

**MECHANIZATION EFFECTS ON CROP PRODUCTION SYSTEMS IN  
IGUNGA DISTRICT TABORA, TANZANIA**

**BY**

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AGRICULTURAL ECONOMICS OF SOKOINE UNIVERSITY OF  
AGRICULTURE. MOROGORO, TANZANIA.**

24 SEP 2010

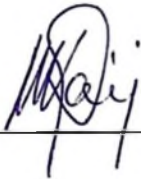
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**ABSTRACT**

The study was carried in Igunga district, Tabora region from November 2008 to April 2009. It is estimated that 70% of land is ploughed by using DAP. Animal power is an advanced technology as compared to hand technology but it is not a reliable power source due to a lot of drawbacks. There is an argument that tractorization is uneconomical for developing countries especially for smallholders. However, statistically analysed evidence to justify this argument in the study area was lacking. Information on economic viability of tractorization in Igunga was also lacking. 108 farming households were randomly selected from 11 villages. The 2007/08 crop production data was used to provide a comparative economic analysis between DAP and tractor power using households. Specific attention was to investigate the impact and implication of tractorization on total crop output, crop income and resource utilization. T- test was used to compare the effects of mechanization on resource utilization between the two groups. It was also used to compare crop output between DAP and tractor power users. Effect of tractorization on total crop income was investigated by using regression analysis. Cobb-Douglas production function was adopted. Tractor use was taken as a dummy variable. Maize yield was higher with DAP while cotton yields were higher with tractor power use. However, labour productivity was higher with tractor use than AT. Tractor using households earn more crop income than their counterpart due to bigger cultivated area. Tractorization had a positive impact on crop income although not highly statistically significant. It is recommended to create awareness to farmers on the availability of animal drawn implements that can be used in planting and weeding. In order to exhaust the potential of cultivated land, agronomic practices should be adhered to.

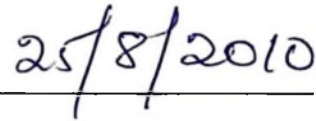
**DECLARATION**

I, MODEST RWEHUMBIZA KAIJAGE, do hereby declare to the Senate of Sokoine University of Agriculture that, this dissertation is my own original work and that it has neither been submitted nor concurrently being submitted for a degree award in any other Institution.



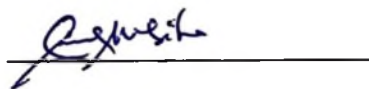
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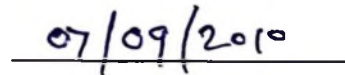
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## TABLE OF CONTENTS

<b>ABSTRACT.....</b>	<b>ii</b>
<b>DECLARATION .....</b>	<b>iii</b>
<b>COPYRIGHT.....</b>	<b>iv</b>
<b>ACKNOWLEDGMENT .....</b>	<b>v</b>
<b>TABLE OF CONTENTS .....</b>	<b>vi</b>
<b>LIST OF TABLES.....</b>	<b>x</b>
<b>LIST OF APPENDICES .....</b>	<b>xi</b>
<b>LIST OF ABBREVIATIONS .....</b>	<b>xii</b>
<b>CHAPTER ONE .....</b>	<b>1</b>
<b>1.0 INTRODUCTION .....</b>	<b>1</b>
1.1 Research Problem and Justification.....	2
1.2 Objectives of the Study.....	5
1.2.1 Overall Objective.....	5
1.2.2 Specific objectives.....	5
1.2.3 Hypotheses.....	5
<b>CHAPTER TWO .....</b>	<b>6</b>
<b>2.0 LITERATURE REVIEW .....</b>	<b>6</b>
2.1 Farm Power.....	6
2.1.1 Overview of farm power.....	6
2.1.1.1 Human power.....	6
2.1.1.2 Animal power .....	7
2.1.1.2.1 Promotion of animal traction in Tanzania .....	7

2.1.1.2.2	Benefits of Animal traction .....	8
2.1.1.2.3	Constraints of adoption of AT .....	9
2.1.1.3	Tractor power.....	9
2.1.1.3.1	Determinants of tractorization/mechanization.....	9
2.2	Agricultural Mechanization .....	11
2.2.1	The meaning of agricultural mechanization .....	11
2.2.2	Objectives of agricultural mechanization .....	12
2.2.3	Advantages of agricultural mechanization .....	13
2.2.4	The role and place of mechanization in agriculture.....	13
2.2.5	Adoption of agricultural mechanization .....	14
2.2.6	Constraints in mechanization.....	14
2.2.7	Agricultural mechanization policy in Tanzania.....	15
2.2.8	Status of agricultural mechanization in Tanzania.....	15
<b>CHAPTER THREE.....</b>		<b>17</b>
3.0	<b>METHODOLOGY .....</b>	<b>17</b>
3.1	Description of the Study Area .....	17
3.1.1	Location of study area .....	17
3.1.2	Administration and population .....	17
3.1.3	Climate.....	17
3.1.4	Land use, economic activities and infrastructure .....	18
3.1.5	Topography, soils, drainage and vegetation .....	19
3.2	Methods .....	20
3.2.1	Sampling Procedures .....	20
3.2.2	Data collection .....	21
3.2.2.1	Primary data.....	21

3.2.2.2	Secondary data.....	21
3.3	Data Analysis.....	21
3.3.1	Descriptive statistics.....	21
3.3.2	Inferential statistics.....	22
<b>CHAPTER FOUR .....</b>		<b>25</b>
<b>4.0</b>	<b>RESULTS AND DISCUSSION .....</b>	<b>25</b>
4.1	Agricultural Mechanization Status in Tabora Region .....	25
4.1.1	Farm power sources in Tabora region .....	25
4.2	Agricultural Mechanization Status in Igunga District .....	26
4.2.1	Farm power sources.....	26
4.2.2	Farm power sources ownership and mode of acquisition.....	27
4.2.2.1	Tractor ownership and mode of acquisition .....	27
4.2.2.2	Draft animals ownership and mode of acquisition .....	28
4.2.3	Farm power hiring rates and operational costs.....	28
4.2.3.1	Draft animal power hiring rates.....	29
4.2.3.2	Tractor hiring rates .....	29
4.2.3.3	Field operational costs .....	30
4.3	Crops Cultivated.....	31
4.3.1	Food crops .....	31
4.3.2	Cash crops.....	32
4.4	Cropping systems.....	34
4.5	Power Sources for Field Operations.....	34
4.5.1	Primary tillage power source .....	34
4.5.2	Secondary tillage power sources in paddy production .....	36
4.5.3	Planting methods and associated power sources .....	37

4.6	Social economic Characteristics .....	38
4.6.1	Age of household head and household size .....	38
4.6.2	Education .....	39
4.6.3	Household composition. ....	39
4.6.4	Land ownership .....	40
4.6.5	Herd size .....	40
4.7	Tractorization effects .....	41
4.7.1	Land allocation .....	41
4.7.2	Resource use by power source in sample households .....	42
4.8	Tractorization effects on Individual Crops .....	43
4.8.1	Effects of tractorization on cotton production .....	43
4.8.2	Effects of tractorization on maize production .....	45
4.8.3	Crop output and productivity .....	47
4.8.3.1	Crop output per unit area .....	47
4.8.3.2	Labour productivity .....	47
4.8.4	Tractorization effects on crop income .....	48
<b>CHAPTER FIVE .....</b>		<b>50</b>
<b>5.0 CONCLUSIONS AND RECOMMENDATIONS .....</b>		<b>50</b>
5.1	Conclusions.....	50
5.2	Recommendations.....	53
<b>REFERENCES .....</b>		<b>54</b>
<b>APPENDICES.....</b>		<b>59</b>

## LIST OF TABLES

Table 1:	Estimated proportions of cultivated land by hand, animal and mechanical power in Tanzania .....	4
Table 2:	Household sampling in the study Area .....	20
Table 3:	Power sources in Tabora region from 2003 to 2008.....	26
Table 4:	Number of draft animals, tractors and power tillers in Igunga .....	27
Table 5:	DAP hiring rates in 2007/2008 cropping season. ....	29
Table 6:	Tractor hiring rates in 2007/2008 cropping season .....	29
Table 7:	Food crops cultivated by sampled households .....	32
Table 8:	Cash crops cultivated by sample households.....	33
Table 9:	Igunga district cropping systems .....	34
Table 10:	Household categories by primary tillage power sources .....	35
Table 11:	Cropping systems and their associated primary tillage power sources .....	35
Table 12:	Paddling power sources .....	36
Table 13:	Socio-economic characteristics of sample households.....	41
Table 14:	Land allocation to crops by household category .....	42
Table 15:	Resource use by power source in sample households .....	42
Table 16:	Resource use in cotton production.....	44
Table 17:	Resource productivity in cotton production .....	45
Table 18:	Resource use in maize production .....	45
Table 19:	Resource productivity in maize production.....	46
Table 20:	Cobb – Douglas production function estimates.....	48

**LIST OF APPENDICES**

Appendix 1: Farmers Questionnaire.....	59
Appendix 2: Socio-economic characteristics of households .....	68
Appendix 3: Multiple Response results .....	71
Appendix 4: Regression analysis results .....	73

**LIST OF ABBREVIATIONS**

<b>ADB</b>	-	<b>Africa Development Bank</b>
<b>AGITF</b>	-	<b>Agricultural Input Trust Fund</b>
<b>ARI</b>	-	<b>Agricultural Research Institute</b>
<b>AT</b>	-	<b>Animal Traction</b>
<b>CBPP</b>	-	<b>Contagious Bovine Pleuropneumonia</b>
<b>DALDO</b>	-	<b>District Agriculture and Livestock Development Officer</b>
<b>DAP</b>	-	<b>Draft Animal Power</b>
<b>DED</b>	-	<b>District Executive Director</b>
<b>FAO</b>	-	<b>Food and Agriculture Organization</b>
<b>MAC</b>	-	<b>Ministry of Agriculture and Cooperatives</b>
<b>MIRPCS</b>	-	<b>Mwanzugi Irrigated Rice Primary Cooperative Society</b>
<b>NBS</b>	-	<b>National Bureau of Statistics</b>
<b>RAS</b>	-	<b>Regional Administrative Secretary</b>
<b>SPSS</b>	-	<b>Statistical Package for Social Sciences</b>
<b>URT</b>	-	<b>United Republic of Tanzania</b>

## CHAPTER ONE

### 1.0 INTRODUCTION

Dependence on human labour is one of the set backs of agricultural production in Tanzania. Human labour is characterized by limited power output but has a superior capability for operations requiring high skills. Mobile power sources are required for field operations such as ploughing, weeding, and harvesting. Mobile power sources that can be used in performing the above mentioned field operations include; human, animals and tractors or power tillers. Human labour is less competitive for operations demanding brute power rather than skills, such as water lifting and heavy soil cultivation (Oladele, 2003). Farm operations consuming much power but little intelligence such as ploughing and water lifting were classified by Binswanger (1984) as power intensive operations. Historically, Binswanger (1984) observed that when new power sources are introduced, they are initially used for power intensive operations such as transport, water lifting and primary cultivation. Mechanization of field operations is among the inputs necessary for increased agricultural production.

#### **Levels of agricultural mechanization**

There are three technological levels of agricultural mechanization in Tanzania; hand-tool technology, draught-animal technology, and mechanical-power technology. Power sources for the above three levels of mechanization are human, animals and mechanical respectively (Pariyar *et al.*, 2001). Full benefits of mechanization are achieved through the use of advanced crop husbandry inputs such as improved seeds, fertilizers and pesticides and in situations where land is not a constraint, increasing farm power can lead to direct increases in production by simply increasing the land area (Clarke, 2000). Individual

ownership of a tractor is not a viable option for most smallholder farmers as compared to draft animals but tractor services hiring is a better alternative.

### **1.1 Research Problem and Justification**

Igunga district is the leading district in utilization of animal power within Tabora region; Tanzania (URT 2003). The district has a total of 314 500ha of arable land. Most of it comprises black cotton soils which are suitable for cotton production. The area is also suitable for production of rice, sorghum, chickpeas and sesame. Data from Igunga District Agriculture and Livestock Development Officer's (DALDO) office shows that cultivated area for the 2007/2008 is 137 390. This is equivalent to 44% of its arable land. Cotton is the only traditional cash crop of the area. Sesame and chickpeas are non traditional cash crops that are fetching high prices in local markets.

