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Agricultural Mechanization for Sustainable Agriculture and Food Security in Zimbabwe: A Case of Bindura District in Mashonaland Central Province.

BY

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DECLARATION

I, the undersigned, hereby certify that, unless specifically indicated to the contrary in the text, this research project/ write up is a result of my original work and that I have not previously submitted it at any university for the purpose of acquiring a degree from any other recognized institution of higher learning.

Dated:

.....
F. F. T. Chisango

DEDICATION

My departed, cherished parents, the late Mrs and Mr Chisango and The Government of The Republic of Zimbabwe.

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I wish to acknowledge contributions by several academics and friends I share with, the ownership of this work. First and foremost, I wish to express my sincere gratitude for the continual guidance, support and motivation of my supervisor Dr A Obi for the hard work he did in guiding and encouraging me throughout the entire period of my research. I am also thankful to Prof Bester who offered me guidance on how to conduct a constructive research work. Without the above named academics this thesis could not have materialized the way it did.

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ABSTRACT

A cardinal development goal of the Zimbabwean government is agricultural mechanization through the acquisition and use of tractors by arable crop farmers in communal and resettlement state land. This research project therefore aimed at investigating the impact of mechanization on agricultural productivity focusing on farmers in Bindura district of Zimbabwe who benefitted under the ongoing farm mechanization program. The existing land policy and the issue of technical efficiency in agricultural productivity are assumed to be the drivers of the program. It is likely that these key issues will constitute an important consideration in determining the sustainability of the mechanization policy. A multistage sampling technique was used to randomly select 90 farmers in the study area. The Cobb Douglas approach and Logistic regression were used to analyze data obtained from the respondents. Results revealed that tractor use was positively influenced by household size, access to extension services and crop output equivalent. Education, land area cultivated, stoniness negatively influenced the probability of adoption of mechanized farming. Furthermore, the technical efficiency estimate of adopter and non-adopters of mechanized farming showed no difference in their level of technical efficiency in agricultural productivity that was 64 percent on average. The level of observed inefficiency was increased by slope, stoniness and household size while age reduced technical inefficiency. It is recommended that government should consolidate the present gains arising from extension services. Also, environmental factors such as slope (topography) and stoniness, which constituted major disincentives in communal areas, could be overcome if government and farmers can identify and open up new areas of farmland for occupation by farmers.

KEY WORDS

Technical Constraints, Market Access, Agricultural Development, Induced Innovation Model, the Stochastic Frontier model, The Productive Efficiency and Mandate of Extension

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ACRONYMS

ACP	African Caribbean and Pacific countries
AgriBank	Agricultural Financing Bank
AIDS	Acquired Immune Deficiency Syndrome
AREX	Agricultural Research and Extension services
CASP	Comprehensive Agricultural Support Programme
DOA	Department of Agriculture
FAO	Food Agricultural Organization
FDT	Farmer Development Trust
FSP	Farmer Support Programme
FTLRP	Fast Track Land Reform Program
GDP	Gross Domestic Product
HIV	Human Immune Virus
IMF	International Monetary Fund
IAC	Inter Academy Council.
ICT	Information and Communication Technology
IFPRI	International Food Policy Research Institute
ISRDS	Integrated Sustainable Rural Development Strategy
LRAD	Land Redistribution for Agricultural Development
MDGs	Millennium Development Goals
NAFU	National Farmers Union
NAMC	National Agricultural Marketing Council
NEPAD	New Partnership for Africa's Development
OECD	Organisation for Economic Co-operation and Development
RDP	Reconstruction and Development Programme
S&T	Science and Technology

SPSS	Statistical Package for Social Scientists
SSA	Sub-Saharan Africa
STW	Shallow tube well
UNDP	United Nations Development Programme.
UN	United Nations

CHAPTER 1: INTRODUCTION

1.1 Background and Context of the study

Farm production and transportation of agricultural produce to markets require power. There are three main options: human power, animal power and the use of motors (Bordet and Rabezandrina, 1996). The choice depends on local circumstances. Human, animal and machine power can complement one another in the same household, farm or village. Agricultural mechanization implies the use of various power sources and improved farm tools and equipment, with a view of reducing the drudgery of farm work (Binswanger, 1986). The end objective of farm mechanization is to enhance the overall productivity and production with the least cost of production. Agricultural machinery has grown progressively larger. It is now feasible for one man to plough in excess of 10 hectares in a day with suitable machinery (Chatizwa and Khumalo, 1996).

The contribution of agricultural mechanization has been well recognized in enhancing production together with irrigation, biological and chemical inputs, high yielding seed varieties, fertilizers, pesticides and mechanical energy. Indian Green Revolution is regarded as one of the greatest achievements of the 20th century (Madras, 1975). Mechanization has been adopted in India on a large scale benefiting small, medium and large sized farms. Effects of mechanization such as its impact on human labor employment in a labor abundant economy have always evoked sharp responses from the policy makers (Jafry, 2000). Several studies have been conducted on the impact of agricultural mechanization on production, productivity, cropping intensity, human labor employment as well as income generation for sustainable livelihoods of households (Sidhu & Grewal, 1991).

New sources of mechanical power were first used on power-intensive operations such as processing, pumping, transport, and tillage, while mechanization of controlled-intensive operations came much later and usually in association with high wages (Rijk, 1999). Finally, an investigation of the process of agricultural machinery innovation shows that the public sector and corporate research has contributed little to machinery invention. Machinery innovation has generally been the domain of small manufacturers, with corporations becoming significant in later stages of product development and engineering optimization (Malik, 1998).

Over the past half a century developing regions, with the exception of Sub-Saharan Africa, have seen labor-saving technologies being adopted at unprecedented levels (Jafry, 2000). Intensification of production systems created power bottlenecks around land preparation, harvesting and threshing operations. Alleviating the power bottlenecks with the adoption of mechanical technologies helped enhance agricultural productivity and lowered the unit cost of crop production even in the densely populated countries such as China (Bergmann, 1978). Economic growth and the commercialization of agricultural systems are leading to further mechanization of agricultural systems in Asia and Latin America (Rijk, 1999). Sub-Saharan Africa continues to have very low levels of mechanization and available data indicate declining rather than increasing levels of adoption, even among the countries that were the early trendsetters, such as Kenya and Zimbabwe (Binswanger, 1978).

Different researchers have concluded that farm mechanization has managed to achieve enhancement of the production and productivity of different crops due to timeliness of operations, better quality of operations and precision in the application of the inputs. Madras (1975) found that the productivity increase on tractor owning and hiring farms ranged between 4.1 and 54.8 per cent. The per cent increase was comparatively low on custom hiring farms as compared to tractor-owning farms due to higher level of inputs and better control on timeliness of operations. These productivity increases were attributed to higher doses of fertilizer, irrigation and mechanization (Bina, 1983). Several studies have indicated that there was significant increase in cropping intensity due to the use of tractors and irrigation as a consequence of mechanization. The increase in cropping intensity has been reported to be 165, 156 and 149 per cent respectively for tractor-owning, tractor using and bullock operated farms respectively (NCAER, 1980). Similar results have been reported in other studies which concluded that as a consequence of mechanization, cropping intensity increased significantly. Furthermore, irrigation and mechanical power helped the farmers in raising the cropping intensity of their farms (Patil & Sirohi, 1987). Singh (2001) concluded that cropping intensity was mainly dependent on annual water availability and nature of the farm power available.

Regarding the effect of agricultural mechanization on human labor employment it has been shown that agricultural mechanization led to overall increase in the employment of human labor (Chatizwa and Khumalo, 1996). The reduction in aggregate labor used on tractor operated farms was quite nominal (1.3 to 12%) compared to bullock operated farms (Sidhu & Grewal, 1991). The increase in employment of casual male labor was reported to be up to 38.55% and the mechanized small farms used 3.7 more labour NCAER, (1973).

Ahmedabad (1975) in studies conducted at Delhi School of Economics in India argues that mechanization does not lead to decrease in human labor employment. He therefore concluded that with mechanization, the demand for hired labor increased while participation of family labor in crop production declined. Carney (1998) also indicated that net human labor displacement in agricultural operations was non-significant and it was more than compensated by increased demand for human labor due to multiple cropping, greater intensity of cultivation and higher yields. Furthermore the demand for non-farm labour for manufacturing, servicing, distribution, repair and maintenance as well as other complementary jobs substantially increased due to mechanization.

Farm mechanization greatly helped the farming community in the overall economic upliftment. Tractor owners and users derived higher per hectare gross income compared to traditional subsistence farms (NCAER, 1980). The gross income per hectare was reported to be about 63% higher on tractor owning farms compared to the traditional farms. The average net return from a tractor owning farm on per hectare basis was reported to be 152% that of a non tractor owning farm (Chopra, 1974).

To sum up, agricultural mechanization studies have shown that farm mechanization led to increase in input use due to higher average cropping intensity, larger area and increased productivity of farm labor (Gopinath, 1975). Furthermore, farm mechanization increased agricultural productivity and profitability on account of timeliness of operations, better quality of work and more efficient utilization of crop inputs. Undoubtedly, farm mechanization displaced animal power from 60 to 100% but resulted in less time for farm work (Chatizwa and Jones, 1997). Also mechanization led to increase in the human labor employment for the on-farm and off-farm activities as a result of manufacture, repair, servicing and sales of tractors and improved farm equipment (Farrington, 1985).

1.2 Problem Context

The intention of Zimbabwe in initiating the mechanization program was to support the land reform program and improve food productivity among the newly resettled farmers (Chatizwa and Khumalo, 1996). Under the mechanization programme, rehabilitation of irrigation infrastructure was also an important component. It has been established that land resettlement and the provision of inputs to farmers without the support of a strong mechanization programme would impact negatively on crop productivity and food security. As farmers got land and inputs, the missing link has therefore been mechanization, which has rendered land preparation ineffective

across the country (Chisoko and June, 2007). The failure to prepare land on time because of the shortage of tractors and machinery resulted in dwindling crop yields and consequently falling agricultural productivity. For years after the Fast Track Land Reform Programme (FTLRP), the absence of an effective mechanization programme however has been the major inhibiting factor to increasing efficiency in crop productivity at individual farmer level. In 2000 the government of Zimbabwe launched the Fast Track Land Reform Programme (FTLRP) as part of its ongoing land reform and resettlement programme, which seeks to address the racially skewed land distribution pattern inherited at the country's independence in 1980. This research uses data on beneficiaries of the two programmes and a control group of communal farmers to investigate the impact of mechanization on the agricultural productivity of the beneficiaries. The data reveals significant differences between the two groups; beneficiaries and non beneficiaries, not only in household production levels and income generation but also in input usage. The results suggest that mechanization and FTLRP beneficiaries are more productive than communal farmers. The source of this productivity differential is found to lie on differences in machinery and input usage (Made, 2006).

