interest rate of the loan obtained?		…….. …	
B014	If credit, what was the length time to return the loan?		…… ……	
B015	What are the difficulties in accessing the credit services?		1= unavailable 2= lack of information 3= bureaucracy 4= other specify……	
C: POWER TILLER CHARACTERISTICS				
C001	What was the purchasing price in Tshs of the 2WT?		…… …..	
C002	What is the year of make of the 2WT?		…… ……	
C003	What type of fuel model does your 2WT use?		1= diesel 2= petrol 3= other	

<table>
<tr><th>Variable code</th><th>Question or variable</th><th>Response</th><th>Coding key</th><th>Skip rule</th></tr>
<tr><td>C004</td><td>What attachments does the power tiller have?</td><td></td><td>
<table>
<tr><td>C0041 Attachment</td><td>C0042; 1=Yes, 2=No</td></tr>
<tr><td>C00411;Trailer</td><td></td></tr>
<tr><td>C00412;Water pump</td><td></td></tr>
<tr><td>C00413;Ridger</td><td></td></tr>
<tr><td>C00414;Plough</td><td></td></tr>
<tr><td>C00415;Cultivator</td><td></td></tr>
<tr><td>C00416;Potato digger</td><td></td></tr>
<tr><td>C00417;Seed cum fertilizer drill</td><td></td></tr>
<tr><td>C00418;Extension wheel</td><td></td></tr>
<tr><td>C00419;Sprayer unit</td><td></td></tr>
<tr><td>C00420;Remote control unit</td><td></td></tr>
<tr><td>C00421;Seat for power tiller</td><td></td></tr>
</table>
</td><td></td></tr>
<tr><td>C005</td><td>From whom did you purchase the power tiller from?</td><td></td><td></td><td></td></tr>
<tr><td>C007</td><td>For how long do you expect to use the 2WT?</td><td></td><td>…….</td><td></td></tr>
<tr><td>C008</td><td>What are the main difficulties do you face when running the 2WT?</td><td></td><td>1= frequent breakdown
2=high cost
3=high cost of labour
4=lack of clients for renting
5= other specify
……..</td><td></td></tr>
<tr><td colspan="5">D: PHYSICAL PERFORMANCE INDICTAORS</td></tr>
<tr><td>D001</td><td colspan="4">Please provide the following information with respect to land ownership (in acre) for 2015/2016 season
<table>
<tr><th></th><th>D0012 Cultivated land</th><th>D0013 Fallow land</th><th>D0014 Rented land</th><th>D0015 Total</th></tr>
<tr><td>D0011; Owned land</td><td></td><td></td><td></td><td></td></tr>
<tr><td>D0012;</td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Variable code</th><th>Question or variable</th><th>Response</th><th>Coding key</th><th>Skip rule</th></tr>
<tr><td></td><td colspan="3"><table>
<tr><td>Rented land</td><td></td><td></td><td></td><td></td></tr>
<tr><td>D0013
Total land</td><td></td><td></td><td></td><td></td></tr>
</table></td><td></td></tr>
<tr><td>D002</td><td colspan="3">How many acres does your power tiller cultivate?<table>
<tr><td></td><td>D0024
No. of acres</td></tr>
<tr><td>D0021;Own</td><td></td></tr>
<tr><td>D0022;On renters</td><td></td></tr>
<tr><td>D0023; Other family members</td><td></td></tr>
</table></td><td></td></tr>
<tr><td>D003</td><td colspan="3">Provide information regarding other farm tools you have used in your farm<table>
<tr><td>Farm tools</td><td>2013/2014</td><td>2014/2015</td><td>2015/2016</td></tr>
<tr><td>tractor</td><td></td><td></td><td></td></tr>
<tr><td>Oxen</td><td></td><td></td><td></td></tr>
</table></td><td></td></tr>
<tr><td>D004</td><td>How many weeks do the 2WT work in a season?</td><td></td><td>…….</td><td></td></tr>
<tr><td>D005</td><td>In which months in the year do the 2WT work the most?</td><td></td><td>1= Jan to march
2=April to June
3= July to September
4= October to December</td><td></td></tr>
<tr><td>D006</td><td>Do you hire services?</td><td></td><td>1= Yes 2=No</td><td></td></tr>
<tr><td>D007</td><td>What types of 2WT activities do you provide hiring services?</td><td></td><td><table>
<tr><td>activity</td><td>D0072
Use (yes/no)</td></tr>
<tr><td>D00711;Ploughing/ tilling</td><td></td></tr>
<tr><td>D00712;Harrowing</td><td></td></tr>
<tr><td>D00713;Sowing</td><td></td></tr>
<tr><td>D0014;Pumping</td><td></td></tr>
<tr><td>D00715;Transportation</td><td></td></tr>
<tr><td>D00716;Milling</td><td></td></tr>
<tr><td>D00717;Threshing/ Shelling</td><td></td></tr>
<tr><td>D00718;Spraying pesticides</td><td></td></tr>
</table></td><td></td></tr>
</table>