The number of tractors in Igunga district decreased from 75 units in year 2002/03 to 53 in 2006/07 and then increased to 58 in 2007/08. Proportion of land cultivated by using tractor power in 2007/08 cropping season was 23% of the total planted area as compared to 18% in 2003/04 cropping season.

Number of oxen increased from 46 268 in year 2002/03 to 94 034 in 2006/07. Proportion of land cultivated by Animal traction (AT) has remained almost constant with an average of 71% as more of human power users have shifted to AT while some of AT users shifting to tractor power. In 2002/03, proportion of land cultivated by using hand was 10% of total planted area. The data from DALDO's office shows that in 2007/2008 cropping season 7% of total planted area was carried out by using human power (using hand hoe), 70% by draft power and the rest 23% by using tractor power. As it has been pointed out, more than a half of Igunga arable land remains uncultivated annually. One of the reasons could be

dependence on draft animal power in performing field operation. Mechanization of crop production operations is one of the necessities in exploiting land resource.

AT is an advanced level of mechanization as compared to human power but it is not reliable because draft animals are living organisms. The drawbacks of draft animal power are low field capacity, the animals become tired, needs time to graze and time for resting. Their power is limited to light implements. The capacity of animals is low due to poor nutrition. This is among the constraints of wide adoption of animal traction in Tanzania which were identified by authors such as Shetto and Kwiligwa (1992); Mrema and Mrema (1993); Shetto and Hatibu (1997), cited by Limbu (1999). Threat of diseases and competing demand for animals were also identified as constraints.

By advancement from AT to mechanical power, the area under fodder and feed for draught animals can be minimized thus the land released can be brought under commercial crops. Agricultural mechanization progress attained in the earlier years is being lost in many parts of sub-Saharan Africa; tractor hire services have declined (FAO, 2008). However, due to limitations of draft animal power (DAP), tractorization is a prerequisite in attaining the objective of transforming subsistence agriculture into commercial agriculture.

One of agricultural mechanization policy statements is “Private sector will be encouraged to establish and run tractor hire centres” (URT- MAC, 1997). Starkey and Mutagubya (1992) stated that “estimates of relative importance of hand cultivation, animal power and tractor vary greatly among different authors. Table 1 as adopted from Starkey and Mutagubya (1992) shows estimated proportions of cultivated land by hand, animal and mechanical power in Tanzania as they were reported by different authors within the same years.

**Table 1: Estimated proportions of cultivated land by hand, animal and mechanical power in Tanzania**

Hand (%)	Animal %)	Tractor (%)	Source/Reference
55	28	17	Hassan(1987)
82.5	12	5.5	Lyimo(1987)
70	20	10	Urassa <i>et al</i> (1990)
80	14	6	Mrema and Hatibu(1990)
78	12.5	9.5	MoA (1991)
84	10	6	Graham (1992)
80-85	15-20	5	Mtenga (1992)

**Source:** Starkey and Mutagubya (1992)

There is a lot of criticism of tractorization in agriculture by authors such as Starkey and Mutagubya (1992) and Hesse (1997). The arguments against tractorization in the reports by ILO and other organizations were enhanced by the first global oil price hikes of the 1973, which made tractorization appear even more uneconomical for developing world, especially for smallholder sector (FAO, 2008). Comparing AT and tractor power Starkey and Mutagubya (1992) stated that if genuine free market competition is allowed between human power, tractor power and animal power, Animal power will prove the more appropriate option in most smallholder systems. Hesse (1997) stated that most of attempts to tractorization failed in several countries including Tanzania, Zambia, Guinea and Ivory Coast. This was also an argument by Starkey and Mutagubya (1992) that subsidized tractor hire schemes have proved unsustainable and ineffective in Tanzania and many other countries. However, statistically analyzed empirical evidences to justify their arguments are lacking. Despite government efforts to promote tractor use in agriculture, information of tractor economic viability in Tanzania is little, hence a need to have a document with farm level information on economic viability of tractorization that will be used by the government in implementing the strategy within the study area.

## **1.2 Objectives of the Study**

### **1.2.1 Overall Objective**

General objective of the study is to provide a comparative economic analysis for farmers using animal traction and those using tractors in crop production. Specific attention is devoted to the impact and implication of tractorization on total crop output, crop income and resource utilization.

### **1.2.2 Specific objectives**

- 1) To investigate the effects of mechanization on resource (land and labour)utilization;
- 2) To compare crop output between animal traction using households and tractor users;
- 3) To investigate the profitability of tractor use in crop production.

### **1.2.3 Hypotheses**

Hypotheses to be tested were

- 1) There is no difference in average total cultivated area per household between animal power using households and tractor power users;
- 2) There is no difference in total labour requirement per unit area between animal power and tractor using households;
- 3) Tractorization has a negative effect on crop income.

## CHAPTER TWO

### 2.0 LITERATURE REVIEW

#### 2.1 Farm Power

##### 2.1.1 Overview of farm power

Tanzania is among the Sub-saharan Africa countries. The studies in the region by FAO in the years 2002-2004 have shown that the principal labour demand peaks in the farming cycle are land preparation and subsequent weeding (FAO, 2006). According to Limbu (1999) in Tanzania 20% to 50% of labour costs (for most crops) are in land preparation and weeding. Weeding is a critical operation in the cropping cycle. Late weed control may cause a loss of more than 30% of crop yield (FAO, 2006). Therefore technologies which reduce these requirements or which enhance labour capacity to deal with these demands are likely to be attractive. The 2002 -2004 study by FAO revealed three main factors that to large extent constrain increased farm production. They include:

- An increased reliance on human power;
- The low productivity of human labour;
- A decrease in the labour available.

The three sources of power in agricultural production are briefly described below:-

##### 2.1.1.1 Human power

Human is a predominant source of power in Tanzania. With human power, productivity is generally low because of the inadequate physical energy available and the limited range of hand tools (FAO, 2006). A typical household that is reliant solely on human power can only cultivate 1.5 ha per year. This rises to 4 ha and 8 ha for draught power and tractor power respectively (FAO, 2006).

### **2.1.1.2 Animal power**

Animal traction (AT) is the use of animal draught power mainly oxen, but may include the use of donkeys and horses as power sources to supplement or replace human power in agricultural tasks of ploughing, hoeing, seeding and transportation (Jaeger, 1986) cited by Jolly and Gadbois (1995). Animal power can also be used for logging, pond excavation and rural road maintenance (FAO, 2006). Animal power is considered to be appropriate, affordable and sustainable power source for small scale farmers (Starkey and Mutagubya, 1992; FAO, 2006). The transition from hand hoe to animal drawn plough is closely correlated with the intensity of farming system (Binswanger, 1984). In China, replacement of human power for transport and tillage by cattle was initiated more than 3200 years ago (Binswanger, 1984). From 1925 to 1940 in the United States, almost all draft animals in use in agricultural production had been replaced by tractors (FAO, 2008). The same occurred in Western Europe after the Second World War from 1945 to 1960. According to Binswanger (1984), draft animals have completely disappeared in North America, Europe, and Japan.

#### **2.1.1.2.1 Promotion of animal traction in Tanzania**

Promotion of AT in Tanzania started as early as 1920 when ox ploughs were introduced in different places like Tarime, Shinyanga and Mwanza . It was when the missionaries and settlers were playing a leading role during the colonial days (Mkomwa and Shetto, 1999). The early colonialist used animal power for transportation and subsequently for cultivation (Starkey and Mutagubya, 1992). According to Starkey and Mutagubya (1992), steel ox ploughs manufactured in Europe were introduced to local farmers in the 1920s and 1930s to encourage production of cotton and later of rice. During the 1950s, large scale colonial farmers employed tractors but smallholder AT spread mainly through cotton belt stimulated by cotton prices and new production potentials (Starkey and Mutagubya, 1992).

The initial spread of AT was more or less through farmer to farmer contact and may have been associated with commercial production of cotton, rice, maize and wheat (Mkomwa and Shetto, 1999). AT is also spreading through farmer migration. The main area of AT use was the cotton belt of Arusha, Mara, Mwanza, Shinyanga, Tabora and Singida which accounted for three quarters of Tanzania's work oxen (Starkey and Mutagubya, 1992). In some areas over 90% of farmers use oxen. The number of draught animals within the country is estimated to be 1 300 000; proportion of land cultivated by using animal power being estimated to be only 20% of total cultivated land.

#### **2.1.1.2.2 Benefits of Animal traction**

Animal traction is significant labour saving when used in appropriate tillage operations (Jolly and Gadbois, 1995). AT is appropriate, affordable and sustainable technology that is increasingly used throughout Eastern and Southern Africa (Starkey and Mutagubya, 1992; FAO, 2006). AT is complementary to tractor power. The benefits of AT as they were pointed out by Starkey and Mutagubya (1992) included: -

- Increased labour productivity; increased cultivated area;
- Improved timeliness of performing key field operations;
- Reduced drudgery and manual labour;
- Intensification of agricultural production and improvement of the efficiency of farm management and the utilization of manure and residues;
- Improvement of crop marketing.

Singh (1988) cited by Jolly and Gadbois (1995) stated that this technology has proven successful in many Asian countries and should be appropriate to the third world countries. The study by Jolly and Gadbois (1995) in Mali showed that there was a significant difference in area cultivated per active labour unit between traditional and AT equipped

groups. However, yield increase per unit area does not necessarily take place with animal traction.

#### **2.1.1.2.3 Constraints of adoption of AT**

The studies by Shetto and Kwiligwa (1992); Mrcma and Mrcma (1993); Shetto and Hatibu (1997) cited by Limbu (1999), identified factors that inhibit wide-scale adoption of draught animal technology. Some of the factors are:-

- Inadequate promotion, extension and training;
- Lack of animals for traction;
- Competing demands for livestock;
- Lack of agricultural mechanization policy and political/donor commitment and seriousness;
- Threat of animal diseases;
- Low power capacity of animals due to poor nutrition.

#### **2.1.1.3 Tractor power**

##### **2.1.1.3.1 Determinants of tractorization/mechanization**

The tractor is economical only if it is gainfully employed for rather than accounting for its unproductive use. Factors that determine adoption of tractorization include:

- Size of operational holdings;
- Agricultural productivity;
- Availability of irrigation facilities;
- Land topography;
- Per hectare profitability which is determined by yield per unit area, cropping intensity and market prices;

- Rural literacy ;
- Tractor price;
- Wages of agricultural labour;
- Labour density ;
- Draught animal density.

The study in Punjab using rank correlation indicated that the important determinants of tractorization were agricultural productivity and irrigation facilities. Farm mechanization is also dependent mainly upon the size of operational holding, land topography, availability of credit facilities and per hectare profitability which in turn is affected by per yield, cropping intensity, market prices etc. Study on the determinants of tractorization in Punjab using both rank correlation and functional analyses led to conclusion that variables such as farm size distribution, agricultural productivity, irrigation, rural literacy, and wages of agricultural labour were positively correlated with tractor density. However there was a negative correlation of tractor density and tractor price, labour density and draught animal density. Study by Panin (1993) in Botswana found that tractor hiring households had a large household size, more adult people and were more educated than the AT using households. Findings by Gajja *et al.* (1985) on the determinants of tractorization in arid areas of Western Rajasthan showed that agricultural productivity, size of holding, labour density; draught animal density and rural literacy were important factors that have a positive impact on tractorization in the area.

There is a contradicting idea that tractor use by smallholders even is not profitable by hiring. Panin (1993) found that system of hiring a tractor for ploughing in Botswana has no impact on total cultivated area, crop yields and total crop output rather it had a significant negative impact on crop production income. It also raises the total household labour

demand for farming operations. Masawe (1994) concluded that tractorization in small scale agriculture is not sustainable. Private sector tractors have been profitable on large holdings but they have seldom proved viable in smallholder sector (Panin, 1993; Masawe, 1994; FAO, 2006). In countries where farming is beginning to be mechanized, power tillers and tractors are still restricted to tillage and a few other operations. Binswanger (1984) generalized that the rate and pattern of mechanization are governed substantially by an economy's land and labour endowments, by the non-agricultural demand for labour, and by demand for agricultural products.