Before the launch of the mechanization program the District Development Fund (DDF) a department mandated by the government to control funds donated by Non Governmental Organizations (NGOs), for fostering rural development, provided tillage operations to A1 and communal farmers (Singh and Singh, 1999). In most areas of Zimbabwe animal draft power is used in preparation of 70% to 90% of the cropped area, tractor power for between 2% to 15%, and hand tillage ranges from 5% to 15% (Chisoko, 2006). Traditional Conservation Farming where farmers practice zero tillage is used in some areas. In areas where rains normally start late, the urgency by most farmers to plant with the first rains results in more farmers practicing minimum tillage as draft power is in short supply (FAO, 2002).

Overall, it can be concluded that Agricultural mechanization remains a questionable input in African agriculture particularly that of small holder farmers (Aggarwal, 1983). Conflicting policy prescriptions have been given for the African agricultural mechanization problem by the academic, donor community and national governments but with little or no impact on productivity (Nandal and Rai, 1986). The failure of many Government sponsored tractorization projects initiated in the late 1950's and early 1960's has greatly contributed to a decline in agricultural productivity as witnessed in Zimbabwe (Salokhe, 2003).

According to FAO (2000) the general trend is that agriculture in most African countries is still undertaken by using the centuries old hand tool technology with entire reliance on human muscle power in about 60-90% of the cultivated lands. Whereas, everybody agrees that this has to change, the main question has been on how the change should come about. Should African countries go through the evolutionary path from hand tool through animal powered to mechanically powered agricultural mechanization as it has happened in the developed countries, or should they aim at skipping the intermediate stage of animal powered mechanization (Binswanger, 1978). The experience of seven African countries (Botswana, Ghana, Kenya, Nigeria, Swaziland, Tanzania and Zambia) in agricultural mechanization policy evidenced that these have failed to yield positive results (FAO, 2000).

1.3 Research Objective

The overall objective of the study is to determine the impact of Agricultural mechanization on agricultural productivity and food security following the Fast Track Land Reform in Zimbabwe. It focuses on the relationship between agricultural production and the use of machinery by farmers in Zimbabwe. More specifically the study aimed to;

- Identify the impact of mechanization on productivity of two principal crops namely maize and soya beans.
- Analyze efficiencies in farming systems adopted by farmers as a result of machinery and equipment availability.
- Identify the level of adoption of the innovation and its implementation by farmers in boosting crop and land productivity focusing on the post Fast Track Land Reform era and recommend other programs that are compatible with strategies for sustainable agricultural development.

The table that follows depicts a summarized relationship that exists between research objectives, research questions and hypothesis.

Table 1. 1: Summary of research objectives, questions and hypothesis

	Research Objectives	Research Questions	Research Hypotheses
1	To determine the impact of mechanization on crop productivity focusing on soya beans and maize.	What is the impact of mechanisation on crop productivity among A1, A2 and communal farmers?	Mechanisation has increased crop productivity of the A1, A2 and communal farmers
2	To analyse efficiencies in farming systems adopted as a result of machinery availability.	Did mechanization effect changes in efficiencies of new farming systems adopted?	Mechanization impacted a change on production efficiencies of maize and soya for food security in the area.
3	Identifies the level of adoption of the innovation and its implementation by farmers in boosting land productivity focusing on the post Fast Track Land Reform era	To what extent has mechanization been adopted and implemented to boost land productivity in the area?	Mechanization has been adopted and implemented fully to boost land productivity in the district.

Source; researcher (2009)

1.4 Justification of the study

Agriculture plays an important role in the economy of Zimbabwe. It provides income to about 75 percent of the population and contributes over 40 percent, national earnings from exports (Rukuni and Eicher 2006). The smallholder farming sector comprises at least 70 percent of the national population (Mudhara et al 1995). In Zimbabwe the importance of livestock kept by the smallholder community is now being recognized by the government as a source of draft power for increased cultivated area for crop production. Like in any other developing nation animals provide approximately 80 percent of the draught power used for farming in Zimbabwe (Pearson, 1993). This research therefore examines the linkage between the use of machinery and ox drawn implements' on agricultural productivity among farmers. The need to investigate arises from the standpoint that other societies have managed to boost production without embarking on similar programmes such as land redistribution and machinery distribution under mechanization. The research findings however justify whether other nations should adopt similar programmes.

According to Zimbabwe's Farmers' Magazine (2004), it was noted that while various initiatives to buy agricultural machinery for farmers led by individuals and organizations have been publicized, not many farmers have benefited from such initiatives. In the meantime farmers are failing to get meaningful tillage services from the District Development Fund (DDF) and the Agricultural Development Authority (ARDA) due to other reasons other than their ability or willingness to pay for the services (Zimbabwe' Ministry of Agriculture, 2000). Farmers therefore, request the government to revisit the provision of tillage facilities to through government institutions. Farmers cited that the biggest proportion of the DDF fleet of tractors and machinery were grounded. There was need therefore to increase the fleet to enable farmers to get meaningful services from the institution (United Nations Development Programme, 2006).

Zimbabwe's agriculture is dualistic, comprises large and small scale farmers. Realization of high yields used to be a common feature as the former white farmers had sophisticated production systems (Tekere and Hurungo, 2003). Land redistribution witnessed a declining trend in the agricultural production levels. Bindura District has a comparative advantage in agriculture

production, as it is endowed with resources that can support agriculture, but yields are also declining. Being in natural farming regions 2a and 2b, it is characterized by a reliable rainfall pattern in normal seasons. The soils are fertile and support a diversified system of agriculture. Water for irrigation can be drawn from reliable sources ranging from perennial rivers, dams and underground sources (Sithole, 1996). It is therefore important that if the potential of the area is to be realized government has to adopt mechanization programme to replace machinery which had fallen prey to vandalism by either the former occupiers or the newly resettled farmers.

This research is designed to share its findings with all stakeholders such as policy makers, government institutions, the private sector, farmers and finally make recommendations relevant to sustainable agricultural development and food security in the country. Understanding the nature of the constraints faced by resettled farmers in Bindura District and how they affect land and crop productivity is viewed as a crucial component. It is expected that the research will provide a platform for policy makers to come up with policies essential in uplifting the living standards of smallholder farmers.

1.5 Delimitations of the project

This section focuses on limitations of the study. The study only seeks to identify the impact of mechanization on agricultural production focusing on the smallholder farmers in Bindura district not the whole of Mashonaland Central province. It only takes into account particular farming areas in the district where the programme was implemented.

1.6 Definition of terms

Key terms are defined in this section.

Agricultural mechanisation: Agricultural mechanization involves the use of tools, implements and machines to improve the efficiency of human time and labour on agricultural activities (FAO, 1997). Narasimha (2003) argues that the most appropriate machinery and power source for any operation depends on the work to be done and the relative desirability, affordability, availability and technical efficiency of the option. He added that a hand hoe may be the best tool for intensive vegetable production. However, if much work needs to be done, human power alone is generally slow.

Agricultural Mechanization embraces the use of tools, implements and machines for agricultural land development, crop production, harvesting, and preparation for storage, storage and on-farm processing. It includes three main power sources: human, animal, and mechanical. The manufacturing, distribution, repair, maintenance, management and utilization of agricultural tools, implements and machines are also components of mechanization (Starkey, 1998).

Hand tool technology: Is the simplest and most basic level of agricultural mechanization which involves the use of tools and simple implements, using human muscle as the main power source (Binswanger, 1978).

Draught animal technology: Refers to implements and machines utilizing animal muscle as the main power source.

Mechanical power technology: Is the highest technology level in agricultural mechanization. It embraces all agricultural machinery which obtains its main power from other sources other than muscular power. "Appropriateness" can only be determined after carefully considering the technical, economic and social characteristics of each situation (Buckett, 1988).

Productivity: Louw and Mostert (1990) relates to the notion of how far input- output ratios and input – input ratios deviate from the theoretical optimum conditions which stipulate that marginal value product (MVP) must equal marginal cost (MC) to all resources ($MVP = MC$). Productivity is usually measured by any of the three following techniques depending on the purpose and type of data (Louw and Mostert, 1990). Input to output relationship, monetary ratios and value judgments concerning productivity changes.

Sustainable agriculture: Sustainability concerns whether a given level of productivity can be maintained over time. Sustainability of agricultural management systems and their capacity to continue producing on a long term basis is a problem when human activities cause ecological changes that undermine agro ecosystem functions. Agriculture might be seen as a ‘stretching’ of nature, and so involves risks of soil degradation. Sustainable agriculture is the ability of a farm to produce food indefinitely, without causing severe or irreversible damage to the ecosystem (FAO, 2000). Two key issues are biophysical (the long-term effects of various practices on soil properties and processes essential for crop productivity) and socio-economic (the long-term ability of farmers to obtain inputs and manage resources (Rukuni, 2004). Sustainable agriculture is designed to increase production, protect natural resources and the environment (Hawkins, 1988).

Agricultural Development: Is the development of the agricultural sector of the economy to improve local food supply and livelihoods of the people. Its mandate is to combat hunger and rural poverty in developing countries through agricultural projects that mainly attempt to improve productivity. These programmes introduce new strategies and expand existing farming techniques.

Food security: Food security refers to access by all people at all times to enough food for an active, healthy life (World Bank, 2006). Food insecurity is therefore described as a condition in which people lack basic food intake to provide them with the energy and nutrients for productive lives. Households that are susceptible are mostly female and child headed.