<table>
<tr><th>Variable code</th><th>Question or variable</th><th>Response</th><th>Coding key</th><th>Skip rule</th></tr>
<tr><td>D008</td><td colspan="4">For each of the variable inputs please indicate the information requested in the table below
<table>
<tr><td rowspan="3">Activities performed by a 2WT</td><td colspan="6">Units</td></tr>
<tr><td colspan="2">2013/14</td><td colspan="2">2014/15</td><td colspan="2">2015/16</td></tr>
<tr><td>Individual</td><td>Hired</td><td>Individual</td><td>Hired</td><td>Individual</td><td>Hired</td></tr>
<tr><td>D00911;Ploughing/ tilling</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Harrowing</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sowing</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Pumping</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Transportation</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Milling</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Threshing/ Shelling</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spraying pesticides</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td colspan="5">E; FINANCIAL PERFORMANCE INDICTAORS</td></tr>
<tr><td>E001</td><td colspan="4">What is the price for hiring the 2WT?
<table>
<tr><td rowspan="3">Activities performed by a 2WT</td><td colspan="6">Price</td></tr>
<tr><td colspan="2">2013/14</td><td colspan="2">2014/15</td><td colspan="2">2015/16</td></tr>
<tr><td>Individual</td><td>Hired</td><td>Individual</td><td>Hired</td><td>Individual</td><td>Hired</td></tr>
<tr><td>Ploughing/ tilling</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Harrowing</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sowing</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Pumping</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Transportation</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Milling</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Threshing/ Shelling</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spraying pesticides</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>E002</td><td colspan="4">How much is the labor cost (Tshs) for different types of farm power tools?
<table>
<tr><td>Farm tools</td><td>2013/2014</td><td>2014/2015</td><td>2015/2016</td></tr>
<tr><td>tractor</td><td></td><td></td><td></td></tr>
<tr><td>2WT</td><td></td><td></td><td></td></tr>
<tr><td>Oxen</td><td></td><td></td><td></td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Variable code</th><th>Question or variable</th><th>Response</th><th>Coding key</th><th>Skip rule</th></tr>
<tr><td>E003</td><td colspan="4">How much cost did you incur in the 2WT 2015/2016 for this activities?
<table>
<tr><td rowspan="2">Activities performed by a 2WT</td><td colspan="7">Units</td></tr>
<tr><td colspan="2">fuel</td><td colspan="2">labor</td><td colspan="2">maintenance</td><td>Other costs</td></tr>
<tr><td></td><td>liters</td><td>price</td><td>No. of labor</td><td>wage</td><td>item</td><td>price</td><td>prices</td></tr>
<tr><td>Ploughing/ tilling</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Harrowing</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sowing</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Pumping</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Transportation</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Milling</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Threshing/ Shelling</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spraying pesticides</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>E004</td><td>Have you ever paid any taxes concerning the power tiller?</td><td></td><td>1= yes
2= no</td><td>If no, skip to E007</td></tr>
<tr><td>E005</td><td>If yes, how much did you pay?</td><td></td><td>……
……</td><td></td></tr>
</table>

Appendix 9: Group power tiller owner's questionnaire

Name of the group……..……

Name of enumerator……..……..

Date of interview …….

Division …… District ……..