## **2.2 Agricultural Mechanization**

### **2.2.1 The meaning of agricultural mechanization**

Agricultural mechanization is often misunderstood as the introduction and use of power-operated machinery, especially tractors (Pariyar *et al.*, 2001; Ajav, 1999). Tractorization is, however, just one of the components of mechanization (Pariyar *et al.*, 2001; Ajav, 1999). Agricultural mechanization is the application of mechanical technology and increased power to agriculture, largely as a means to enhance the productivity of human labour and often to achieve results well beyond the capacity of human labour (FAO, 2008). This includes the use of tractors of various types as well as animal-powered and human-powered implements and tools, and internal combustion engines, electric motors, solar power and other methods of energy conversion (FAO, 2008). Mechanization also includes irrigation systems, food processing and related technologies and equipment. Levels and types of improved mechanical technologies need to be appropriate, that is, compatible with local, agronomic, socio-economic, environmental and industrial conditions (FAO, 2008).

The term “mechanization” is used to describe tools, implements and machinery applied in improving productivity of farm labour and land; it may use either human, animal or

motorized power, or a combination of these (FAO, 2006). It therefore involves the provision and use of all forms of power sources and mechanical assistance to agriculture from simple hand tools, to draught animal power and to mechanical power technologies (FAO, 2006). Agricultural mechanization embraces the operation of the hand tools, implements and machines for agricultural land development, production, harvesting and on-farm processing. Mechanization as it relates to agriculture requires the study, manufacture, utilization, maintenance and repair of all tools, implements, machines, equipment and structures which will enable the farmer to raise the productivity of human labour economically (Khalequzzaman and Karim, 2007). Based on power source there are three technological levels of mechanization; hand-tool technology, draught-animal technology and mechanical-power technology (Pariyar *et al.*, 2001; FAO, 2006).

### **2.2.2 Objectives of agricultural mechanization**

Mechanization is a key input in any farming system (FAO, 2006). It aims at achieving the following

- Increased productivity per unit area;
- Expansion of area under cultivation where land is available;
- Accomplishment of tasks that are difficult to perform manually;
- Reduction of drudgery in farming activities.

Farm mechanization accounts to alleviate drudgery of manual tillage, which may be important to keep younger people interested in farming (So *et al.*, 2001) cited by Tooy and Murase (2007). Full benefits of mechanization are achieved through the use of advanced crop husbandry inputs such as improved seeds, fertilizers and pesticides and in situations where land is not a constraint, increasing farm power can lead to direct increases in production by simply increasing the land area (Clarke, 2000). Binswanger (1984)

generalized that mechanization leads to direct yield increase only in exceptional cases such as the application of seeds, pesticides or fertilizers. Thus, higher levels of mechanization usually substitute for labour. The profitability of mechanization tractor in particular and its contribution to economic growth depends on the opportunities available to workers released from their tasks (Binswanger, 1984). It thus works via the indirect effects of released labour. Mechanization is most profitable and contributes most to growth where land is abundant, where labour is scarce relative to land or where labour is being rapidly absorbed into the non agricultural sector (Binswanger, 1984).

### **2.2.3 Advantages of agricultural mechanization**

Benefits of agricultural mechanization include:- Expansion of cultivated area and increased production through increased acreage and productivity, timeliness of operations and risk reduction especially in rain fed agriculture, reduces drudgery thereby increasing labour efficiency and transportation of both inputs and outputs becomes easy. The study by Ajao *et al.* (2005) showed that technical efficiency of mechanized and non-mechanized farms in Oyo state of Nigeria were 0.72 and 0.62 respectively. In semi arid areas, rainfall is a limiting factor therefore farm operations should be carried out timely in order to match with the rain season.

### **2.2.4 The role and place of mechanization in agriculture**

Mechanization is a management tool for maximizing production and profit. The type and the degree of mechanization should be decided by the producer to best suit his business and his own particular circumstances. Mechanization determines the areas under cultivation, timeliness of operations, the effective use of other inputs and ultimately the productivity of the farming system (FAO, 1995). The choice of suitable methods will therefore be just one of number of choices that a farmer has to make (Clarke, 2000). The decision on if and how

to mechanize is a complicated mix of reasons with economic reasons paramount. A mechanized farm appears to require very much less family labour input as compared with non – mechanized farm (Lim, 1985). Mechanization requires less labour inputs and hence releases labour to be used for further work. A machine which replaces labour will receive the wages formerly paid to labourers. Studies by Herdt (1983) in Asia rice mechanization showed that, a major benefit was increased output generated from larger harvested areas and high yields resulting from deeper ploughing and better cultivation practices. A farmer will have an incentive to adopt machines when they reduces production costs

### **2.2.5 Adoption of agricultural mechanization**

The pattern and speed of adoption of existing design of machines is influenced heavily by economy – wide factor scarcities and other macroeconomic variables (Binswanger, 1984). According to Binswanger (1984), other economic factors that influence the pace of mechanization include; capital scarcity and energy cost, farm size and subsidies. Capital scarcity and energy costs have the following effects on mechanization:-

- Reduces profitability of all forms of agricultural investment (land improvement, irrigation, animals, buildings etc);
- Causes farmers to allocate whatever investment funds are available away from mechanical input;
- Produce bias in mechanization towards power intensive operations.

### **2.2.6 Constraints in mechanization**

Arguments advanced against farm mechanization are :- Small scale and scattered holdings which result to farm machinery remaining generally underutilized; Majority of farmers are poor and therefore not in position to purchase costly machinery like tractors; The farm machinery have large turning radius and thus require comparatively large farm size for

economical use; Lack of proper knowledge of farmer to purchase farm machinery, operate and maintain it properly leads to wrong choice, make it uneconomical and risky too; Due to seasonal nature of agriculture, the farm machinery remains idle for much of the time. This means unnecessary high costs unless there is an alternative use of that machinery during off season.

### **2.2.7 Agricultural mechanization policy in Tanzania**

The mechanization policy under implementation appears in the Agriculture and Livestock Policy, 1997. In this policy, the government objective is promotion of the supply of sufficient farm machinery, equipment and tools to the farming community by private sector in order to meet demand at reasonable costs (URT- MAC, 1997). Under this section there are 8 policy statements but, to mention a few; “The government will establish effective information system regarding farm implements, machinery and equipments; Private sector will be encouraged to establish and run tractor hire centres and The ministry will support the development and adaptation of appropriate farm equipments.”

### **2.2.8 Status of agricultural mechanization in Tanzania**

It is estimated that in Tanzania a total of 44 million hectares are arable land. However, cultivated land is estimated to be 10.8 million ha (URT-MAFS, 2007). In Tanzania as in most countries of SSA, hand hoe is still used for land preparation on 80% of cultivated land , with only 15% being prepared by draft animal power (DAT) and the remaining 5% using tractors (FAO, 2008). The total number of tractors within the country is estimated to be 7200 but only 1200 are in good working condition. This conforms to observations by Starkey and Mutagubya (1992) and FAO (2006) that Government-run tractors hire schemes in Sub-Saharan Africa Tanzania inclusive, never widely effective and are now in state of collapse. Since its establishment in 1997, the agricultural input trust fund (AGITF)

has offered loans for buying 221 new tractors only. Only 256 old tractors have been repaired by using AGITF loans. Tractors are mostly used in tillage and transportation of farm produce.

## **CHAPTER THREE**

### **3.0 METHODOLOGY**

#### **3.1 Description of the Study Area**

##### **3.1.1 Location of study area**

Igunga district is one of the six districts of Tabora region. The district is located between latitudes 3°51' and 4°48' South of Equator and longitudes 33°22' and 34°8' East of Greenwich (DED, 2007). Geographically, the district is located in the East of Tabora municipality which is the headquarters of Tabora region. It covers an area of 4 499 km<sup>2</sup>. The district borders Kishapu district Shinyanga region in the North, Iramba district Singida region in the East, Uyui district in the South and Nzega district in the West.

##### **3.1.2 Administration and population**

Igunga district is administratively divided into 4 divisions; Igunga, Manonga, Simbo and Igurubi. It comprises of 26 wards, 96 registered villages and 637 hamlets (DED, 2007).

According to the 2002 national population and housing census, the district had a population of 325 547. The number of households was 51 176 with an average household size of 6.4 (URT, 2002). However, the district is projected to have a population of 396 738 in the year 2008 (URT, 2006). The ethnic groups within the district include; Nyamwezi, Sukuma, Nyiramba and Taturu.

##### **3.1.3 Climate**

Igunga district altitude is between 900m and 1200m above sea level. Its temperature ranges from 20°C to 33°C. The district is semi arid experiencing monomodal type of rainfall. Annual rainfall lies between 500 mm and 800mm. Rain season starts in mid November and

ends in April. Rainfalls are in most cases not reliable and are unevenly or poorly distributed. There is a dry spell in January and February (DED, 2008). South and South West part of the district receive more rains than North and North East parts. Due to climatic variations and soil variability, the district is divided into two Agro ecological zones; Northern and Southern zones. The Northern zone covers Igurubi division and parts of Igunga and Manonga divisions while the southern part covers Simbo division, most parts of Manonga division and some parts of Igunga division.

#### **3.1.4 Land use, economic activities and infrastructure**

Igunga district has a total area of 4 499km<sup>2</sup> (449 900 ha). Arable land is estimated to be 3 145km<sup>2</sup> (3 14 500 ha), 513 km<sup>2</sup> (51 300 ha) are range land while 1 125km<sup>2</sup> (1 12 500ha) are forests (DED, 2007). These forests are dominated by *Miombo* and *Acacia* species. Arable land is also used for cattle grazing during off season.

Most of the district population lives in rural areas where main economic activity is agriculture that is crop production and livestock keeping (DED, 2008). Another economic activity is fishing although it is not of great importance. Fishing is carried out in Wembere swampy area and Mwamapuli and Bulenya dams.

Crop production is mainly of subsistence. In average, a household which solely depend on crop production operates 0.4 to 2.5ha and per capita land holding is estimated to be 0.5ha (DALDO, 2008). Commonly grown crops are maize, sorghum and paddy as food crops. Sweet potatoes and cassava are also grown but in small quantities. The traditional cash crop cultivated is cotton but sunflower and groundnuts are also grown. Simsim is cultivated in very small areas and therefore considered to be negligible.

Most of livestock keepers are agro pastoralist keeping an average of 80 cattle per household, utilizing about 80% of arable land (DALDO, 2008). A minor ethnic group of Taturu comprises pure pastoralists. According to DED (2007), types of livestock kept and their number in brackets include; cattle (647 697), goats (340 678), sheep (134 331) and pigs (26 187).

The district has a road network of 886 km classified as trunk road (88km), regional roads (118), district roads (290km) and village feeder roads (390 km). Some of them are not passable during rain season.

### **3.1.5 Topography, soils, drainage and vegetation**

According to URT (2006) the district comprises of flat inundated low land plains, very gently and gently undulating plains with different drainage characteristics.

District soils vary greatly. They include; sandy and loamy sands with low natural fertility, calcareous clay loams with high natural fertility, imperfectly drained soils with moderately to high natural fertility and dark grey to black cracking soils (URT, 2006). The district is drained by 4 seasonal rivers which are Manonga, Kagong'ho, Mbutu and Mapilinga (DED, 2007). All the rivers drain to Wembere.

The district comprises of mixed vegetations; grasslands, woodlands and shrubs (DED, 2008).

## 3.2 Methods

### 3.2.1 Sampling Procedures

A combination of stratified, purposive and random sampling procedures was adopted. The district was stratified into three zones; the northern agro ecological zone which is potential for cotton and sorghum production, the southern zone which potentially grows sorghum, maize, paddy and groundnuts although it can grow cotton. Mwamapuli irrigation scheme was considered to be a third zone since it is the only irrigation scheme where paddy is produced under good management. Purposive sampling was adopted to obtain 5 villages from each zone with the exception of Mwamapuli in which Mwanzugi was the only village to be included in the sample. Random sampling procedure was used to obtain representative households for each village by using household list available at Village Executive Officers' offices. The sample size was expected to be 121 households (Table 2).