1.7 Outline of Dissertation

The dissertation is divided into five chapters. Chapter one provided an overview of the study, highlighting the background and problem context, objectives and justification of the study. Delimitations and definitions of key terms were also outlined. Chapter 2 reviews the relevant literature on mechanization, its impact on agricultural productivity and production efficiencies. Mechanization strategies, government policies and contributions of other stakeholders are also outlined. Reference is made to case studies where such programmes were a success. In Chapter 3 methodologies and analytical models used are reviewed. The reviewed literature in Chapter 2 would provide a guide to data collection methods and analytical tools used. Chapter 4 presents the findings with regards to the impact of mechanization on productivity and production efficiencies based on the Cobb Douglas Model and the Logistic Regression. The summary, conclusions and recommendations of the dissertation are outlined in Chapter 5.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In this chapter the relevant literature on the mechanization program and agricultural performance in Zimbabwe is reviewed. Aspects of importance include its implementation, adoption by targeted beneficiaries and its impact on agricultural productivity and production efficiencies. Mechanization strategies, government policies and contributions of other stakeholders are also discussed. The pros and cons of the programme as well as barriers associated with the implementation of the mechanization program are also mentioned. Some reference is also made to cases where the program scored success in agricultural productivity, in the Soviet Union during the green revolution the yields from mechanized agriculture were 12.8% higher than those from the conventional farming (Richards, 1985). The reviewed literature is intended to guide data collection, analysis, discussions and recommendations to be made.

2.2 General Overview of the Agricultural Mechanization Program

Farm mechanization is more often associated with tractorisation, but in actual fact it is a broad area that involves far much more than just tractors. According to (Agripedia, 2000) farm mechanization involves the use of machines to till the soil and to harvest crops, resulting in a dramatic increase in farm yields and a reduction in the farmers' workload. Human and animal power - where farmers perform planting and harvesting by hand - is substituted by machinery to revive the agricultural sector. In theory, smallholder productivity can be increased through the implementation of farm mechanization (Richards, 1985). Whilst this would be expected to demand additional tools and higher costs, there is an economic argument that mechanization increases agricultural production. However, social and cultural factors are as influential as economic factors and few imposed mechanization programmes in developing countries have had successful outcomes (Rijk, 1999). Agricultural mechanization has the principal aim of increasing land productivity by increasing labour productivity and decreasing other production costs. According to Ferguson V (1992) productivity in America increased greatly after the introduction of mechanization and even created the need for newer machines. The research therefore tries to establish the authenticity of this economic phenomenon.

Farmers have always been fully aware of the immense benefits that could accrue from the use of machinery in agricultural production but the huge cost involved has been the major drawback in acquiring equipment (Lal, 1995). It is for this reason that the Central Bank of Zimbabwe implemented farm mechanization programme. Other stakeholders supported fully as they believed in the programme's medium to long-term favorable impact on agricultural productivity and inflation reduction (Gono, 2006). The experiences of countries such as China and South Korea bear testimony to the huge benefits that can be reaped from farm mechanization (Viegas, 1991). Results of studies conducted at China Agricultural University demonstrated that there was an increase in the yields of rice from two machinery cultivated sampled plots as 8.9% and 6.8% increases were recorded respectively.

Narasimha (2003) suggests that, the most appropriate machinery and power source for any operation depends on the work to be done and the relative desirability, affordability, availability and technical efficiency of the options. If much work needs to be done, human power alone is generally slow and tedious. Mechanization, using animal or motor power, can significantly increase the productivity of human labour and improve the quality of life for the farmers (Humphreys, et al, 1996). Mechanization embraces the use of tools, implements and machines for agricultural land development, crop production, harvesting, and on-farm processing for value addition on agricultural produce (Starkey, 1998). It includes three main power sources: human, animal, and mechanical. The manufacturing, distribution, repair, maintenance, management and utilization of agricultural tools, implements and machines are also important aspects of mechanization (Richards, 1985).

The level, appropriate choice and subsequent proper use of mechanized inputs in agriculture have direct effects on achievable levels of agricultural production, the profitability of farming and the environment (Ruthenberg, 1985). Generally, in situations where agricultural land is not limiting like in Zimbabwe, the application of advanced tools and machines alone does not lead to increased yields (Moyo, 2003). High productivity is only achievable when other inputs are made available on the right time. The full benefits of mechanization are achieved through the use of many advanced crop husbandry inputs such as improved seed, fertilizer, and pesticides (Timmer, 1991). In situations where land is not a constraint, increased farm power can lead to direct increases in production by simply increasing the land area or animal numbers that one man can handle (FAO, 2002). In the past, misconceptions and inappropriate selection of certain mechanization inputs (mainly tractors and heavy machinery) have, in many parts of the world, led to heavy financial losses through lower agricultural production and environmental degradation (FAO, 2004).

In the past agricultural mechanization in developing countries has been much criticized because it has failed to be effective, and was blamed for exacerbating rural unemployment and causing other adverse social effects (Rijk, 1999). This was largely the result from experiences during the 1960s until the early 1980s when large quantities of tractors were supplied to developing countries either as donations, or on very advantageous loan terms. In particular projects which were designed to provide tractor services through government agencies have had a miserable record (Malik, 1998). These projects proved not to be sustainable because of the intrinsic inefficiencies of government-run programmes. An overvalued foreign exchange rate and low real interest rates made agricultural machinery artificially cheap compared to labor and draft animals (Ruthenberg, 1985).

Mechanization has often become a burden to national budgets and the farming community rather than being a productive input (Moyo, 2003). This has especially been the case in centrally planned economies, where mechanization was heavily subsidized through the provision of government planned and operated machinery services (Miller et al., 1994). Similar models of government supported mechanization have been tried in many developing countries and have in every case failed (FAO, 2000). The development of "appropriate" tools and equipment has also been a favourite subject for development strategies (Moyo, 2003). However, the major weakness of the projects was that they took place in isolation of research departments and other stakeholders (FAO, 1999). Like in Zimbabwe, the mechanization programme was the mandate of the central bank, which is a state institution. Further examples of misapplied mechanization programmes can be found in many technical co-operation projects, which were mostly planned and implemented in an uncoordinated way (Squires, 1991). It is unfortunate that few mechanization projects have been successful (Moyo, 2003).

These experiences often combined with a very narrow perception and lack of knowledge about mechanization, namely the one sided promotion of tractors and other capital-intensive mechanical power technology, has caused the aid community to largely turn its back on mechanization (Widdowson, 1987). At the same time there are many examples where mechanization has been very successful, contributing to increased food production, productivity and advancement of rural economies. Examples being, privately owned mechanization in South Asia, single-axle tractors in Thailand, and various forms of farm mechanization in many parts of China (Scherr and Yadav, 1995).

It has been established that appropriate choice and proper use of mechanized inputs in agriculture have a significant effect on agricultural production and productivity, the profitability of farming, and on the environment (Barrow, 1995). In most cases, the mere application of advanced tools, draft animals or machines does not by itself lead to increased yields, but is usually applied to reduce cost of production

and to counteract labour shortfalls (Jafry, 2000). However, the benefits achievable by using advanced and improved inputs such as irrigation, better seed, fertilizer and pesticides cannot be fully realized without an increased application of farm mechanization (Richards, 1985). In situations where land is not a constraint and expansion of cultivated area is feasible, increases in farm power input have led to direct increase in production by simply increasing the land area or the number of animals that one person can handle (Chatizwa and Jones, 1997).

According to Rijk (1999), there are nine stages to the agricultural mechanization process, as shown in the Table below. Based on previous experience, most smallholders in India, Latin America and sub-Saharan Africa are operating in the first three stages. Clearly, moving from one stage to the next requires more than engineering inputs, but equally, if the engineering is flawed, progress will not be made. In the earlier stages, the mechanization inputs might appear relatively straightforward but applying mechanization solutions in societies with limited assets, strong traditions and limited infrastructure is a big challenge. Hence research and development are still needed to convert potential mechanization solutions to practical realities.

Rijk (1999) says there are nine stages of the agricultural mechanization process, as shown in the Table below

Table 2.1: The nine stages of agricultural mechanization

Stages	Brief description
Hand tools	Simple devices (originally sticks and stones) used to increase labour productivity.
Draught animal power	Animal muscle power is substituted for and complements human muscle power
Stationary power substitution	Engine power is substituted for human and animal power in stationary operations
Motive power substitution	Engine power is substituted for human and animal power in field operations. It is particularly beneficial for power-intensive operations such as ploughing.
Human control substitution	The equipment control functions are allocated to machinery elements (dependent on complexity)
Adaptation of cropping practices	Machines are becoming dominant and cropping practices may change according to the characteristics of the machine, rather than machines facilitating traditional practices
Farming system adaptation	Farming methods as well as cropping practices are modified to achieve the economies of scale needed to justify investment in machinery
Bio-adaptation	Engineering improvements near their limit so characteristics of crops and animals offer better opportunities to raise productivity
Automation of agricultural Production	Minimal human intervention: information from sensors used to initiate and control events and processes

Source: Rijk (1999)

According to Barrow (1995) four factors influence the implementation of mechanization programmes in developing nation, these are listed below.

- The process of mechanization is driven by changes in relative prices and particular cost of labor versus cost of capital.
- The reasons for mechanization are economic. The driving force behind mechanization is the farmer's effort to increase or maintain net income.
- Mechanization is demand-driven: ultimately it is the farmer who will decide what machine to buy, from whom to buy, and how to use it. Experience has shown that mechanization must be left to the private sector as much as possible.
- Government should not actively get involved in the manufacture, importation, distribution, and repair of agricultural machinery and its operation, but provide the incentives for private sector response; this is not generally the scenario in developing nations.

2.3 Zimbabwe's Agriculture and the Mechanization Program

Zimbabwe's economy is 75 percent agricultural with three quarters of industry agriculturally driven (Nebakwe, 2002). It is the leading economic sector and an engine for economic growth as it contributes between 15-20% of the gross domestic product (GDP), 40-45% of the total exports and about 60% of the value of raw materials to the manufacturing sector, and supports the livelihoods of about 70% of the economically active population engaged in agricultural production (Mazuru, 2005). Made (2000) argues that poverty in Zimbabwe cannot be solved by equitable land distribution alone, but needs to be supported by sound economic policies such as the mechanization program. Above all, to make land reform succeed the mechanization program has to be supported by marketing, supply and credit facilities. Land redistribution and mechanization programs, as means of alleviating poverty have to be viewed as long term oriented and require great commitment and hard work of the farmers and other stakeholders (Mazuru, 2005).