Village …… Ward ……..……

Time started……..…….. Time finished..…….……..……

<table>
<tr><th>Var. code</th><th>Question or variable</th><th>Response</th><th>Coding key</th><th>Skip rule</th></tr>
<tr><td colspan="5">A: GROUP CHARACTERISTICS</td></tr>
<tr><td>A001</td><td colspan="4">Fill in the information required
<table>
<tr><th>S/N</th><th>Number of group members member</th><th>Gender 1=male, 2=female</th><th>Age (years)</th><th>Education level</th><th>Total # of years spent in school</th><th>Major activity</th></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>7</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>8</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>9</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>10</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>A002</td><td>What are the main 3 crops cultivated by most members?</td><td></td><td>1 = Maize
2 = Paddy
3 = Beans
4 = others</td><td></td></tr>
<tr><td colspan="5">B: ASSERT OWNERSHIP AND FINANCES</td></tr>
<tr><td>B001</td><td>Does the group own a power tiller?</td><td></td><td>1= Yes 2= No</td><td></td></tr>
<tr><td>B002</td><td>How many power tillers does the group own?</td><td></td><td>1= 1
2=2
3= more than two
specify…….</td><td></td></tr>
<tr><td>B003</td><td>How many years have group members been using power tiller?</td><td></td><td>…….</td><td></td></tr>
</table>

<table>
<tr><th>Var. code</th><th>Question or variable</th><th>Response</th><th colspan="2">Coding key</th><th>Skip rule</th></tr>
<tr><td>B004</td><td>What other farm power assert does a group own?</td><td></td><td colspan="3"><table>
<tr><td>Name of asset</td><td>Yes/no</td><td>Number</td></tr>
<tr><td>Tractor</td><td></td><td></td></tr>
<tr><td>Ox-plough</td><td></td><td></td></tr>
<tr><td>Ox-cart</td><td></td><td></td></tr>
<tr><td>Sickle</td><td></td><td></td></tr>
<tr><td>Panga knife</td><td></td><td></td></tr>
<tr><td>Axe</td><td></td><td></td></tr>
<tr><td>Spade/shovel</td><td></td><td></td></tr>
<tr><td>Hand hoe</td><td></td><td></td></tr>
<tr><td>Sprayer/water pump (electric)</td><td></td><td></td></tr>
<tr><td>Sprinkler set/ drip irrigation</td><td></td><td></td></tr>
<tr><td>Harvester/ thresher/Sheller</td><td></td><td></td></tr>
<tr><td>Wheelbarrow</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>B005</td><td>How did you come across the knowledge of the power tiller?</td><td></td><td colspan="3">1= Extension officer
2= FACASI officers
3= Fellow farmers
4= Selian officers
5= specify……</td></tr>
<tr><td colspan="6">Please provide the below information based on the most recent used power tiller.</td></tr>
<tr><td>B006</td><td>How did the group obtain the capital for acquiring the 2WT?</td><td></td><td colspan="3">1= Equity
2= Credit
3= Both</td></tr>
<tr><td>B007</td><td>If credit, where did it get the credit from?</td><td></td><td colspan="3">1= Bank
2= Microfinance banks
3= Farmers cooperatives banks
4= Saccos groups
5= Government</td></tr>
<tr><td>B008</td><td>If credit was obtained from the government, what was the down payment did the group have to pay?</td><td></td><td colspan="3">1 =10%
2 = 20%
3 = 30%
4 = other specify
…….</td></tr>
<tr><td>B009</td><td>If credit, what was the interest rate of the loan obtained?</td><td></td><td colspan="3">……..…</td></tr>
<tr><td>B010</td><td>If credit, what was the time frame to return the loan?</td><td></td><td colspan="3">……</td></tr>
</table>

Var. code	Question or variable	Response	Coding key	Skip rule
B011	If credit, what was the exact amount obtained?		……..	
B012	What are the difficulties in accessing the credit services?		1= unavailable 2= lack of information 3= bureaucracy 4= other specify …… …….....	
C: POWER TILLER CHARACTERISTICS				
C001	What was the purchasing price in Tshs of the 2WT?		…… ……..	
C002	What is the year of make of the 2WT?		…… ……	
C003	Who was the dealer of the power tiller?		…… ……	
C004	What is the model/s of 2WT owned?		…… …… …… …….	
C005	What type of engine model does your 2WT have?		…… ……..	
C006	What attachments do the power tiller have?		Attachment: 1=Yes, 2=No Trailer Water pump Plough Cultivator Potato digger Seed cum fertilizer drill Extension wheel Sprayer unit Remote control unit Seat for power tiller	
C007	How long does the group expect to use the 2WT?		…… ……	