**Table 2: Household sampling in the study Area**

Division	Ward	Sampled Village	Number of Households in the village	Number of Sampled Household
Igurubi	Mwamashimba	Mwamashimba	1442	15
	Igurubi	Igurubi	679	6
	Itunduru	Itunduru	784	11
Igunga	Igunga	Igunga	3669	12
		Mwanzugi	1287	11
	Mbutu	Bukama	668	10
	Nyandekwa	Ussongo	370	10
Manonga	Itumba	Lugubu	555	13
	Choma	Choma	1302	9
	Ndembezi	Ndembezi	1281	6
	Nkinga	Nkinga	1341	5
	<b>Total</b>			

However, after sampling only 108 respondents were interviewed. This is due to the fact that Southern zone lacked farmers who use tractors as primary tillage power source in all of the cropping systems. Tractors in that zone are used to transport building materials such as fine and coarse aggregates and stones.

### **3.2.2 Data collection**

#### **3.2.2.1 Primary data**

Data to be used in the study were crop production data for the 2007/08 cropping season. Primary data for the 2007/08 season were collected through formal survey by interviewing heads of 108 sampled households using structured questionnaire. Personal observation was made in the study areas to verify some of the information obtained during the interview.

#### **3.2.2.2 Secondary data**

Secondary data were collected through review of available relevant documents at the district ward and village levels. Important data of the study area collected included demographic data, climatic data, soil data and rain fed crop suitability. Another data collected was on the use of different types of power sources in crop production within the district.

### **3.3 Data Analysis**

Collected data was summarized, coded and edited ready for analysis. Statistical Package for Social Sciences (SPSS) software was used to summarize and analyse data.

#### **3.3.1 Descriptive statistics**

Descriptive qualities of data collected were determined using SPSS software before further analysis.



### **3.3.2 Inferential statistics**

The T- test was used to test the mean differences for different parameters in socio-economic characteristics between animal power and tractor power using households. The same test was used to test for mean differences in productivities between the two groups. This test was adopted because it was designed for small samples and it is useful in situations where independent samples are not of equal sizes. Tractor using households were found to be very few while animal power using households were many within the district. It is expected that labour and land productivity is higher with tractor using households than animal power using households

#### **Test for crop output and productivity.**

To account for differences in crop types, the total crop output per household was expressed as the total sum of gross values from all crops grown and harvested by the household. This was also assumed to be the total gross crop income for the household. The values were computed basing on the average market prices for individual crops for the period of April 2008 when food crops prices are lowest to January 2009 when food crops prices are said to be maximum assuming that there is no storage costs. Value of cotton was calculated by using actual prices offered by seed cotton buyers in that season. The total costs for inputs were evaluated in the similar way by using actual prices paid by individual farmers with the exception of labour input. Labour input regardless of whether hired or family labour was evaluated basing on average hiring rate for performing that particular field operation during the 2007/08 cropping season.

Regression analysis was used to test whether mechanization have effects on crop production income when differences in other inputs are taken into account. A Cobb-

Douglas production function was adopted. General form of the Cobb – Douglas production function is

$$Y = F(X_i) \quad (1)$$

Where; Y is output and  $X_i$  is production factor inputs

The model tested is as shown below:-

$$Y = \alpha X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} X_5^{\beta_5} e^{\eta} \quad (2)$$

Equation 2 was linearized by introducing natural logarithm. Therefore it appears as follows

$$\ln Y = \ln \alpha + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \eta \quad (3)$$

Where; Y= Gross crop revenue (Gross value of crop outputs in Tshs)

$\alpha$  = intercept

$X_1$ = total cultivated arca (ha)

$X_2$ = ploughing and planting labour (hours)

$X_3$ = weeding labour (hours)

$X_4$ = harvesting and threshing labour (hours)

$X_5$ = use of tractor (dummy. 0-1)

$\beta_1 - \beta_5$  = coefficients to be estimated

$\eta$  = random error term.

The Cobb – Douglas production function was adopted since it is expressed by many other researchers that its equations are appropriate for analyses intended for the agricultural activities (Goksel and Altug, 2007). In addition, it is preferred since it provides easy calculation, ability to test production flexibilities statistically and to obtain sufficient number of degrees of freedom even where data is very few (Goksel and Altug, 2007).

It is anticipated that if properly used, tractor power will result to increased total cultivated area. Due to timeliness and better seedbed preparation, it is also anticipated that by employing tractor power, land productivity (production per unit area) will rise. Both increased total cultivated area and increased productivity are expected to cause an increase in total crop output. By increasing output, tractor power use is expected to have a positive impact on total crop income.

It is also expected that tractor use in farm operations reduces labour requirement especially in power intensive activities. Farm operations that demand high labour include ploughing and weeding. Ploughing and planting can be combined and therefore performed concurrently when either of the technology is employed. Although tractor use can reduce ploughing labour, increased cultivated area may result into high labour demand during successive farm operations especially weeding if the operation is not mechanized. Therefore tractor use may be labour shifting rather than labour saving. In this case, significance of tractor use on increased output may happen to be low even if total cultivated area is increased.

## CHAPTER FOUR

### 4.0 RESULTS AND DISCUSSION

#### 4.1 Agricultural Mechanization Status in Tabora Region

##### 4.1.1 Farm power sources in Tabora region

Reviewed secondary materials have shown that, farm power sources within Tabora region are human power, animal power and mechanical power. Mechanical power sources were found to be tractors and power tillers. Animal power is mainly from oxen and to a small extent from donkeys. According to the 2002/03 Tanzania Agriculture sample census, Ox ploughing was the main method used for soil preparation which represented 51% of the total cultivated area, followed by hand cultivation(48%) and tractor ploughing accounted for 1%. Igunga district had the largest planted area cultivated with oxen followed by Nzega, Uyui, Sikonge, Urambo and Tabora urban (URT, 2007).These findings are supported by Igunga DALDO data that in 2007/08 cropping season, 70% of total cultivated area was by using AT. It was also reported by Starkey and Mutagubya (1992) that western cotton growing areas in which Tabora region is inclusive accounted for three quarters of Tanzania's oxen. Igunga district lies within this cotton belt where it is estimated that more than 90% of farmers use oxen. Igunga and Nzega districts are main contributors of Tabora's oxen while the contribution from the remaining districts is low. Human power was a dominant power source in weeding, harvesting and threshing. According to the 2002/03 agriculture sample census, proportion of maize harvested by DAP was 0.3% of total cultivated area. Small amounts of oil seeds (groundnuts) were harvested by DAP, the proportion being 0.3%. Most common threshing method was hand which accounted for 99.1%. Engine driven machines cereal threshing accounted for 0.1 to 0.8%. The numbers of oxen, donkeys, tractors and power tillers in Tabora region are shown in Table 3.

As shown in Table 3, there was 1.2% increase in the number of tractors within Tabora region from 170 units in 2003 to 172 in 2008. The number of power tillers increased dramatically by 227% from 11 units in 2003 to 25 in year 2008. However, the current number of tractor in good working condition is 113 while 59 tractors equivalent to 34% of the total number of tractors are grounded. These tractors are substituted by DAP since the number of oxen and donkeys increased by 41% and 167% respectively from the year 2003 to 2008.

**Table 3: Power sources in Tabora region from 2003 to 2008**

Year	2003	2004	2005	2006	2007	2008
Number of tractors	170	172	174	163	177	172
Number of power tillers	11	12	14	17	18	25
Number of Oxen	116 687	117 649	118 447	159 504	157 463	164 219
Number of donkeys	5 408	6 910	8 900	9 587	10 414	14 453

Source: RAS –Tabora

## 4.2 Agricultural Mechanization Status in Igunga District

### 4.2.1 Farm power sources

The study showed that farm power sources are human, animal and mechanical power. Dominant power source was found to be draft animals; mainly oxen. The number of tractors draft animals and power tillers have been changing over time. Table 4 shows a trend of changes in the number of draft animals, tractors and power tillers in Igunga district.

The number of oxen has decreased in 2004/05 due to Contagious Bovine Pleuropneumonia disease (CBPP). Migration to search for pastures was also a reason for declining number of oxen in some of years. Increase in number of donkeys within the district due to their

tolerance to harsh climatic condition and their resistance to diseases. Donkeys also demand less grazing area and less water. Pasture and water are always a great problem in the study area during dry season.

**Table 4: Number of draft animals, tractors and power tillers in Igunga**

Year	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
Tractors	75	74	67	67	53	58
Power tillers	0	0	1	5	7	8
Oxen	46 268	58 700	57 056	57 056	94 034	86 613
Donkeys	2 000	2 117	3 250	4 968	5 230	7 374

Source: DALDO office

During the year 2007/08, twenty eight out of fifty eight tractors were in good working condition. Thirty tractors were in poor working condition, three of them being scraps therefore could not be repaired. Most of tractors are beyond economic useful life. More than 50% of the tractors had 30 years of age or above. In some cases it was impossible to establish the date of manufacture of tractors simply because they had already passed in hands of more than one person. Therefore even the current owner had no reference. The only way of estimating its life is by considering its model since most of the models are no longer manufactured. Nine tractors were found to be bought between 1964 and 1969. There is an argument that high cost and poor supply of spare parts are major reasons of most of tractors being grounded.

#### **4.2.2 Farm power sources ownership and mode of acquisition**

##### **4.2.2.1 Tractor ownership and mode of acquisition**

Tractors under private ownership were found to be 49. By the end of 2008 only one tractor was obtained by loan from AGTF, the rest were bought by using own resources. Igunga

district council owns nine tractors but are under the management of Mwamapuli Irrigated Rice Producers Cooperative Society (MIRPCS). The tractors were acquired through ADB credit in 1991. Three tractors are working while the remaining six are grounded. There was an argument by rice producers that the tractors are not capable of paddling in their rice fields. Tractor hire services are being provided by individuals who own tractors which were bought for the purpose of cultivating their own field. MIRPS also provides tractor hire services to scheme non members but this is very rare. There is no tractor hire centre in the district. Descriptive statistics show that among tractor power users, 28.6% use their own tractor while 71.4% hire tractor services.

#### **4.2.2.2 Draft animals ownership and mode of acquisition**

Draft animals are privately owned by farmers. Sixty nine percent of DAP users own oxen while 31% hire services from their neighbours. Modes of acquisition of draft animals include buying by using own cash, training of animals from own stock, gift from friends and inheritance. Buying by using own resources accounted for 50% of the respondents followed by training from own stock which accounted for 40%. Gift from friends and inheritance altogether accounted for 10%.

#### **4.2.3 Farm power hiring rates and operational costs**

Hiring rates for both tractors and DAP differ depending on the type of crop being cultivated. This is associated with type of soil and soil condition at the time of carrying out that particular field operation. Demand and availability of power source also influence hiring rates.

#### 4.2.3.1 Draft animal power hiring rates

Table 5 shows DAP hiring rates in the 2007/08 cropping season in cotton, maize and paddy production. DAP hiring rates in primary tillage for cotton, maize and sorghum production was found to be the same. DAP hiring rates were highest in paddy production. This is due to inability of tractors to work in muddy conditions. Highest ploughing rates in paddy production were at Mwanzugi irrigation scheme.

**Table 5: DAP hiring rates in 2007/2008 cropping season.**

Crop	Hiring rates (Tshs./ha)		
	Maximum	Minimum	Mean
Cotton	45 000.00	20 000.00	29 732.00
Maize	45 000.00	20 000.00	30 625.00
Paddy	100 000.00	30 000.00	51 660.00

#### 4.2.3.2 Tractor hiring rates

Primary tillage tractor hiring rates in cotton and maize are higher than DAP hiring rates. Contrary to expectations, average DAP hiring rates in paddy primary tillage are greater than tractor power rates. Table 6 shows tractor hiring rates in the 2007/08 cropping season for cotton, maize and paddy primary tillage. Average tractor power hiring rates in cotton and maize were higher than average DAP hiring rates by 49.7% and 64.4% respectively. In contrast, tractor average hiring rate in paddy production was less than DAP hiring rate by 17%.

**Table 6: Tractor hiring rates in 2007/2008 cropping season**

Crop	Hiring rates (Tshs./ha)		
	Maximum	Minimum	Mean
Cotton	62 500	25 000.00	44 531
Maize	62 500	25 000.00	50 357
Paddy	50 000	40 000.00	42 857

Tractor hiring rates in paddy were found to be lower than hiring rates in cotton and maize production. Mwanzugi irrigation scheme was the only location where tractors are employed in paddy production. Hiring rates are predetermined by MIRPCS therefore not liable to change with increased tractor hire demand. Primary tillage for paddy in all other areas of the district is carried out by using oxen.