Zimbabwe therefore through its central bank, the Reserve Bank of Zimbabwe (RBZ) took into cognizance the high cost of acquiring machinery on individual farmer basis. It therefore took it upon itself as a mandate to provide machinery to farmers under a special input scheme called Agricultural Special Program Fund (ASPF) (Gono, 2007). The vision was that land alone without mechanization and financial support was not going to realize the ultimate goals of the Land Reform Programme; which are food security, export growth, employment creation, and empowerment of the people (Mugabe, 2007). With

mechanization, farmers could increase productivity through intensification, increase farm household welfare and create employment opportunities. The programme, bank-rolled by the central bank has benefited farmers in both the commercial and communal sectors (Made, 2004). In launching the program the mandate of the RBZ was basically to support the productive sectors and consolidate the Land Reform Programme.

The implementation of the program was to be done in five years, and its focus was on equipping farmers with mechanized capabilities across the entire cropping cycles covering tillage, planting, fertilizer and chemical application, crop tendering as well as harvesting and right up to transportation of agricultural produce to the market (Chisoko, 2004). In Zimbabwe Phase 1 of the program saw the acquisition of a total of 925 tractors, 35 combine harvesters and 586 disk ploughs, 463 disc harrows, 78 vicon fertilizer spreaders, 241 boom sprayers and 71 planters. The equipment was distributed to various sectors of the farming community (Made, 2006).

2.4 The Role and Place of Mechanization

Hardly any agricultural activity is undertaken without equipment systems or facilities supported by engineering technology. The ARC-Institute for Agricultural Engineering is therefore involved in research, development and implementation of engineering technology, including the evaluation and testing of equipment and systems specifically for southern African conditions, as well as the transfer of technology (Institute of Agricultural Engineering, 1995). Despite its high cost mechanization is an input like any other and is one of a mix of management tools that maximizes production and profit (Brown and Nooter, 1992). Therefore in a free market situation it is inappropriate for governments to formulate mechanization policies without consulting other stakeholders as cited by FAO (1998).

Almost by definition, traditional farmers tend to make minimal use of farm machinery, and when they do, it is usually on a hired basis. In most African countries mechanization tends to be concentrated among large-scale commercial farms (Made, 2007). Reliance on hand tools is still the norm among smallholders throughout Africa, and the use of draught animals is generally low compared with other developing regions, particularly South Asia (FAO 2000).

Despite generally increasing commercial energy use for agriculture, the number of tractors in use in Mali, Tanzania, and Zimbabwe has grown only slightly since 1970 (Jafry, 2000). Mechanization, on an aggregate level, would not appear to be a factor in the significant gains in smallholder maize yields as

witnessed in Tanzania and Zimbabwe in the 1980s, (Oxfarm 2001). Its performance is based on the support of other inputs such as seed, fertilizer and capital for fuel and general maintenance.

2.5 Mechanization as a Productivity Enhancing Technology.

Farm Power or machinery is an essential farm input. In Zimbabwe mechanization as an agricultural input proved that its operational costs exceeds the cost of other agricultural inputs (Mawanda, 2008). In many developing countries, agricultural production and food security are adversely affected because of insufficient use of farm power, low labor productivity and or labor scarcity. The need to improve agricultural labor productivity is therefore increasingly being recognized (Hassan, 2008). Hence the utilization of pump sets for irrigation and the need for machinery has risen.

The term mechanization is unfortunately often very narrowly perceived while its real purpose, namely, enhancing productivity of land and labor is often not well understood (Abasioudiong, 2008). According to Njie (2008) rather than calling it agricultural mechanization, it would be appropriate to use the term Farm Power or Labor Productivity Enhancing Technology, to recognize not only the importance of manual labor and hand tools, draft animals, and mechanical power, but also other issues related to labor scarcity.

Lal (1995) cited that finding solutions to environmental problems in agriculture requires improved agricultural tools and machinery, for example for soil tillage and pesticide application. Similarly, machines are required to assist with post-harvest loss reduction and on-farm processing. Thus it is now recognized that agricultural mechanization is crucial in the fight against hunger and poverty, and at the same time to address environmental and health concerns (Richards, 1985).

According to Viegas (1991) three principal purposes of mechanization are summarized as increase in labor productivity; i.e. the introduction of machinery to substitute for labor (“laborsaving”) is a common phenomenon associated with the release of labor for employment in other sectors of the economy. This facilitates cultivation of larger areas with the same labor force (Humphreys, et al, 1996). On increasing land productivity the purpose of mechanization is to produce more from the existing land. Machinery is therefore a complementary input, required to achieve higher land productivity. The introduction of irrigation equipment and planting machines has been used to achieve higher cropping intensities and better yields (Ruthenberg, 1985). Decreasing the cost of production; Humphreys et al, (1996) cited that a combination of the three objectives will be achieved and additional benefits to the user may be associated

with a reduction in the drudgery of farm work and risk. These are subjective benefits and difficult to translate into cash. However Squires (1991) argues that frequently, mechanization increases an individual's workload, can be hazardous to health and may reduce the social interactions usually associated with farm work.

2.5.1 Mechanization for Reduction of Poverty and Land degradation

The Fast Track Land Reform increased the number of farmers on the land in Zimbabwe. This intensified pressure on existing resources and if measures are not taken resettlement areas are going to be subjected to massive land degradation. Mechanization is therefore taken as a way of controlling land degradation as it is used in land designing and conservation works. The inter linkages of mechanization and other biophysical factors to control land degradation and poverty in developing nations as cited by Templeton and Scherr (1996) are shown in the figure below.

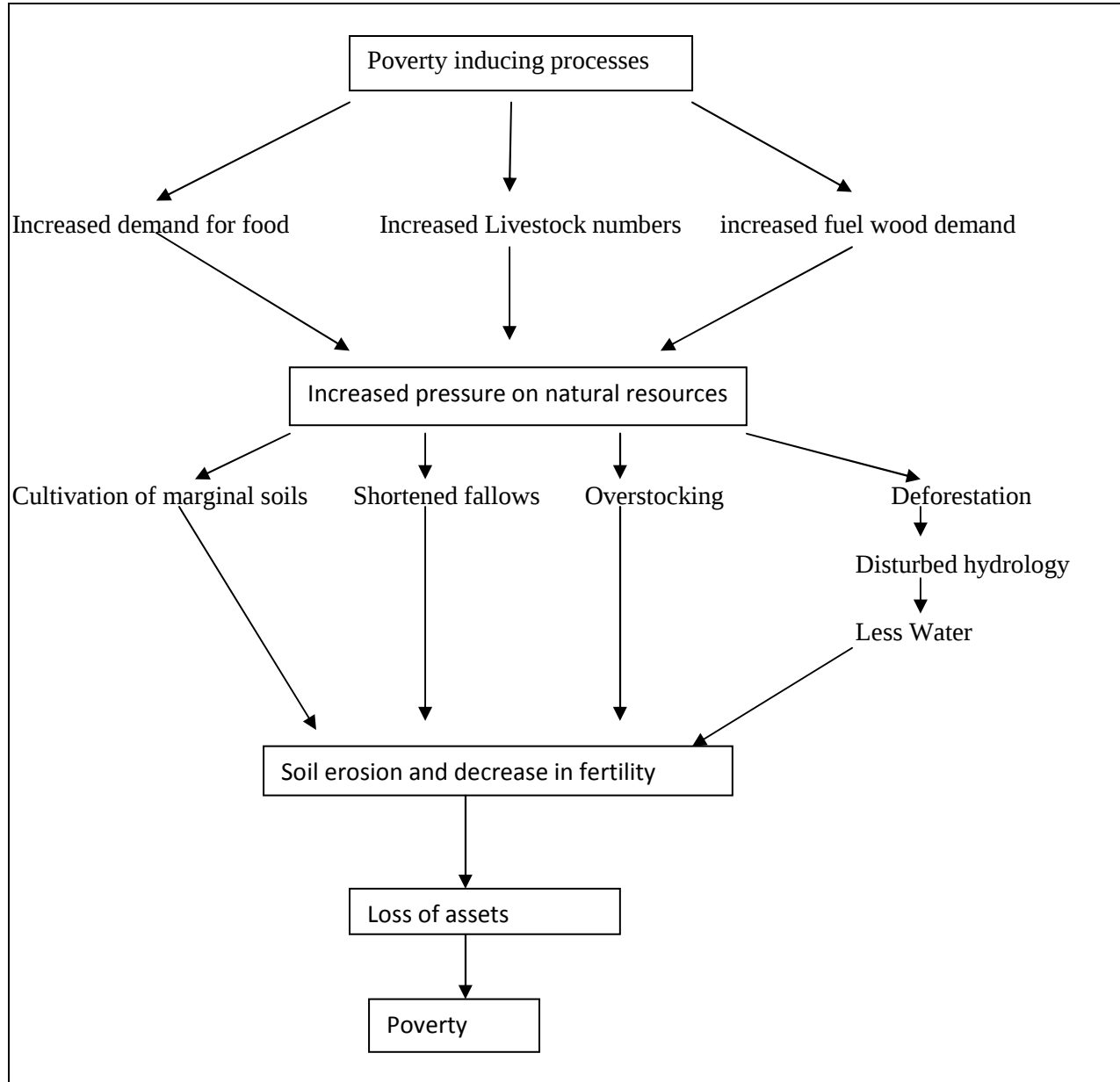


Figure 2. 1: The biophysical consequences of mechanization on poverty processes
Source: Templeton & Scherr, (1996)

When rural households are faced with declining productivity as a result of land degradation rendering usage of machinery difficult, they either look to the improved or extended use of land, or embark on alternative livelihood strategies (Scherr & Yadav, 1995). Decisions will depend on perceptions of risk and the potential returns, as well as local tradition and culture. In examining the resources of rural households in sub-Saharan Africa, the predominant source of farm power is labour, with better-resourced farmers

using draught animal power and only the commercially oriented farmers using machinery (Twomlow et al, 1999). In cases where labour is used to substitute machinery particular attention must be paid to women and children who, in most smallholder farming systems, devote many more hours on agricultural production (Rijk, 1999). Households can as well invest in short-term yield enhancing or longer-term soil conserving technologies (Malik, 1998). Soil conservation technologies are inherently different from other crop improvement technologies such as fertilizers, pesticides and seeds.