<table>
<tr><th>Var. code</th><th>Question or variable</th><th>Response</th><th>Coding key</th><th>Skip rule</th></tr>
<tr><td>C008</td><td>What are the major difficulties do you face when running the 2WT?</td><td></td><td>…….
……..
…….</td><td></td></tr>
<tr><td colspan="5">D: PHYSICAL PERFORMANCE INDICTAORS</td></tr>
<tr><td>D001</td><td colspan="4">Please provide the following information with respect to land ownership (in acre) for 2014/2015 and 2015/2016 season
<table>
<tr><th>S/N</th><th>Amount of Land owned</th><th>Land cultivated</th><th>Land rented</th><th>Amount of land cultivated using 2WT</th><th>Other tools used (tractor and/or animal traction)</th><th>Major activity the 2WT does for each member</th></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>7</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>8</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>9</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>10</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>D002</td><td>How many weeks does the 2WT work in a season?</td><td></td><td>…….</td><td></td></tr>
<tr><td>D003</td><td>In which months in the year does the 2WT work the most?</td><td></td><td>1= Jan to march
2=April to June
3= July to September
4= October to December</td><td></td></tr>
<tr><td>D004</td><td>Does the group provide hiring services on the 2WT?</td><td></td><td>1= Yes 2=No</td><td></td></tr>
<tr><td>D005</td><td>What types of 2WT activities does it provide hiring services?</td><td></td><td><table>
<tr><th>activity</th><th>Use (yes/no)</th></tr>
<tr><td>Ploughing/ tilling</td><td></td></tr>
<tr><td>Harrowing</td><td></td></tr>
<tr><td>Sowing</td><td></td></tr>
<tr><td>Pumping</td><td></td></tr>
<tr><td>Transportation</td><td></td></tr>
<tr><td>Milling</td><td></td></tr>
<tr><td>Threshing/ Shelling</td><td></td></tr>
<tr><td>Spraying pesticides</td><td></td></tr>
</table></td><td></td></tr>
</table>

Var. code	Question or variable	Response	Coding key	Skip rule

D006 For each of the variable inputs please indicate the information requested in the table below

Activities performed by a 2WT	Units					
	2013/14		2014/15		2015/16	
	Individual	Hired	Individual	Hired	Individual	Hired
Ploughing/ tilling						
Harrowing						
Sowing						
Pumping						
Transportation						
Milling						
Threshing/ Shelling						
Spraying pesticides						
Ploughing/ tilling						

E; FINANCIAL PERFORMANCE INDICTAORS

E001 What is the price for hiring the 2WT?

Activities performed by a 2WT	Price					
	2013/14		2014/15		2015/16	
	Individual	Hired	Individual	Hired	Individual	Hired
Ploughing/ tilling						
Harrowing						
Sowing						
Pumping						
Transportation						
Milling						
Threshing/ Shelling						
Spraying pesticides						
Ploughing/ tilling						

E002 How much is the labor cost (Tshs) for different types of farm power tools?

Farm tools	2013/2014	2014/2015	2015/2016
tractor			
2WT			
Oxen			

E003 How much cost did you incur in the 2WT 2015/2016 for this activities?

Activities performed by a 2WT	Units						
	fuel		labor		maintenance		Other costs
	liters	price	No. of labor	wage	item	price	prices

Var. code	Question or variable	Response	Coding key	Skip rule
	Ploughing/ tilling			
	Harrowing			
	Sowing			
	Pumping			
	Transportation			
	Milling			
	Threshing/ Shelling			
	Spraying pesticides			
E004	Have you ever paid any taxes concerning the power tiller?		1= yes 2= no If no, skip to E007	
E007	If yes, how much did you pay?		……	
F; GROUP CHARACTERISTICS				
F001	How many leader are there in the group?		1= 2 2 = 3 3 =4	
F002	What is the age and gender of the leaders?		chairman / secretary / treasurer Age gender	
F003	When was the last election done?		……..	
F004	How often do election occur in the last 3 years?		1= one time 2= two times 3= three times	
F005	How many general meeting are being held during last 3 years?		…….	
F006	How often in a year do financial report presented to the group and discuss?		……	
F007	What was the last time for the financial report regarding the 2WT presented?		……	

Var. code	Question or variable	Response	Coding key	Skip rule
F008	Is the group satisfied with the whole performance of the 2WT?		1= yes 2= no	
F009	If no, why are the not satisfied, please describe		……. ……. ……	
F010	What benefits do the individual members get from the use of 2WT?		……. ……. ……. ……. ….	
F011	What benefits do the individual members get from the group?		……. ……. ……. ……. …	