#### **4.2.3.3 Field operational costs**

Field operational costs under consideration by tractor owners include fuel, lubricants and wages for tractor operator. All these costs are inclusive in hiring rates.

##### **Fuel costs**

Average fuel consumption in primary tillage was found to be 12.5 litres per ha. In 2007/08 cropping season, fuel cost per ha was Tshs 17 500.00 (at Tshs 1 400.00 per litre of diesel fuel).

##### **Cost of lubricants.**

Costs of oil was estimated to be Tshs 20 000.00 per month. There is no routine tractor maintenance as per manufacturer's operator's manual. Engine oil is drained once in a month regardless of the number of running hours. Small amounts of oil are added to top up oil tanks whenever necessary. During peak period, a tractor ploughs in average a total of 480 ha in a month. Therefore oil cost per ha is estimated to be Tshs 417.00. Tractor and plough greasing is carried out daily during ploughing peak period. Estimated costs for greasing is Tshs 2 500.00 per day leading to a cost of Tshs 156.00 per ha. Under normal circumstances where routine maintenance is being carried out; lubricant costs are estimated to be 20% of fuel costs. This is useful when determining tractor hiring rates.

**Wage for tractor operator**

Tractor operators are paid on daily basis depending on the actual area cultivated. Operator wage is usually 10% of the hiring rate. In 2007/08 cropping season, wage for operator ranged from Tshs 2 500.00 to Tshs 6 250.00 per ha.

**Fixed Costs**

Fixed costs that could be included in determining tractor hiring rates are insurance, interest on capital, depreciation and storage costs. All these costs are not taken into consideration. None of tractor owning respondents has insured his tractor. Ignorance of fixed costs especially depreciation causes failure in replacing old tractors.

**Farm machinery transportation cost.**

When the area to be cultivated is too small to justify tractor transportation fuel cost, then a client has to pay that cost.

**4.3 Crops Cultivated****4.3.1 Food crops**

The surveyed areas cultivate maize, sorghum and paddy as food crops. Maize is the first food crop in importance which accounted for 60.5% of the responses followed by paddy which accounted for 25% of the responses. Sorghum accounted for 14.5% of the responses. Table 7 shows the combinations of food crops as cultivated by sampled households. Out of 108 respondents, four respondents do not grow any food crop. These were cotton producers who depend solely on purchasing cereals from their neighbours.

**Table 7: Food crops cultivated by sampled households**

<b>Crop</b>	<b>Number of households</b>	<b>Percent</b>
Maize only	45	41.7
Paddy only	11	10.2
Maize and paddy	24	22.2
Maize and sorghum	21	19.4
Maize, sorghum and paddy	3	2.8
None	4	3.2
<b>Total</b>	<b>108</b>	<b>100.0</b>

Fifty six percent of respondents in Northern agro ecological zone of the district grow maize only as food crop while maize and sorghum are grown by 32%. Other combinations of food crops in the zone and their percentage in brackets are maize, sorghum and paddy (5%); maize and paddy (5%) and paddy only (2%). In the southern agro ecological zone of Igunga district, 47% of respondents grow maize and paddy. Other food crops in the zone and their percentage in brackets include maize only (35%); paddy only (12%) and maize and sorghum (6%). None of respondents grow a combination of maize sorghum and paddy within the southern agro ecological zone. Paddy is dominant food crop at Mwamapuli although it is regarded as a cash crop. Fifty five percent of the respondents cultivate paddy only. A combination of maize and paddy is grown by 45% of the respondents. Paddy is irrigated while maize is grown in upland. Maize grown under irrigation during the dry season is negligible. Other food crops combinations as they appear in Table 7 do not exist in that area.

#### **4.3.2 Cash crops**

Results show that 61.1% of sample households cultivate cash crops while the remaining 38.9 do not grow cash crops. Main cash crop was found to be cotton which accounted for 70% of responses. Other crops included groundnuts (23%) and sunflower (7%). The two

crops are cultivated in small areas and therefore to be regarded as minor crops in the cropping systems. All the crops are monocropped. However in some cases a household may intercrop maize and groundnuts or maize and sunflower. Types of cash crops cultivated and the proportion of households cultivating those crops are presented in Table 8.

**Table 8: Cash crops cultivated by sample households**

<b>Crop</b>	<b>Number of households</b>	<b>Percent</b>
Cotton	45	41.7
Groundnuts	13	12.0
Sunflower	4	3.7
Cotton and groundnuts	4	3.7
None	42	38.9
<b>Total</b>	<b>108</b>	<b>100.0</b>

Cotton is major cash crop in northern agro ecological zone of Igunga district cultivated by 71% of respondents. Other cash crops in this agro ecological zone are groundnuts (8%) and sunflower (3%). Respondents not growing any cash crop in the northern agro ecological zone accounts for 18%.

In the southern agro ecological zone, 32% of the respondents grow groundnuts but in small quantities, 9% of the respondents cultivate sunflower and 6% cultivate cotton. Fifty three percent of respondents do not grow any cash crop. Paddy at Mwamapuli is regarded as a cash crop. Non irrigated cotton was found to be grown by 18% of the respondents. Neither sunflower nor groundnuts is grown by any respondent.

#### 4.4 Cropping systems

A cropping system may be defined as a community of plants which is managed by a farm unit to achieve various human goals (FAO, 1995). Human goals include food, fibre and other raw materials, wealth and satisfaction. Two farms with identical climates and soils may be managed with different aims to achieve different mix of outputs. A cropping system is one of the three subsystems within a broader farming system (FAO, 1995). The results show that in Igunga district, there are a total of 17 different cropping systems. A household can cultivate one up to four crops in separate fields (monocropping of up to four crops). Different crops grown in those cropping systems are shown in Table 7 and 8. However, main cropping systems were found to be maize and cotton, maize and paddy, maize only and maize, sorghum and cotton. Table 9 shows the proportion of cropping systems in sample households.

**Table 9: Igunga district cropping systems**

<b>Cropping system</b>	<b>Households proportion (%)</b>
Maize and cotton	20
Maize and paddy	11
Maize only	11
Maize, sorghum and cotton	10
Other minor cropping systems	48

#### 4.5 Power Sources for Field Operations

##### 4.5.1 Primary tillage power source

Primary tillage was found to be the only field operation which is mechanized by using tractor power. Other power sources for primary tillage are animal power and power tillers. In all types of crops with the exception of paddy, secondary tillage was not applicable. Sampled households were categorized according to primary tillage power sources. Resulted household categories are presented in Table 10.

**Table 10: Household categories by primary tillage power sources**

<b>Household category</b>	<b>Number of households</b>	<b>Percent</b>
Tractor power user	23	21.3
Animal power users	76	70.4
Users of both TP and AP	8	7.4
Power tiller users	1	0.9
<b>Total</b>	<b>108</b>	<b>100.0</b>

Tractor power was considered an appropriate power source in cotton and sorghum production reason being season sensitivity of cotton and drought tolerance of both cotton and sorghum. A producer is sure of harvesting something to cover production costs even if rainfall becomes poor. Tractor as a primary tillage power source was also found at Mwanuzigi irrigation scheme. The scheme grows paddy during rainfall season and sometimes maize and vegetables during dry season. It was evident that household could hire tractor for cotton and sorghum cultivation while the rest of crops in its cropping system remaining to be carried out by using animal power. Cross tabulation results of cropping systems and household category are presented in Table 11.

**Table 11: Cropping systems and their associated primary tillage power sources**

<b>Cropping system</b>	<b>Household category</b>				<b>Total</b>
	<b>Animal power user</b>	<b>Tractor power user</b>	<b>Both DAP and Tractor user</b>	<b>P tiller user</b>	
Maize, cotton	13	7	2	0	22
Maize, paddy	8	1	3	0	12
Maize	8	4	0	0	12
Maize, sorghum, cotton	6	4	1	0	11
Other systems	41	7	2	1	51
<b>Total</b>	<b>76</b>	<b>23</b>	<b>8</b>	<b>1</b>	<b>108</b>

### Reasons for using tractor power

Reasons put forward for using tractor power in primary tillage were timeliness which accounted for 51.1% of the responses followed by better seedbed preparation hence high productivity of land (24.5%), less cost farm operation(8.9), high cost of labour (6.7%), lack of draft animals during peak period (4.4%). Suitability of land for being tractorized accounted for 4.4%.

Reasons put forward against the use of tractor power and their percentage response in brackets were unavailability of custom hire (28.4%), high cost of operation (27.6%), availability of draft animals (20.9%) and high investment requirement (11.2%). In some cases, there were arguments that soils are very light such that do not require high power input and tractor use in such soil encourage soil fertility loss. The two arguments accounted for 11.9%.

### 4.5.2 Secondary tillage power sources in paddy production

Paddling is being carried out by using power tillers, animal power and human power. However, the dominant power source for this field operation is animal power. Table 12 shows the proportion of sampled households by secondary tillage power source.

**Table 12: Paddling power sources**

Power source	Number of households	Proportion (%)
Animal power	25	64.1
Human power	8	20.5
Power tillers	6	15.4
<b>Total</b>	<b>39</b>	<b>100.0</b>

#### 4.5.3 Planting methods and associated power sources

Planting is done by using human power in all types of crops. Planting methods in maize and cotton production were found to be of three types. These include; broadcasting prior to ploughing, sowing behind the plough (seed dropping into the furrow during ploughing by using ox plough) and using hand at recommended crop spacing. Broadcasting prior to primary tillage was the only planting method applicable in sorghum production while paddy is transplanted manually.

Cotton producing households using broadcasting as a planting method accounted for 67% of all cotton producers in the sampled area. Other planting methods were planting behind plough (18% of cotton producing households) and hand hoe at recommended spacing (15%). In maize production, 30% of the households broadcasted seeds prior to ploughing, 59% dropped seeds in furrow behind a plough and 11% planted by using hand hoe at recommended spacing. Reasons for manual planting were lack of knowledge of ox drawn planting equipments due to poor extension services. Respondents were not aware that there are animal drawn implements that could be used to reduce drudgery and labour hours in planting and weeding operations. This was the same problem identified by Oluwatayo *et al.* (2008) in Nigeria that technical innovations are not getting to grass root level and therefore diffusion rate is low. Some of the respondents although were aware, they argued that appropriate implements for the two operations are not available. It is easier to weed manually in farm with plants planted in arrows than in where plants are arranged randomly. This makes DAP user advantageous as compared to tractor users since plants in animal power cultivated area are in rows.

#### **Sowing method by tractor users**

Broadcasting was found to be the most common planting method among tractor using households. Sixty seven percent of cotton producers in this group used broadcasting as planting method while 33% planted cotton at recommended spacing by using hand hoe. Broadcasting sowing method results into plant population which is not optimum. Plant population per unit area may either be lower or higher than recommended. All these have effects on crop yield. Maize broadcasting prior to ploughing was a sowing method employed by 71% of tractor using households while 29% planted at recommended spacing by using hand hoe.

#### **4.6 Social economic Characteristics**

Socioeconomic characteristics for animal traction and tractor power users are presented in Table 13. Some of socio- economic characteristics have influence on the adoption of tractor power use.

##### **4.6.1 Age of household head and household size**

As shown in Table 13, average age for the household head in tractor power using households is slightly higher than the age of animal power using household but it is not statistically significant at 5% significance level. Animal power using household size was found to be slightly greater than the size of their counterpart but not statistically significant at 5% level of significance. However, the size of household may have an influence on the adoption of tractorization since the smaller the size of the household the less is household labour.

#### **4.6.2 Education**

Table 13 shows that, proportion of illiterates in animal power using households is more than twice that of tractor power using household. This was found to be statistically significant at 5% level of significance indicating an influence on the use of tractor power. High proportion of illiterates within the household is most likely to influence the rate of adoption of new technology. Less educated farmers are likely to be slow adopters and also can not seek for information on new innovations. Proportion of household members with primary education was found to be almost the same in the two groups; proportion being slightly higher in animal power using households. As shown in Table 13, proportion of household members with secondary education or above was found to be higher in tractor using households than their counterpart and statistically significant at 10% level of significance. These were found to be having other sources of income earned as salary from their employers. Extra income earned from other sources is adds to their financial capital that enables them to hire tractor services.