2.5.2 Impact of mechanization on conditions of farm workers

Work conditions in developing countries for agricultural workers are not conducive to good health and proper living as labour substitutes machinery. Workers are frequently in contact with dangerous chemicals and the environment under which they work is not friendly (Rukuni, 2006). With appropriate mechanization drudgery of farm workers is mitigated. From a safety point of view technical departments have been developing technologies for safe working conditions at work place particularly while using agro-machinery and agro chemicals (Owen, 1998). Governments in most African states have enacted safety laws like the Dangerous Machinery Act of (1972) for designing and manufacturing of machinery that is user friendly in Mali and Tanzania (Sims et al, 1999). Efforts were made to improve working conditions of agricultural workers particularly female workers as these constitute the highest percentage of human labour force on farms (FAO, 2000).

2.5.3 Land Tenure/Property Rights and Agricultural Investment

Principally the tenure system under the FTLR is based on a 99-year lease with an option to purchase the land. The reality is that the FTLR settlers have been issued with many different types of temporary licenses. This has been claimed to be a source of tenure insecurities among the beneficiaries (Hungwe and Matondi, 2006). Given that agricultural production is influenced by the level of capital investment on the farm, it can be argued that the rapid decline in production is due to low levels of land-related investments conditioned by the reform process and insecurity as occupants lack property rights (Shaw, 2003).

Economic theory postulates three links between tenure security and agricultural investment incentives. The first link is what Besley (1995) refers to as a ‘Security Argument. This captures the direct and positive link between tenure security and investment incentives. The concept is that insecure land tenure systems lead to market imperfections and increase the risk associated with farming through threat of dispossession. The second link, referred to as ‘a Collateral-Based View’ is based on the assumption that

when land tenure is secure and is easy to collateralize, this would reduce the price of capital from lending institutions and farmers would want to invest in machinery.

The third link is referred to as 'a Gains-from-Trade Perspective; is based on the fact that secure land rights increase investment incentives by lowering transaction costs, that is if land is to be either rented out or sold it expands trading opportunities and the ability to take advantage of gains from trade (Roth et.al 1994). A study by Fortmann (1998) argues that lack of tenure security discourages farmers from making long term investments such as mechanization on their land.

2.5.4 Adoption of the mechanization programme

Adoption of mechanization programmes is a challenge to many developing countries where it is implemented before assessing the particular needs of farmers. In Zimbabwe mechanization has failed to yield positive results of boosting agricultural production and food security as anticipated by the policy makers. Zimbabwe therefore has huge food deficits and has become one of the main importers of food in the region even after the mechanization programme FAO (2008).

It is at the initial stages of a programme where a complete assessment of the needs is gathered through surveys and interviews. These would offer information which becomes the basis for recommendations on a suitable mechanization programme. In the event that there are no available machines for the specific mechanization need, a short-term R&D subproject is done to come up with a more appropriate programme (Rosegrant and Evenson, 1995). Available machinery could be subjected to some changes to suit the environmental and soil conditions of a particular country. However, there are instances where new mechanization needs are identified and at this stage other institutions would be involved (Davis, 1980).

2.6 Agricultural Mechanization Implementation Strategy

There is no guaranteed procedure to ensure the transfer of mechanization technology because of the variability of situations and conditions surrounding its extension (Salokhe, 2003). Some important initial considerations in mechanization technology dissemination are; careful assessment of mechanization needs and prescribing the appropriate machinery or set of machinery and the approach on how stakeholders attempt to have farmers adopt or adapt the technology offered (Rodulfo et al, 1998).

A strategy on mechanization should therefore be regarded as one of a number of strategies leading to the achievement of the overall government policy (Capareda, 2002). According to FAO (2002) Agricultural Mechanization Strategy formulation has been carried out in several countries in the Latin America, Africa, Asia and Eastern Europe but with limited success. Recently with the changes occurring due to structural adjustment programmes (SAPs), Agricultural Mechanization Strategies have been further developed and adopted (FAO, 2000). The main objective of a Mechanization Strategy is the establishment of conditions which will ensure free, undistorted development and operation of linkages in mechanization and the definition of actions which will allow the program to succeed (Salokhe, 2003).

The philosophy behind the Agricultural Mechanization Strategy is that national governments should provide the basic conditions for a largely self- sustaining development of the agricultural subsector of mechanization within a policy of minimum direct intervention (FAO, 1999). The purpose of any interventions should be clearly identified and should fall within the objectives of the strategy. However, that does not mean that agricultural mechanization can be neglected in the formulation of national policy (Latin, 1985). On the contrary, very special attention should be paid to the effects that other policies have on the level and use of engineering inputs in agriculture (Amongo, 2001).

A typical formulation of Agricultural Mechanization Strategy according to Capareda, (2002) will be comprised of the following logical steps;

- The first step is an overall analysis of the agricultural sector related to farm power inputs as well as an analysis of the existing national farm mechanization situation including national inventories, domestic manufacturing and assembly (tools, implements, tractors etc.), importation of farm tools and machinery, descriptions of farming systems in relation to the use of farm power and their respective changes over time (Salokhe, 2003). This should lead to characterization of the existing situation.
- Secondly, policy issues which impact on farm mechanization are identified and an analysis of problem areas and constraints is made (Amongo, 2001). This work is generally carried out in close co-operation with officials or experts from the Ministry of Agriculture. Thus awareness can be created of the implications of political measures on agricultural mechanization and further on agricultural production.
- Thirdly, before formulation of a strategy, it is important to define an (ideal) future situation (Encanto 2000). The resulting strategy will be the definition of the actions required to move from the existing situation to the future situation. This will generally be divided into defining the respective roles of the private and government sectors.

- Finally, the strategy document should clearly define follow-up actions and activities to assist policy makers and planners to carry out the strategy (David, 1995). These follow-up activities generally consist of recommendations on policy adjustment to correct distortions in the sub-sector, investment plans to develop manufacturing, commercial companies and farm mechanization, and definition of government support actions and activities required for the sub-sector.

Virtually all mechanization inputs have to be paid for by the farmer and all have to be purchased or replaced on a regular basis. Similarly a retailer or small manufacturer (village shop or artisan) has to have access to supplies from a wholesaler as large scale manufacturers would need regular access to supplies and other inputs (Elliot, 1988). The fundamental requirement for a sustainable mechanization is therefore regarded as a strong linkage between the different parties or stakeholders and that all of them must be able to make a livelihood from their participation and if one of these parties is not making a livelihood then the whole sector will be adversely affected (Rukuni, 2001).

2.6.1 Mechanization Implementation strategy

A strategy on mechanization should therefore be regarded as one of a number of strategies leading to the achievement of the overall government policy (Capareda, 2002). The main objective of a Mechanization Strategy is assumed to be the establishment of conditions which will ensure the free and undistorted development and operation of linkages in mechanization and the definition of actions which will allow the program to succeed (Salokhe, 2003). The figure below summarizes the fundamental stages of the mechanization implementation strategy and their inter linkages.

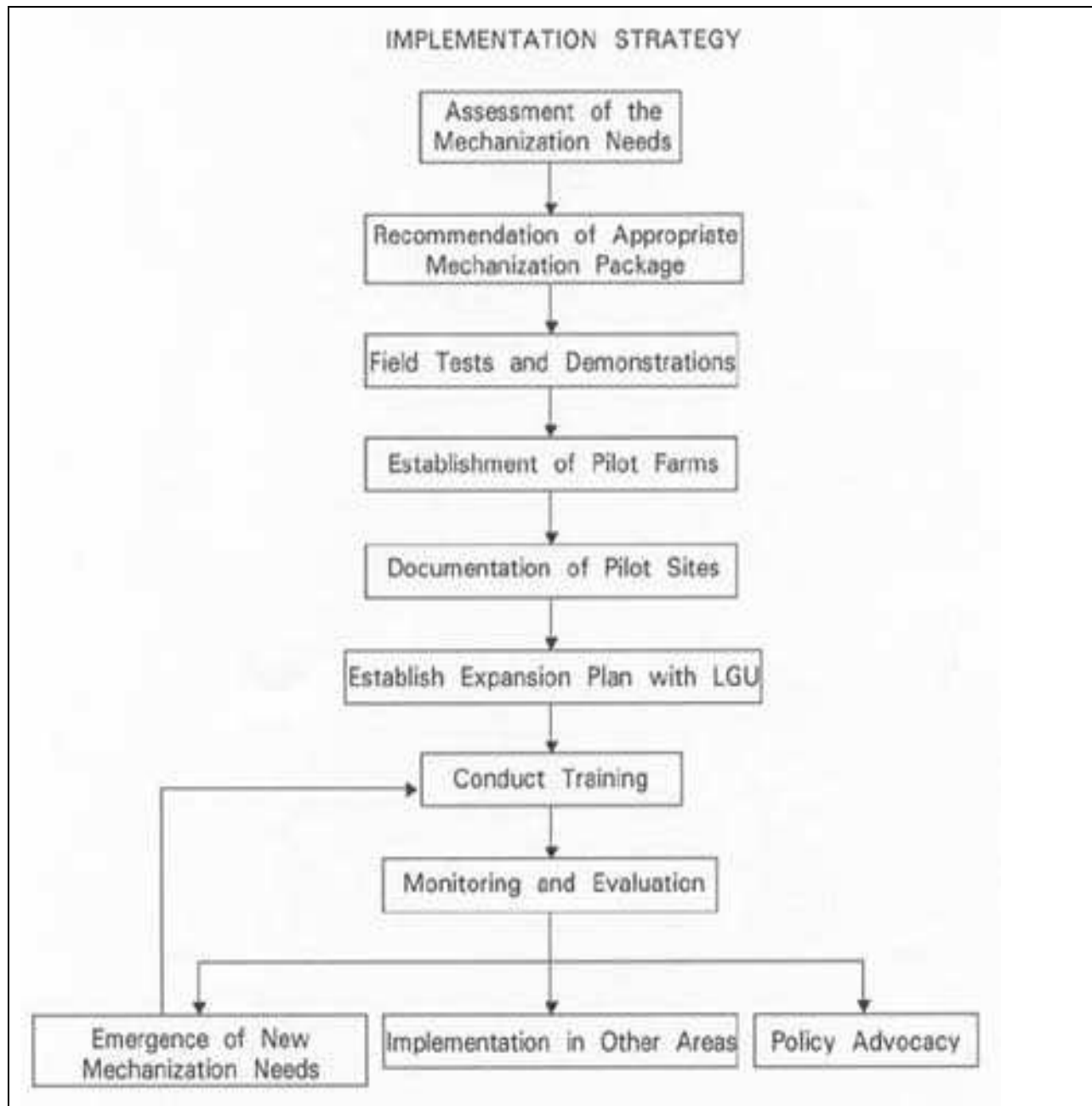


Figure 2. 2: A summary of mechanization implementation strategy
Source: Department of mechanization, Zimbabwe (2006)

2.6.2 Barriers to Agricultural/Small Farm Mechanization

According to Latin (1985) there is no absolute guideline for transferring mechanization technology, nor is there a tailored set of strategies to promote the adoption of agricultural machinery. Variability of conditions and the needs of the farmers limit the creation of a standard approach to dissemination of mechanization technologies (Rodulfo, 1998). In order to suggest appropriate strategies for mechanization technologies, it is therefore crucial to reflect on the problems associated with mechanizing the agriculture sector. The figure below shows barriers that impede implementation and adoption of mechanization

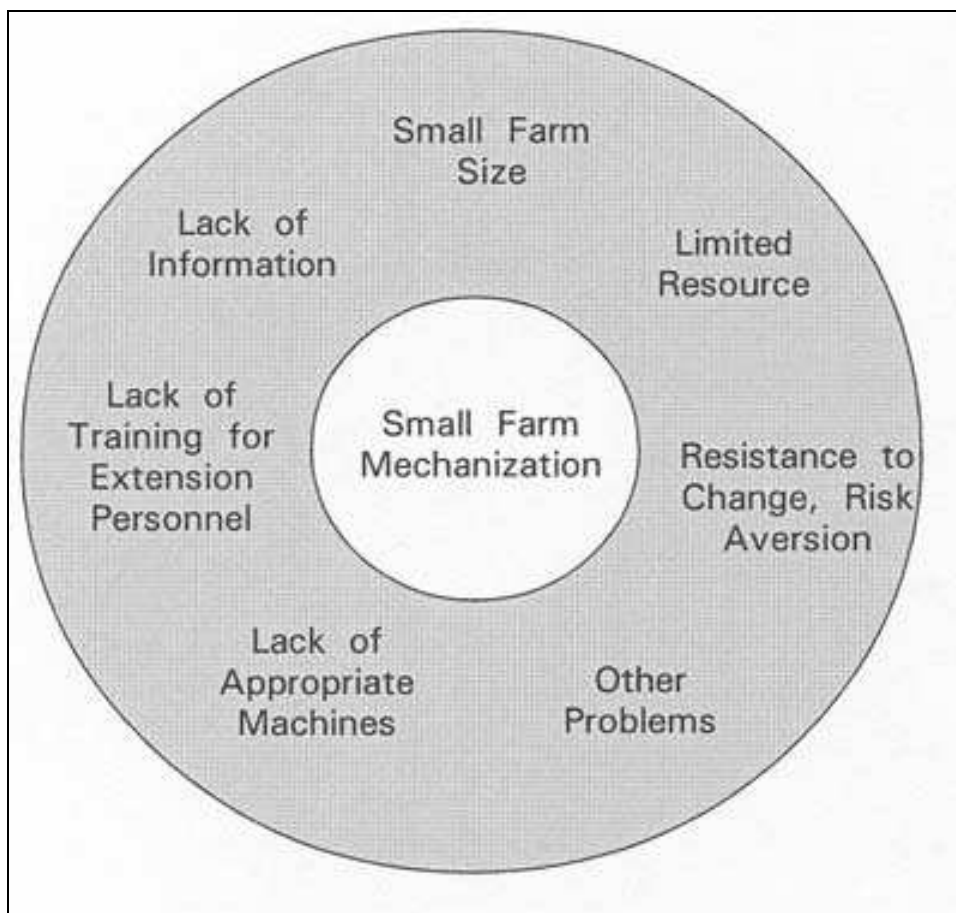


Figure 2. 3: Barriers to implementation and adoption of farm mechanization and possible remedy
Source: FAO (2000)

(a) Lack of Information

Information is the key to making sound decisions. Some farmers are unaware of the availability of suitable machines, tools, or implements that could aid in their usually tedious work (Latin, 1985). They might be secluded from the technology by natural barriers and socio political boundaries and sadly enough, some farmers are even lackadaisical and seemingly uninterested in mechanization as a new innovation.

(b) Small Farm Size

A small-sized farm is a big issue when it comes to mechanization because this is against economies of scale (Salokhe, 2003). Indeed, the majority of agricultural farms in Zimbabwe are small and the reduction in size is a result of the (FTLR). The mechanization of small, fragmented portions of land may prove to be inefficient especially in operations like land preparation and harvesting as movement of machinery is impeded (Amongo, 2001). However underlying the establishment of large-scale farms is the misguided perception that there is a relationship between mechanization and large farms. This has been clarified in the literature by (Johnson and Ruttan, 1994). The substitution process, brought about by changes in relative factor prices (Peterson and Kislev, 1991), indirectly causes larger farms to be more productive when mechanized. According to Hayammani and Ruttan, (1985) Machinery allows farmers to work progressively on large units of land. However the findings of a recent intensive survey in Bangladesh argues that mechanization makes little or no difference to land productivity, i.e. cultivation of bigger sized land but causes substantial direct and indirect labour displacement.

(c) Reluctance, Resistance to Change and Risk Aversion

Traditionally farmers are calculative and generally reluctant to changes in their farming activities, they have a "wait-and-see" attitude (David, 1995). Although many farmers are open to new ideas and technology, there are more farmers who would first want to see a working model before they follow (FAO, 2000). This is believed to be the psychological biasness of man in nature. Farmers fear to take the lead in adopting new innovations as they trust and prefer the traditional ones. In reality, the more progressive farmers are the ones with more resources. At times, the unfavorable attitudes and orientation of farmers caused by risk associated with adopting new machinery is rooted in their bad experiences with such agricultural machinery (Encanto, 2000).

(d) Lack of Appropriate Machinery (Design and Quality)

Even if as much as 80% of the farm power is provided by human, there is still a need to develop simple, manual equipment for various farm operations (FAO, 2004). In most developing countries, the human labor force is comprised of, as much as 60% women workers. Thus, the proposed appropriate machine designs should be based on the limitations of the individuals and be gender sensitive (Salokhe 2003). According to Rukuni (1998) research and development (R&D) has a bias against the development of appropriate machinery for small scale women farmers. Engineers have a tendency to create something that is novel, without much regard to small scale women farmers' applications in developing appropriate machinery. The perception is that developing such machinery for small-scale application is not as rewarding as it is with creating bigger and more complex machines (Lantin, 2003).

In terms of quality workmanship for the local manufacture of machinery, the majority of local manufacturers are still in the "cut-and-weld" level of manufacturing technology (Rodulfo and Geronimo, 2004). This limits the capability of local machinery manufacturers in designing and fabricating machines. Also according to Amongo (2001) the availability of low-cost, low-quality machinery in the market could be disastrous to the objectives behind mechanization. The purchase of a low-cost, low-quality machine may, in the end, be a liability owing to frequent repairs on the machinery. The influx of used imported machinery is also a problem. However, these machines are attractive to farmers because of their lower initial cost (Paras, 2004). But because these are not locally manufactured, replacement parts may be hard to find. Furthermore, the purpose for which the machinery was designed for may not be suitable to the local farming conditions.

(e) Lack of Extension services

Extension is the battlefield of technology transfer (Koppel, 1994). The people involved in extension must not only be technically updated but must also possess good management and interpersonal skills. With so much on their shoulders, most of them might be lacking the capability to integrate the mechanization technology into the total farming system (Encanto, 2000).

(f) Political interference

In Zimbabwe the government has been allocating funds for the development of the countryside, including mechanization of farms. However, some politicians use mechanization projects for their own interests especially in areas where agricultural development is not a priority of the local government (Clarke,

2000). They only use mechanization projects to source funds and the actual implementation is sometimes not realized. Apart from this if the project is implemented, the acquisition of machines is sometimes being dictated by political leaders who may not have the technical background, often resulting in purchase of inappropriate machinery (Bishop, 1997).

2.6.3 Institutional weaknesses

Problems in the overall organizational structure obscure accountability. In Zimbabwe the mechanization programme had no clear policy on how the beneficiaries were going to pay back their loans. The absence of monitoring strategies of the programme led to abuse of the machinery and agricultural production declined. The department of mechanization in Zimbabwe is responsible for the performance of the sector, but does not have effective control over agricultural R&D budgets and management (Mhamba, 2000). The research community blames slow technological progress on the extension system; not realizing that without being given the mandate to monitor the programme by the government, extension cannot perform (Tapela, 2002). Since neither the Department of mechanization nor the state colleges and universities (SCUs) are held accountable for agricultural development there is no effective pressure on the research system, to improve its performance through more efficient allocation of resources as this is the mandate of departments that are not linked to agricultural production (David, 1995).

2.7 Breaking down the Barriers to Farm Mechanization

After identifying the major problems that hinder the transfer of mechanization technology, identification of strategies to deal with the barriers is important. The Fig below illustrates some strategies to accomplish the objective of breaking barriers to agricultural mechanization (FAO 2000).