#### **4.6.3 Household composition**

Proportion of children under 16 years of age was slightly higher in animal power using households (41.7%) than their counterpart (40%). Proportion of household members aged between 16 and 55 years was 52% in animal power using households while it was 49.6% in tractor power using households. However the differences in the two cases are not statistically significant at 5% level of significance. Tractor using households composed of 14.3% members aged above 55 years while it was 6.2% in their counterparts. This was also not statistically significant. Although not statistically significant, it is an indication that DAP using households consist of energetic members capable of carrying out manual works. Sample household active members in agriculture were 54.8% of the household size

in animal power using households while in tractor using households it was 49%. This causes a demand for additional power in order to meet labour demand during peak periods.

#### **4.6.4 Land ownership**

Tractor using households own more land averaging to 20.9ha as compared to 8.81ha of their counterpart. The difference is significant at 5% level of significance. The size of land owned determine power requirement in crop production. Big land ownership necessitates employment of tractor.

#### **4.6.5 Herd size**

As it is shown in Table 13, average number of cattle per household in sampled area was higher in tractor power using households than their counterpart. Cattle keeping are traditionally an indicator of wealth among the district rural population. Livestock are generally regarded as banks for rural households. The difference in numbers of livestock kept by the two groups is an indication of higher incomes earned by tractor using households. The same applied to sheep and goats and donkeys. Average number of oxen was slightly higher in animal power using households than their counterparts but not statistically significant. This conforms to the fact that there is a negative relationship between tractorization and draught animal density. AT is the frequently used means of transportation of crops in all household categories. In general, 75% of the sample households use AT in produce transportation. Households using tractor power in transportation accounts for 12% of total sample households. Other means of transportation include carrying by head, use of bicycles and hiring of vehicles. All these carry 13%. Therefore keeping of draft animals can not be completely separated from tractor use in sampled area. Even in tractor using households, 52% use AT as the sole means of transportation.

**Table 13: Socio-economic characteristics of sample households**

<b>Characteristic</b>	<b>APHHs<sup>1</sup></b>	<b>THHs<sup>1</sup></b>
Sample size	76	23
Household size	7.97 (0.46)	7.78 (1.14)
Age of the household head	48.11 (1.45)	49.87 (2.97)
<b>Literacy (%):</b>		
Illiterates	7.90 (1.50)	3.00 (1.80)**
Primary education	88.40 (2.00)	85.00 (4.30)
Secondary education and above	3.90 (1.50)	13.00 (5.50)*
<b>Household composition (%):</b>		
Children under 16 years of age	41.70 (2.70)	40.40 (4.50)
Members aged between 16 and 55years	52.10 (2.00)	49.50 (5.00)
Members over 55 years of age	6.20 (1.00)	14.30 (5.90)
Active workers in agriculture (%)	55.00 (2.70)	49.00 (4.40)
Land owned (ha)	8.81 (1.76)	20.90 (4.80)**
<b>Herd size:</b>		
Cattle	15.13 (2.47)	18.43 (6.40)
Seep and goats	9.03 (1.41)	10.30 (4.24)
Oxen	4.72 (0.54)	4.35 (0.14)
Donkeys	0.26 (0.14)	0.39 (0.29)

<sup>1</sup> APHHs = Animal power using households; <sup>1</sup> THHs = Tractor power using households  
 \*Significant mean difference between APHHs and THHs at  $p = < 0.1$ . \*\* Significant mean difference between APHHs and THHs at  $p = < 0.05$  Standard error in parentheses

#### 4.7 Tractorization effects

##### 4.7.1 Land allocation

Tractor users own bigger land than their DAP users counterparts. The proportions of land allocated to cotton and sorghum production by tractor power using households are greater than the proportions of land allocated to the same crops by animal power using households.

**Table 14: Land allocation to crops by household category**

	Animal power users	Tractor power users
Sample size	76	23
Total area(ha)	8.81	20.9
<b>Allocation (%)</b>		
Cotton	20.3	31.9
Maize	53.7	44.3
Sorghum	4.1	11.6
Paddy	20.6	12.2

#### 4.7.2 Resource use by power source in sample households

There was a significant difference in both total cultivated area per household and total cultivated area per active worker between the two groups. Total cultivated area was higher in tractor using households than animal power users. The differences were significant at  $p < 0.05$ . Total labour use per unit area was higher in animal power using households than their counterparts but not statistically significant.

**Table 15: Resource use by power source in sample households**

Resource type	APHHs <sup>1</sup>	THHs <sup>1</sup>
Sample size	76	23
Land(ha)		
Total land owned	8.82( 1.77)	20.91 (4.84)
<b>Total cultivated area per:</b>		
Household	3.43 (0.32)	8.45 (2.11)**
Active worker	0.97 (0.09)	2.55 (0.54)**
Labour (h ha <sup>-1</sup> )		
Total labour	464.72 (86.30)	312.43 (40.43)

<sup>1</sup>APHHs = Animal power using households; <sup>1</sup> THHs = Tractor power using households  
 \*\*Significant mean difference between APHHs and THHs at  $p = < 0.05$  Standard error in parentheses

#### **4.8 Tractorization effects on Individual Crops**

Due to a great diversity of cropping systems, a comparative economic analysis was carried out separately in two main crops; cotton and maize. Crop management practices on both maize and cotton were the same among the two groups. There was no household that used fertilizers in producing the two crops. Types of seeds used in maize production were local varieties which accounted for 78% of the total planted area. Hybrid seeds accounted for 11% of total planted area and composite seeds accounted for 11%. Cotton was produced by using improved seeds. Primary tillage power sources were found to be the only difference and therefore a basis for comparison.

Tractor power was found to be used in paddy production at Mwanzugi irrigation scheme where other inputs such as herbicides and fertilizers are applied. This could not be compared with other traditional paddy producers. Secondary tillage power sources were also of various types.

##### **4.8.1 Effects of tractorization on cotton production**

Out of 108 sample households, 46 households cultivated cotton during the 2007/2008 cropping season. Primary tillage power sources were mechanical (tractor) power and animal traction. The two groups were compared to determine the effects of power sources on cotton production. Results are presented in Table 16.

Cotton cultivated area by tractor using households was greater than cultivated area by DAP using household but the difference was only statistically significant at 10% level of significance. Total labour use in person hours per hectare was higher in tractor using households than animal power users by 9%. Labour use in weeding contributed more on this difference.

**Table 16: Resource use in cotton production**

Type of resource	APHHs <sup>1</sup>	THHs <sup>1</sup>
Sample size	28	18
Total land owned	13.96(4.51)	22.59(5.39)
Cotton cultivated area	2.56(0.36)	4.49(0.91)*
Labour use(hrs ha <sup>-1</sup> )		
Total labour	382.20(25.30)	417.57(78.69)
Ploughing and planting	42.41(6.00)	33.30(19.07)
Weeding	148.66(13.45)	228.94(61.18)
Harvesting	188.21(19.35)	152.61(10.54)

<sup>1</sup>APHHs = Animal power using households; <sup>1</sup> THHs = Tractor power using households  
 \*Significant mean difference between APHHs and THHs at  $p < 0.1$  Standard error in parentheses

Most of tractor users planted by broadcasting therefore plants were randomly arranged in farms making weeding cumbersome. Cotton weeding is done by using human power and it requires high labour input since it is not mechanized. Expanding cultivated area resulted to increased labour demand in subsequent field operations.

### **Resource productivity in cotton production**

As it is seen in Table 17, cotton production per unit area, cotton net income per unit area and cotton net income per hour of labour were found to be numerically higher in tractor using households as compared to their counterparts. However their differences were not statistically significant. Cotton yield by THHs exceeded cotton yield in APHHs by 12%. This confirms timeliness in cotton production when tractorization is employed. Like wise, per hectare cotton net income was higher in THH than their counterparts by 18%. Cotton net income per hour of labour was also higher in THHs than APHHs by 21%. The table below shows productivities of resources in cotton production among the two groups

**Table 17: Resource productivity in cotton production**

Productivity	APHHs <sup>1</sup>	THHs <sup>1</sup>
Sample size	28	18
Cotton yield (kg ha <sup>-1</sup> )	844 (68.39)	947 (94.42)
Cotton gross income(Tshs)	1 034 089 (183 003.00)	1 827 500 (435 019.05)
Cotton net income (Tshs)	561 309 (131 090.29)	1 053 061 (324 268.49)
<b>Cotton net income per:</b>		
Hectare (Tshs ha <sup>-1</sup> )	199 330 (32 675.27)	234 976 (40 396.25)
Hour of labour(Tshs hr <sup>-1</sup> )	611 (114.12)	738 (147.19)

#### 4.8.2 Effects of tractorization on maize production

Maize is the staple food in Igunga district. Survey data show that 85% of sample household grow maize as one of the component in their cropping system. Resource uses in maize production by maize primary tillage power source are presented in Table 18. There was a significant difference in total land owned among maize producers of the two groups. Tractor users own more land than animal power users. Maize cultivated area per household was more in tractor users than animal power using households by 49%.

**Table 18: Resource use in maize production**

Type of resource	APHHs <sup>1</sup>	THHs <sup>1</sup>
Sample size	71	21
Total land owned	9.80 (1.88)	21.39(5.28)**
Maize cultivated area	2.18 (0.27)	3.26(0.69)
<b>Labour use(hrs ha<sup>-1</sup>)</b>		
Total labour	288.24 (18.42)	249.52(37.11)
Ploughing and planting	33.65 (1.93)	32.00(10.99)
Weeding	121.06 (10.09)	108.57(22.82)
Harvesting and threshing	146.47 (11.71)	123.71(18.11)

<sup>1</sup>APHHs = Animal power using households; <sup>1</sup> THHs = Tractor power using households  
 \*\*Significant mean difference between APHHs and THHs at  $p = < 0.05$  Standard error in parentheses

However, the difference is not statistically significant. Total labour requirement per unit area in maize production was higher in animal power using households than tractor using households but statistically not significant. Ploughing and planting labour use was almost the same contrary to expectation.

### Resource productivity in maize production

Maize productivity on different resources during the 2007/08 cropping season is presented in Table 19. Maize production per unit area in animal power using households was slightly above production per unit area in tractor power using households by only 7% but not statistically significant. These findings are similar to findings by Panin (1993) in Botswana. Maize net income per household was higher in THHs than their counterparts by 25%. This difference is due to total cultivated area. These results confirm the statement by Clarke (2000) that where land is not a limiting factor, benefits of mechanization can be realized by just increasing cultivated area. Maize net income per hectare was slightly higher in APHs than THHs but maize income per hour of labour was higher in THHs than APHs by 27%. Production per unit area in both maize and cotton is still below maximum attainable yields in Tanzania since agronomic practices in crop production are not adhered to.

**Table 19: Resource productivity in maize production**

Productivity	APHs <sup>1</sup>	THHs <sup>1</sup>
Sample size	71	21
Maize yield (kg ha <sup>-1</sup> )	1 496 (116.33)	1 403 (195.88)
Maize gross income (Tshs)	698 805 (98 642.62)	997 575 (243 920.22)
Maize net income (Tshs)	471 413 (81 783.53)	588 022 (20 254.65)
<b>Maize net income per:</b>		
Hectare (Tshs ha <sup>-1</sup> )	235 841 (25 676.58)	214 124 (51 538.25)
Hour of labour(Tshs hr <sup>-1</sup> )	902 (1077.70)	1 144 (1 382.79)

### **4.8.3 Crop output and productivity**

To account for differences in crop types, the total crop output per household was expressed as total sum of values of all crops harvested in 2007/08 cropping season. Production costs were also evaluated in the same way.

#### **4.8.3.1 Crop output per unit area**

Total crop output per hectare expressed in Tshs in DAP using households was observed to be 342 750.60 while it was Tshs 333 584.80 in tractor using households. DAP using households earned 3% higher than their counterparts but the mean difference was not statistically significant. The same was observed in net return per hectare. In both groups, net returns were positive although they differed in magnitude. This differs from the findings by Panin (1993) in Botswana where a considerable number of tractor power using households had negative net income. DAP using households received Tshs 212 913.60 as compared to tractor power using households which had a net return of Tshs 187 999.40 per hectare. Net return per unit area in DAP using households was observed to be 13% higher than their counterparts but the mean difference was not statistically significant. Observed lower net return per unit area in tractor using household is a result of increased production costs when tractor is employed in ploughing.