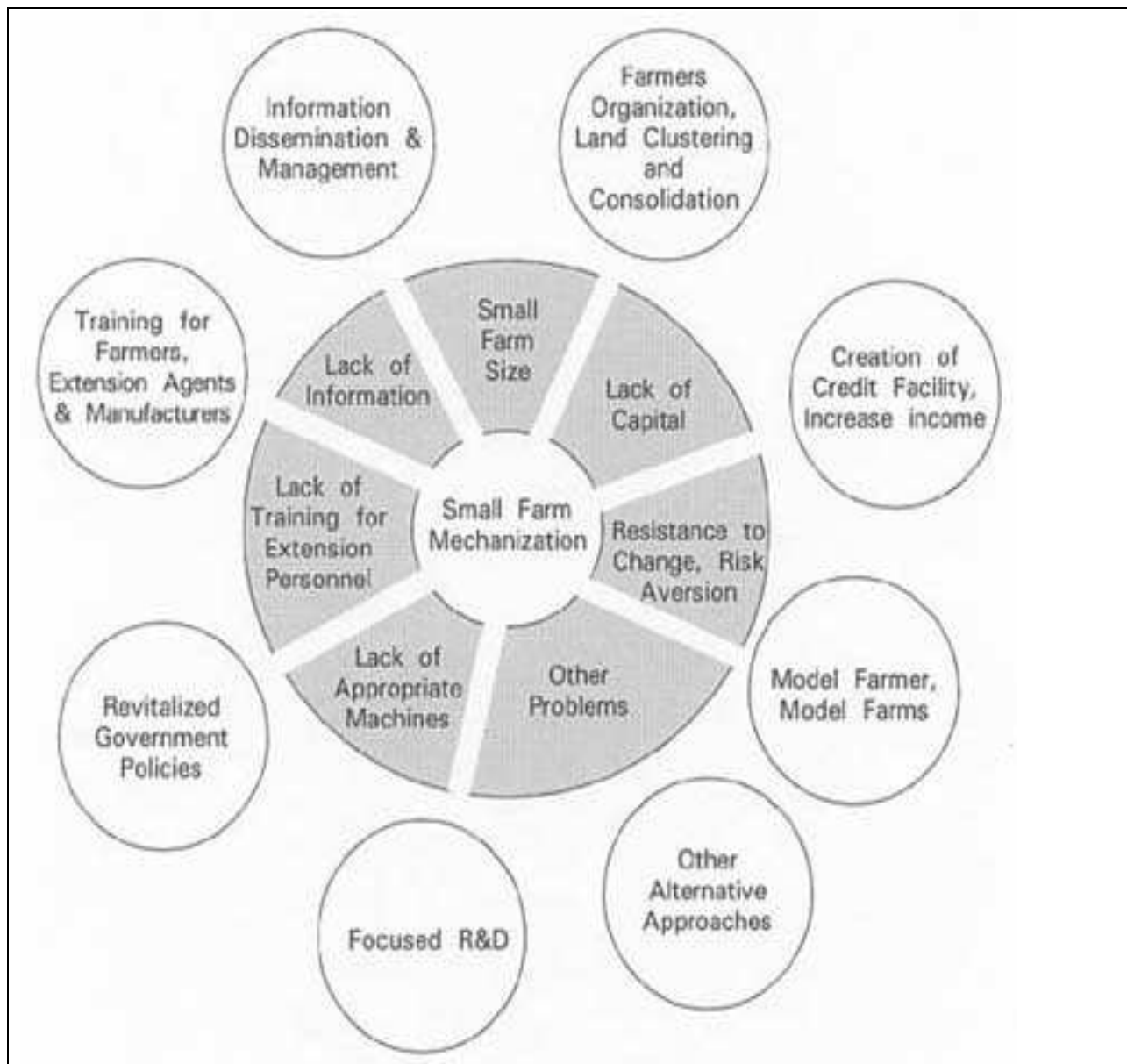


Figure 2. 4: Breaking barriers of farm mechanization
Source: FAO (2000)

(a) Information Dissemination and Management

According to Binswanger (1986) information is the key to the making of sound decisions. It is this information that is needed by farmers so that they may be able to have better control of their resources and lives. Information dissemination activities through mass-media campaigns such as displays, farmers' field days, and agricultural shows should be pursued in the countryside and resettlement areas (Viegas, 2003).

With the rich culture of Zimbabwe, a lot of traditional agricultural systems have been gained. These included conservation tillage techniques/zero tillage where machinery is not used but farmers get yields to sustain their lives. Incorporating this knowledge into the mechanization system would limit farmers' reluctance to the mechanization technology. Popularized versions of training and technical materials in the local dialects would promote better understanding of the materials (Gordon, 1994). A centralized information database for Zimbabwe, linking all farming information on mechanization programmes and new scientific research findings for better yields can be accessed by farmers to boost agricultural production. (Made 2004).

(b) Creation of Farmers' Organizations

Encouraging and helping farmers to establish farmers' organizations has been an effective approach towards development (Sadighi, 2002). The formation of such organizations may empower farming communities (Adams, 2006). Furthermore it is the take off point of strategies to be implemented for adoption of new technology regarded crucial. Technical support, facilitation of credit assistance, land clustering and consolidation, will not work without cooperation among farmers. This occurs when strategies implemented on the onset are inappropriate. Farmer's organizations can be an entry point of developmental programs by government and non-government organizations (NGOs) (Sadighi, 2002). The premise for land clustering and consolidation is to transform the land and facilitate the adoption of larger-scale mechanization rather than fitting the mechanization technologies to small farms (Lantin, 2003).

(c) Focused R&A Development

Due to increasing cost of fuel, priority should be given to development of technologies that will harness nonconventional sources of energy (Weijiang, 2003). More energy-efficient machinery such as cultivating machines which incorporate plant residues into the soil to increase fertility, seeders and

planters for optimum planting uniformity, crop protection for rationalized use of chemicals, and harvest and post-harvest operations that include village-level processing of farm products and by-products need to be developed (Rodulfo and Geronimo, 2004).

(d) Training of Farmers, Extension Agents and Manufacturers

Rukuni and Eicher (2000) argue that the education and training of farmers who work with machinery is at times inadequate and need intensification by both government agencies and machinery-manufacturing firms. This would guide beneficiaries of mechanization programmes on the proper use of machinery. Local manufacturing of agricultural machinery which can be operated by local farmers can be promoted through trainings of village-level craftsmanship. Extension agents should have ample time to learn proper application of such technologies before they can effectively teach other farmers. Extension personnel may need more training than other farmers to garner credibility (Shuyou, 1995).

(e) Model Farmers and Model Farms

Farmer leaders are likely to adopt new technologies first, these therefore yield expected results and are often emulated by their co-farmers or peers. Farmers have a way of convincing other farmers to adopt a technology that they have successfully and profitably utilized (Bloom, 1990). This is the basis for the model farmer and model farm strategy. However, this could create reluctance rather than acceptance among farmers. A sustainable working system being used by a farmer cooperator would enhance receptivity to the mechanization technology. Governments should therefore try to control and make policies on the influx of imported, second-hand machinery in the market. This would protect not only the farmers but also the local manufacturers (Akbari, 1986).

(f) Monitoring and Evaluation

The evaluation and assessment of a programme establishes the potential of the technology and reveals possible modifications to further enhance performance and acceptability of machinery (Paras et al, 2004). This enables planners and implementers to establish future needs of farmers for the same innovation or technology.

2.8 The role of governments in agricultural mechanization

Mechanization should not be an end in itself and therefore, in a true free choice situation, governments should refrain from making policies which will stipulate the methodologies through which agricultural mechanization should be implemented and adopted by the beneficiaries. The philosophy behind Agricultural Mechanization Strategy is that national governments should provide the basic conditions for a self sustaining mechanization programmes (FAO, 2007). The government should provide this assistance to all participating stakeholders including the private sector. Wicks (1981) argue that the traditional role of government needs to be clearly defined and he outlined the following as the mandate of the government.

- Policy formulation
- Research and development
- Testing
- Education, training and extension
- Information supply
- Consumer protection
- And create departments and ministries responsible for monitoring implementation strategies.

Policies relating to agricultural mechanization can be divided into two groups Scherr and Yadav (1995); those about a general need for government intervention and those which disagree. Policy areas in which it is agreed that government intervention is desirable according to Scherr (1996) include;

Agricultural research is considered an important and legitimate area for government intervention because of its "public good" characteristics (Twomlow et al, 1999). However, the case for government intervention is less clear in the case of research into large-scale agricultural machinery because of the involvement of private sector (Timmer, 1991). According to Rijk (1999), agricultural marketing infrastructure policies are relevant to agricultural mechanization in that an important element of motive power is the machinery and equipment used to transport agricultural products from the farm and agricultural inputs to the farm.

2.8.1 Specialized responsibilities of the government

Zimbabwe's mechanization programme has been politicized, it was the government that championed the programme and mandated its central bank to channel resources towards the programme. Participation of external stakeholders was minimal; the programme therefore is regarded controversial and not targeted at boosting agricultural production Mabasa (2007). To avoid the controversy FAO (2004) outlined the same roles suggested by Wicks (1981) as specialized responsibilities governments in developing nations should take to improve efficiency in agricultural productivity. The outlined responsibilities are listed and explained below;

Research and Development; Although this is best carried out by the private sector because companies are in the best position to judge what is best for their own particular business, research and development can be expensive for individual companies as this may require skills and expertise which may not be affordable by individual companies (Carney, 1998). It may therefore be necessary for governments to be involved in R&D aimed at benefitting individual companies and farmers. However this should be carried out in close co-operation with the private manufacturing sector to ensure that research and development is closely linked with the identification of markets/farmers' needs and subsequent manufactured products (Jafry, 2000).

Testing of Farm Machinery; Is very controversial as other stakeholders argue that, the main issue surrounding governments is whether they are able to run testing programmes without preventing the free development of the private sector and restricting the choice of farmers (FAO, 2004). In Zimbabwe all imported farm machinery including tractors purchased for the mechanization program had to be tested at the Central Farm Machinery Testing, Farm Mechanization and Engineering Department. The machinery had to satisfy Minimum Performance Standard guidelines before being distributed to farmers (Gono, 2007).

Education, training and Extension or The Need for Technical Assistance in mechanization; this is required at both farmer level and government level. Farmers require assistance in all aspects of their activities; agricultural advice, financial advice and planning advice. To develop these services government require assistance which may come from external donors and channeled through individual ministries and agricultural banks or other appropriate institutions (Agritex 1998). Governments should develop an integrated and inter-linked education, training and extension programme (Chatizwa & Khumalo, 1996). The type and level of education and

training will need to be geared towards the requirements of farmers linked to agricultural manufacturing and production sectors (Agricultural engineering and development, 1992).

Mechanization Departments and Ministries of Agriculture; With the generally prevailing constraints to government spending, many individual governments' policies are to reduce the amount of national resources spent on the civil service and to remove from them all but the essential policy making functions (FAO, 1998). Under such conditions, Mechanization Departments should be primarily responsible for advice to the government on the formulation of mechanization policy, strategy, and programmes for the development of the whole sector as well as the collection of data and statistics and the dissemination of information particularly to farmers (Sims et al, 1999).