#### **4.8.3.2 Labour productivity**

Returns per hour of labour were higher in tractor using households than DAP using households by 49.8%. Labour productivity was Tshs 878 and 586 for tractor power using households and DAP users respectively but mean difference not statistically significant.

#### 4.8.4 Tractorization effects on crop income

Regression analysis used to test whether mechanization had effects on crop production income gave the results as they are shown in Table 20. Fertilizer was not taken into consideration since it was not used. There was argument that soil is naturally fertile. Some of respondents argued that they could not afford to buy fertilizers.

**Table 20: Cobb – Douglas production function estimates**

Explanatory variables	Estimated coefficients
Intercepts	10.80
Cultivated area (ha)	0.63**
Ploughing and planting labour (hrs)	-0.03
Weeding labour (hrs)	-0.63
Harvesting and threshing labour (hrs)	0.44
Tractor use( dummy, 0-1)	0.29*
<i>R</i> – square	0.83
<i>F</i> – value	82.24**
Sample size	86

\*\* =  $p < 0.01$  level of significance

\* =  $p < 0.1$  level of significance

The coefficient for land was large and strong (significant at  $p < 0.01$ ). This is an indication that crop revenue could increase by increasing farm size. This shows that crop revenue could be increased by just increasing cultivated area. With the Cobb – Douglas production function, the same results was observed in maize production in Nigeria by Oluwatayo *et al.* (2008) that cultivated area was a significant determinant of maize output. Tractor use dummy variable coefficient was also positive and significant at 10% level indicating a positive impact on crop production income. According to Oluwatayo *et al.* (2008) tractor use as a dummy variable was expected to hasten field operations. This also followed expectation by having a positive relationship with maize output. Its coefficient was not very much significant since tractor is used only in ploughing while other operations were

carried out by using human power. These findings refute findings by Panin (1993). He found that tractor use had negative impact on crop output. The estimated coefficient of determination ( $R^2$ ) was high. This was 0.83 and the fitted model was significant at  $p < 0.01$ .

## CHAPTER FIVE

### 5.0 CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Conclusions

##### **Draught power use in Igunga district**

From the findings, it is concluded that threat of animal diseases is among the setbacks of utilization of animal traction in Igunga district. Other constraints include lack of pasture and drinking water for draught animals during dry periods. This is due to the fact that Igunga district is a semi arid area experiencing unreliable rainfalls. Type of soil and topography of Igunga district allow draught animals to be used in all field operations including planting and weeding. Due to inadequate extension services and training, draught animals, are being under utilized. Their use is limited to primary tillage and transportation. Draught animals are also employed in paddling rice fields. However, implements used in this field operation are improper leading to poor efficiency. Therefore the objectives of agricultural mechanization as regards to animal traction are not fulfilled.

Financial capital requirement for acquisition of draught animals is lower as compared to the costs of acquiring mechanical power sources (Tractors and power tillers. It is therefore easy for a small scale farmer to purchase oxen. Incomes obtained through crop sales are used to purchase livestock. Apart from being a prestige to own cattle, livestock are considered by small scale farmers as a bank. Part of kept livestock is trained as oxen. This also cases acquisition of draught animals by small scale farmers. It has been observed that as an ox grows, it appreciates and therefore fetch higher prices in markets. High population density of draft animals is the limitation of adoption of tractorization in Igunga district.

The use of draught power in maize and cotton production reduces weeding labour costs in terms of hours. This is due to distribution of plants in the field. Farmers using draught animal power in ploughing have a tendency of dropping seeds in the furrow behind the plough as a result; plants appear to be in rows therefore easing manual weeding. Planting method applied by tractor power users is broadcasting prior planting. Plants are unevenly spaced therefore making manual weeding a cumbersome operation leading to higher labour requirements in terms of hours.

#### **Tractor power use in Igunga district**

Tractors are used in ploughing of maize, cotton and sorghum farms. They are also used in ploughing paddy fields at Mwazungi Irrigation scheme. Tractors are widely used in cotton and sorghum production. Cotton is both sensitive to timeliness and drought tolerant while sorghum is drought resistant. At least a farmer can breakeven even in bad years. The limitations of adopting tractorization in the district include:-

- Availability of draught animals;
- Unreliable rainfalls. Small scale farmers are not ready to invest highly to avoid risks of crop failures;
- Lack of financial capital. It has been observed that most of farmers hiring tractors have got occupations other than agriculture. The extra income earned is invested in agriculture;
- Labour density. There is no labour shortage during pick period. Cost of tractorization is higher than employing manual labour;
- High cost and poor supply of tractor spare parts.

### **Tractor and DAP hiring rates**

Hiring rates of farm power sources are influenced by type of crop, type of soil and the supply and demand of available power sources. In most cases tractor hiring rates are higher than DAP hiring rates. Hiring rates are higher at Mwanzugi Irrigation scheme. Due to lack of appropriate tractors, hiring rate of draught animals in the scheme goes up to TShs 100,000.00 per hectare. This rate is too high to justify the cost of using tractor suited to that type of soil and condition.

Tractor hiring rates are not predetermined by considering tractor ownership costs. The priority is given to tractor running costs such as fuel and wages of operators. Fixed costs such as depreciation, interest on capital, shelter and insurance are ignored hence failure to replace tractors that are getting old. Fifty percent of tractors are beyond economic life. They are more than 30 years since their manufacture.

### **Impact of tractorization in Igunga**

Analysis of farmers' data from Igunga district suggests that tractorization has impact on total cultivated area and crop output. However, tractorization has no impact on yields (production per unit area) in maize but it has a positive impact on cotton yields (cotton production per unit area). Tractorization also has impact on labour utilization as it increases production per hour of labour compared to draft animal power. Although not statistically significant, tractorization has a positive impact on crop income. The results show that tractorization lead to increased crop income.

Both drought and tractor power sources are under utilized since they are only utilized in primary tillage. Other operations are being carried out manually. Tractor power and DAP

could be more profitable if they were used in other field operations such as planting, weeding harvesting and threshing.

Production per unit area in all crops is still below the possible maximum attainable levels; because agronomic practices are not adhered to by both DAP using households and tractor users. This causes mechanization to be less profitable.

## 5.2 Recommendations

- It is recommended that extension services should be strengthened so as to create awareness to farmers on the availability of animal drawn implements that can be used in planting and weeding in order to reduce labour requirements in these two operations. Emphasis should be on effective utilization of available power sources. In order to exhaust the potential of cultivated land, agronomic practices should be adhered to;
- Tractor owners should be trained on how to come up with a tractor hiring rate that can justify tractor ownership costs such that tractor ownership is sustainable. Tractor owners should also be trained on the importance of routine tractor maintenance;
- It is also recommended that before a new tractor is purchased, a buyer must consult expert for tractor and implement selection. This is aiming at avoiding having machinery that is not right to type of soil and field operation.
- Private sector should be sensitized in order to supply tractor spare parts at affordable prices.
- Owners with very old tractors should be encouraged to replace them bearing in mind that running costs for very old farm machinery are too high.
- Igunga District Council must create awareness of availability of Agricultural Input Trust Fund. Rural farmers should be encouraged to get loans from this fund. There is still a need to exploit the remaining arable land that remains uncultivated.

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## APPENDICES

### Appendix 1: Farmers Questionnaire

#### QUESTIONNAIRE FOR FARMERS (BOTH TRACTOR USING HOUSEHOLDS AND ANIMAL TRACTION USERS)

Name of Interviewer..... Questionnaire No .....

District.....Ward.....Village.....

Date.....

Name ..... Male [ ] Female [ ]

Household Head: 1. Yes [ ] 2. No [ ]

Agro ecological zone:

1. Northern [ ]

2. Southern [ ]

3. Mwapuli [ ]

#### SECTION A: SOCIAL CHARACTERISTICS OF THE HOUSEHOLD

1. Age of household head.....years
2. Education: 1. No Education [ ] 2. Adult [ ] 3. Primary [ ] 4. Secondary [ ] 5. other levels (Specify).....
3. Occupation.....
  1. Agriculture [ ] 2. Civil Servant [ ] 3. Trade [ ] 4. Other (Specify)
4. Marital Status:
  1. Married [ ] 2. Single [ ] 3. Widower [ ] 4. Widow [ ]
5. Size of household
  - i. Number of male adults in the household: .....

ii. Number of female adults in the household: .....

6. Age structure of the household members by education

Age group	Primary	Secondary and above	Illiterates	Total
< 16 years				
16 – 55 years				
> 55 years				
<b>Total</b>				
Active members in Agriculture				

7. Main economic activities

i. ....

ii. ....

8. Main sources of income

i. ....

ii. ....

**SECTION B: LAND OWNERSHIP AND CROPS GROWN**

9. What is the total area of land do you own? .....ha

10. What are the main crops do you cultivate?

Food Crops

a. ....

b. ....

Cash Crops

a. ....

a. ....

11. What are crops grown under irrigation

a. ....

b. ....

12. Please provide information on production and value of main crops during the past two seasons.

(i) 2006/2007 Season

Crop	Area(ha)	Total production		
		Quantity(t)	Average price(TSh/t)	Value(TSh)

(ii) 2007/2008 Season

Crop	Area(ha)	Total production		
		Quantity(t)	Average price(TSh/t)	Value(TSh)

### SECTION C: POWER SOURCES AND COST OF FIELD OPERATIONS

13. Household Category

1: Animal traction user [ ] 2: Tractor power user [ ] 3: Power tiller [ ]

14. What are your power sources for field operations?

1: Human power, 2: Animal power, 3: Tractor power, 4: Power tiller

Operation	Crop	Power source	Ownership (hired/own)	Cost/acre or /bag
1 <sup>o</sup> Tillage*	1.			
	2.			
	3.			
2 <sup>o</sup> Tillage**	1.			
	2.			
	3.			
Planting	1.			
	2.			
	3.			
Weeding	1.			
	2.			
	3.			
Fertilizer application	1.			
	2.			
	3.			

\* Primary tillage

\*\* Secondary tillage

15. What are the field capacities in performing each operation according to the power source you are using?

Power Source	Field Operation	Crops					
		Cotton	Rice	Maize	Sorghum	G/ nuts	Others
Human	1 <sup>o</sup> Tillage(Mhrs*/ Acre)						
	2 <sup>o</sup> Tillage(Mhrs*/ Acre)						
	Planting(Mhrs*/ Acre)						
	Weeding(Mhrs*/ Acre)						
	Insecticides application						
	Fertilizer application						
	Harvesting(Mhrs*/ Acre)						
	Threshing(Mhrs*/ Acre)						
Animal	1 <sup>o</sup> Tillage(Hours/ Acre)						
	2 <sup>o</sup> Tillage(Hours/ Acre)						
	Planting(Hours/ Acre)						
	Weeding(Hours/ Acre)						
	Fertilizer application						
	Harvesting (Hrs/ Acre)						
	Threshing						
Power tiller	1 <sup>o</sup> Tillage(Hours/ Acre)						
	2 <sup>o</sup> Tillage(Hours/ Acre)						
	Planting(Hours/ Acre)						
	Weeding(Hours/ Acre)						
	Fertilizer application						
	Harvesting (Hrs/ Acre)						
	Threshing(Hours/ Acre)						
Tractor	1 <sup>o</sup> Tillage(Hours/ Acre)						
	2 <sup>o</sup> Tillage(Hours/ Acre)						
	Planting(Hours/ Acre)						
	Weeding(Hours/ Acre)						
	Fertilizer application						
	Harvesting (Hrs/ Acre)						
	Threshing						

\* Mhrs = Man-hours

16. What are the reasons for using tractor power? Choose from the given possible reasons

- i. Suitable plot/land condition [ ]
- ii. Shortage of labour during peak periods [ ]
- iii. High labour cost [ ]
- iv. Timeliness of operation [ ]
- v. Higher productivity of land [ ]
- vi. Less costly farm operation [ ]
- vii. Others (Specify).....

17. What are the reasons for not using tractor power? Choose from the given possible reasons

- i. Abundant/cheap labour supply [ ]
- ii. Availability of draught animals [ ]
- iii. Small farm plots [ ]
- iv. Fragmented holdings [ ]
- v. High investment requirement [ ]
- vi. Lack of knowledge (awareness) [ ]
- vii. High cost of operation [ ]
- viii. Lack of skill [ ]
- ix. Limitation due to physical condition of land [ ]
- x. Unavailability of machines for purchase [ ]
- xi. Unavailability of custom hire [ ]
- xii. Government policy [ ]
- xiii. Others.....

#### **SECTION D: LIVESTOCK, DRAUGHT ANIMALS, FARM**

##### **IMPLEMENTS/EQUIPMENTS OWNERSHIP AND THEIR MODE OF ACQUISITION**

18. Livestock owned

- i. Number of cattle .....
- ii. Number of small stocks (sheep and goats in total).....

19. Draft Animals

- i. Number of oxen.....
- ii. Number of donkeys.....

20 What is the mode of acquisition of your draught animals?

1. Bought on own cash
2. Bought on credit
3. From own stock
4. Others (Specify.....)

21. A. Please indicate the number of owned ox drawn implements, their average years in use and mode of acquisition. Put a tick on appropriate mode in the table provided

Implement/Equipment	No. owned	Average years in use	Mode of acquisition		
			On Cash	Credit	Others
Plough					
Harrow					
Cultivator					
Planter					
Ridger					
Cart					

B. Please indicate the number of owned tractor drawn implements, their average years in use and mode of acquisition. Put a tick on appropriate mode in the table provided

Implement/Equipment	No. owned	Average years in use	Mode of acquisition		
			On Cash	Credit	Others
Plough					
Harrow					
Cultivator					
Planter					
Ridger					
Trailer					
Sprayer					

#### SECTION E: INPUTS USE AND THEIR COSTS IN 2007/08 SEASON

##### Fertilizer use

22. Did you apply fertilizer/manure in your farm? Yes  No
23. What type of fertilizer did you use?
- i. Farm yard manure

- ii. Artificial fertilizers [ ]
- iii. Both farm yard manure and artificial fertilizers [ ]
- iv. Others (Specify).....

24. Quantity of fertilizers used and their total cost in each of cultivated crops during the previous cropping season.

Crop	Quantity applied (t)	Rate (Tsh/t)	Total cost (TSh)
Maize			
Rice			
Sorghum			
Cotton			
Ground nuts			

**Seeds**

25. Type of seeds used and their associated costs

Please put a tick on appropriate alternatives provided on the right of each crop in the table below.

Crop	Type of seeds and cost			
	Local	Improved	Hybrid	Total cost
Maize				
Rice				
Sorghum				
Cotton				
Ground nuts				

**Other inputs**

26. Put a tick in the brackets against input used

- i. Insecticides [ ]
- ii. Herbicides [ ]
- iii. Both i and ii [ ]

27. In which crops did you apply pesticides?

- i. ....
- ii. ....

28. What was the cost for insecticides in each crop?

Crop	Type of insecticide	Quantity applied	Total cost
Maize			
Rice			
Sorghum			
Cotton			
Ground nuts			

#### SECTION F: EXTENSION SERVICES

29. Access of extension services

1 = Easily accessed [ ]

2 = Not accessed [ ]

#### ADDITIONAL QUESTIONS FOR TRACTOR OWNERS

#### SECTION F: INFORMATION ABOUT TRACTOR OWNED

30. Total number of tractors owned.....

Tractor type..... Model.....Year of

Purchase.....Purchase price.....Power rating .....

31. Mode of acquisition

1= Purchased on own [ ] 2= Purchased on credit [ ]

#### SECTION G: INFORMATION ABOUT TRACTOR USAGE

32. Annual use of tractor

i. Own farm..... (ha)

ii. Hired.....(ha)

iii. Annual use in agriculture.....days

iv. Annual use in non agriculture activities.....days

33. What are the hiring rates for the field operations?

Na	Field Operation	Rate (Tsh./Acre)
1	Primary tillage	
2	Secondary Tillage	
3	Weeding	
4	Fertilizer application	
5	Harvesting	
6	Transportation (Tsh/ton/Km)	

34. What did you consider in computing those rates? /How did you arrive at those rates? .....

35. What are fuel consumption rates in performing the following farm operations?

Please fill the table below

Na	Field Operation	Rate (Litres./Acre)
1	Primary tillage	
2	Secondary Tillage	
3	Weeding	
4	Fertilizer application	
5	Harvesting	
6	Transportation (Tsh/ton/Km)	

36. What is the wage for tractor operator?.....

37. What are the annual fixed costs as regards to the following items?

- i. Insurance.....
- ii. Interest.....
- iii. Depreciation.....
- iv. Storage.....

38. What are average annual repair and maintenance costs of your tractor and its implements?.....

39. What are the advantages of owning tractor?

- i. ....
- ii. ....

40. What are the problems associated with owning a tractor?

- i. ....
- ii. ....

41. In your opinion, what should be done to solve those problems?

.....

42. In your opinion, what should be done to promote tractorization in the district?

**THANKS FOR YOUR COOPERATION**

## Appendix 2: Socio-economic characteristics of households

### Sex of household head

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	97	89.8	89.8	89.8
	Female	11	10.2	10.2	100.0
	Total	108	100.0	100.0	

### Education of house hold head

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No education	20	18.5	18.5	18.5
	Primary	73	67.6	67.6	86.1
	Secondary	15	13.9	13.9	100.0
	Total	108	100.0	100.0	

### Occupation of household head

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agriculture	95	88.0	88.0	88.0
	Civil servant	7	6.5	6.5	94.4
	Trading	5	4.6	4.6	99.1
	Other	1	.9	.9	100.0
	Total	108	100.0	100.0	

## Respondent cropping system

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Maize only	12	11.1	11.1	11.1
	Maize,cotton and groundnuts	3	2.8	2.8	13.9
	Maize and groundnuts	6	5.6	5.6	19.4
	Maize and Sunflower	4	3.7	3.7	23.1
	Paddy and cotton	1	.9	.9	24.1
	Maize paddy and sunflower	1	.9	.9	25.0
	Maize paddy and groundnuts	6	5.6	5.6	30.6
	Maize,sorghum and paddy	2	1.9	1.9	32.4
	Maize,sorghum, cotton and groundnuts	1	.9	.9	33.3
	Maize and sorghum	8	7.4	7.4	40.7
	Paddy only	10	9.3	9.3	50.0
	Maize and Paddy	12	11.1	11.1	61.1
	Cotton only	4	3.7	3.7	64.8
	Maize and cotton	22	20.4	20.4	85.2
	Paddy,maize and cotton	4	3.7	3.7	88.9
	Maize,sorghum and cotton	11	10.2	10.2	99.1
	Maize, paddy,sorghum and cotton	1	.9	.9	100.0
	Total	108	100.0	100.0	

## Respondent cropping system \* Household category Crosstabulation

Count

		Household category				Total
		Animal power user	Tractor power user	Both ATand Tractor power using hh	Power tiller user	
Respondent cropping system	Maize only	8	4	0	0	12
	Maize,cotton and groundnuts	3	0	0	0	3
	Maize and grounnuts	6	0	0	0	6
	Maize and Sunflower	3	1	0	0	4
	Paddy and cotton	0	0	1	0	1
	Maize paddy and sunflower	1	0	0	0	1
	Maize paddy and groundnuts	6	0	0	0	6
	Maize,sorghum and paddy	2	0	0	0	2
	Maize,sorghum,c otton and groundnuts	0	1	0	0	1
	Maize and sorghum	7	1	0	0	8
	Paddy only	7	2	0	1	10
	Maize and Paddy	8	1	3	0	12
	Cotton only	4	0	0	0	4
	Maize and cotton	13	7	2	0	22
	Paddy,maize and cotton	2	1	1	0	4
	Maize,sorghum and cotton	6	4	1	0	11
	Maize, paddy,sorghum and cotton	0	1	0	0	1
Total		76	23	8	1	108

### Appendix 3: Multiple Response results

Group \$ECONAC Economic activities of respondent  
(Value tabulated = 1)

Dichotomy label	Name	Count	Pct of Responses	Pct of Cases
Agriculture (Crop production)	AGRIC	108	61.0	100.0
Livestock keeping	LIVEST	51	28.8	47.2
Trading	TRADING	11	6.2	10.2
Civil services	CIVILSE	7	4.0	6.5
		-----	-----	-----
	Total responses	177	100.0	163.9

0 missing cases; 108 valid cases

—

Group \$INCSOUR Main sources of income  
(Value tabulated = 1)

Dichotomy label	Name	Count	Pct of Responses	Pct of Cases
Sales of agricultural produce (Crops)	SALESCRO	103	60.6	98.1
Custom hiring of tractor	CUSTOMT	1	.6	1.0
Custom hiring of power tiller	CUSTOMP	3	1.8	2.9
Custom hiring of animal power	CUSTOMAT	5	2.9	4.8
Sales of livestock products	SALESLIV	37	21.8	35.2
Salary/Wages from my employer	WAGES	9	5.3	8.6
Retail shop	RETAIL	10	5.9	9.5
Transportation of passengers	TRANSP	2	1.2	1.9
		-----	-----	-----
	Total responses	170	100.0	161.9

2 missing cases; 105 valid cases

Group \$REASUSE Reasons for using tractor power  
(Value tabulated = 1)

Dichotomy label	Name	Count	Pct of Responses	Pct of Cases
Better seedbed preparation	REASUSE1	3	6.7	11.1
Timeliness of operation	REASUSE3	23	51.1	85.2
High productivity of land	REASUSE5	8	17.8	29.6
Less cost farm operation	REASUSE6	4	8.9	14.8
Lack of Daught animals during peak perio	REASUSE7	2	4.4	7.4
High labour cost	REASUSE8	3	6.7	11.1
Suitable plot/land condition	REASUSE9	2	4.4	7.4
		-----	-----	-----
	Total responses	45	100.0	166.7

81 missing cases; 27 valid cases\_

Group \$REASNOT Reasons for not using tractor power  
(Value tabulated = 1)

Dichotomy label	Name	Count	Pct of Responses	Pct. of Cases
Availability of draught animals	REASNOT1	28	20.9	35.9
Lack of enough capital	REASNOT2	1	.7	1.3
Unavailability of custom hire	REASNOT3	38	28.4	48.7
High investment requirement	REASNOT4	15	11.2	19.2
Risky to use expensive machinery in crop	REASNOT5	1	.7	1.3
High cost of operation	REASNOT6	37	27.6	47.4
Unavailability of machinery to purchase	REASNOT7	3	2.2	3.8
Lack of skills	REASNOT8	8	6.0	10.3
Cheap labour supply	REASNOT9	2	1.5	2.6
Light soils; donot require much power	REASNOT10	1	.7	1.3
		-----	-----	-----
	Total responses	134	100.0	171.8

30 missing cases; 78 valid cases

## Appendix 4: Regression analysis results

### Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.911(a)	.830	.820	.50672

a Predictors: (Constant), Tractor use dummy variable, LN for harvesting and threshing labour, LN for ploughing and planting labour in maize cotton and sorghum, Naturallog for maize, cotton and sorghum cultivated area, LN for weeding in cott,maize and sorg

### ANOVA(b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	105.588	5	21.118	82.246	.000(a)
	Residual	21.568	84	.257		
	Total	127.156	89			

a Predictors: (Constant), Tractor use dummy variable, LN for harvesting and threshing labour, LN for ploughing and plantin labour in maize cotton and sorghum, Naturallog for maize, cotton and sorghum cultivated area, LN for weeding in cott,maize and sorg

b Dependent Variable: LN for maize,cotton income

### Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	10.803	.458		23.590	.000
	Naturallog for maize, cotton and sorghum cultivated area	.634	.115	.514	5.518	.000
	LN for ploughing and plantin labour in maize cotton and sorghum	-.030	.065	-.029	-.461	.646
	LN for weeding in cott,maize and sorg	-.063	.106	-.060	-.595	.553
	LN for harvesting and threshing labour	.443	.071	.494	6.257	.000
	Tractor use dummy variable	.292	.175	.098	1.663	.100

a Dependent Variable: LN for maize,cotton and sorghum income