Consumer Protection; Involves the introduction of laws and regulations which will protect farmers from purchasing sub-standard machinery (Koza et al, 2000). This includes safety regulations, enforcement of contract law, introduction and enforcement of standards, consumer information services, publication of test reports, protection against unscrupulous commercial practices, consumer credit protection etc (FAO, 1987).

Land Tenure; Uncertainty of ownership leads to lack of investment and commitment (Dijkman et al, 1999). Governments and other involved parties should cease speculating on what size and type of farm machinery is most appropriate or economic. Emphasis should be given to creating conditions whereby it is possible for any person, company or group of individuals to create a farm business, as successfully achieved in Zimbabwean (Utete, 2006). It is vitally important that farmers have title deeds for their land so that collateral is available for borrowing. Credit and Finance; this should be available for all sizes and types of farm operations. Collateral requirements should be realistic and physical accessibility to credit should be made easy, but with the condition that the business plan and cash flow appear realistic and attainable (Rukuni and Eicher, 2000).

2.8.2 Revitalizing Government Policies

Reviewing policies on local and import taxes/tariffs regarding the importation of agricultural machinery would have a large effect on the success of mechanization (Malik, 1998). Governments should try to build confidence in foreign investors as this would boost investment and enable them to manufacture agricultural machinery locally. This would cut the cost of machinery on the local market. It has also been

noted that high tariffs and political situations in most developing countries detour investing manufacturing/assembling companies from these countries (Scherr & Yadav, 1995).

2.8.3 Some Raised Issues against mechanization

According to Rijk (1999), mechanization replaces labour. If there are no distortions in the cost of capital versus the cost of labour, which has become the case in most developing nations after voluntary or imposed structural adjustment programs (SAPs). Mechanization is introduced only in response to labor scarcity, i.e. in cases where labour is being drawn from policies that make labour expensive.

Again the expensive and complex agricultural machinery developed in the Industrialized Countries is usually not suitable for low-income developing countries. According to Rukuni (2002) development of the local machinery manufacture industry is a prerequisite for successful mechanization as limited machinery is designed and available to operate on small and fragmented plots as can be witnessed in (East) Asian agriculture Rijk (1999).

It is however argued that in many developing countries, imported tools and machinery are cheaper because domestic demand is too small to achieve economies of scale (Sims et al., 1999b). Dijkman et al (1999) argues that the agriculture sector should aim at reducing fossil energy consumption by putting more emphasis on Draft animal technology rather than on fuel-consuming mechanical power technologies.

2.9 Summary of the chapter

The chapter reviewed relevant literature on mechanization, its implementation, adoption by targeted beneficiaries and its impact on agricultural productivity and production efficiencies. Mechanization strategies and policies were also reviewed. References to cases where mechanization programmes were implemented and scored success in agricultural productivity as evidenced by the changing trends of the resultant yield outcomes were made. The reviewed literature shows that farmers have always been fully aware of the immense benefits that can accrue from the use of machinery in agricultural production but the huge cost involved has been so prohibitive (Lal, 1995). In the past mechanization in developing countries has been much criticized because it has failed to prove its effectiveness and was blamed for exacerbating rural unemployment and causing other adverse social effects (Rijk, 1999).

Overallly it has been established that appropriate choice and subsequent proper use of mechanized inputs in agriculture have had a significant effect on agricultural production and productivity, the profitability of farming, and on the environment (Barrow, 1995). The reviewed literature when employed in the research would make a significant contribution to the existing debate on various aspects of the ongoing mechanization programme in Zimbabwe especially post the Fast Track Land Reform.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter describes the research methodology and selection of the study site. It focuses on location, physical setting, socioeconomic setting and agricultural production or economy of the district and province under study. The soils and vegetation types of the district and province under study reflect the relevance of the types of farming activities mainly intensive cropping and livestock production which portrays the seriousness with which they should be considered for support by both the external (development and donor organizations) and the government. The chapter also discusses the methodological approaches and specific data gathering techniques used. It spells out the sources of data used in the evaluation of the socio-economic impact of mechanization on the livelihoods of farmers in Bindura district. Justification of the use of data analysis tools is based on previous studies that focused on the impact of mechanization on productivity, sustainability and food security in the country. The study therefore takes the form of a comparative analysis of the two groups of farmers namely beneficiaries and non beneficiaries of the programme in terms of their productivity focusing on maize and soya beans which are the two major crops grown in the area.

3.2 Geographical location of the Study Area

The study area is located in Bindura district which lies in the northeast of the capital city of Zimbabwe, Harare in the Mashonaland Central province. The area covers approximately 525 km². The altitude varies from 940 m to 1440 m above sea level, falling into the middle veldt. Total arable area for the province is 850 350 hectares. 37% of this area lies in natural region four which receives less than 650mm rainfall during the rainy season. Only 536672, 6 ha that is 63% of the total arable land is in natural region 2 and 3 which is suitable for intensive and semi intensive agricultural activities in the province. According to the Provincial Statistical Department Mashonaland (2006) the figure given below shows the land classification of the study area.

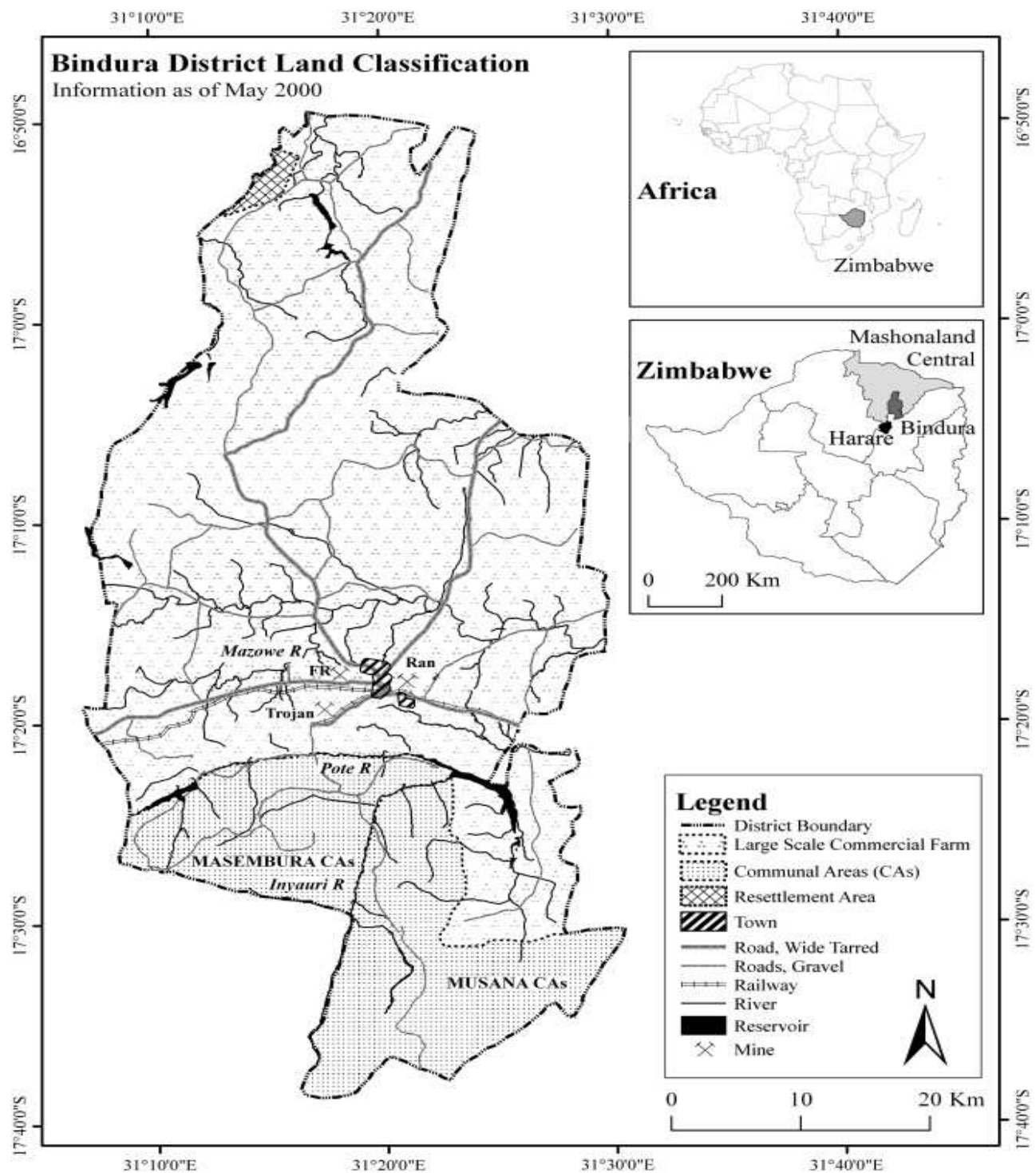


Figure 3. 1: Map showing the study cite
Source: Provincial Statistics Department Mashonaland, Bindura (2006)

3.2.1 Physical Setting

Mashonaland Central has large areas of good crop land especially in the districts of Mazowe, Bindura and Guruve. Fine grained archaelian rocks, granodiorites soils with pockets of dolerite and gneiss are predominant in the study area. The underlying geology has a marked influence on soils in the study area, which are mostly sandy fersialitic soils with inherent low fertility and low water holding capacity (Nyamapfene, 1991). Masembura and Musana communal areas are dominated by Miombo woodlands, and most predominantly bush land with canopy 28–80%. Musana communal area is characterized by more intensive cultivation of horticultural crops and mixed rangelands than woodlands.

3.2.2 Zimbabwe's Agro-Ecological Zones and their Characteristics

Zimbabwe's land is divided into five natural zones on the basis of soil type and climatic factors as shown on the Figure below. Natural regions 1, 2 and 3 are suitable for intensive cropping and livestock production while regions 4 and 5 offer limited scope for crop agriculture but are suitable for livestock production at large scale. The bulk of Mashonaland (West, East and Central), Midlands and Manicaland Provinces are under regions 1, 2 and 3, while Matebeleland (North and South) and Masvingo Provinces are under natural regions 4 and 5. The three Mashonaland Provinces constitute the bread-basket of the country. Zimbabwe's farming sector can produce, and has produced in the past, exportable surpluses of maize and other food crops. Severe constraints such as unavailability of machinery for prime land utilization have resulted in less than full capacity utilization of Zimbabwe's natural land resources.

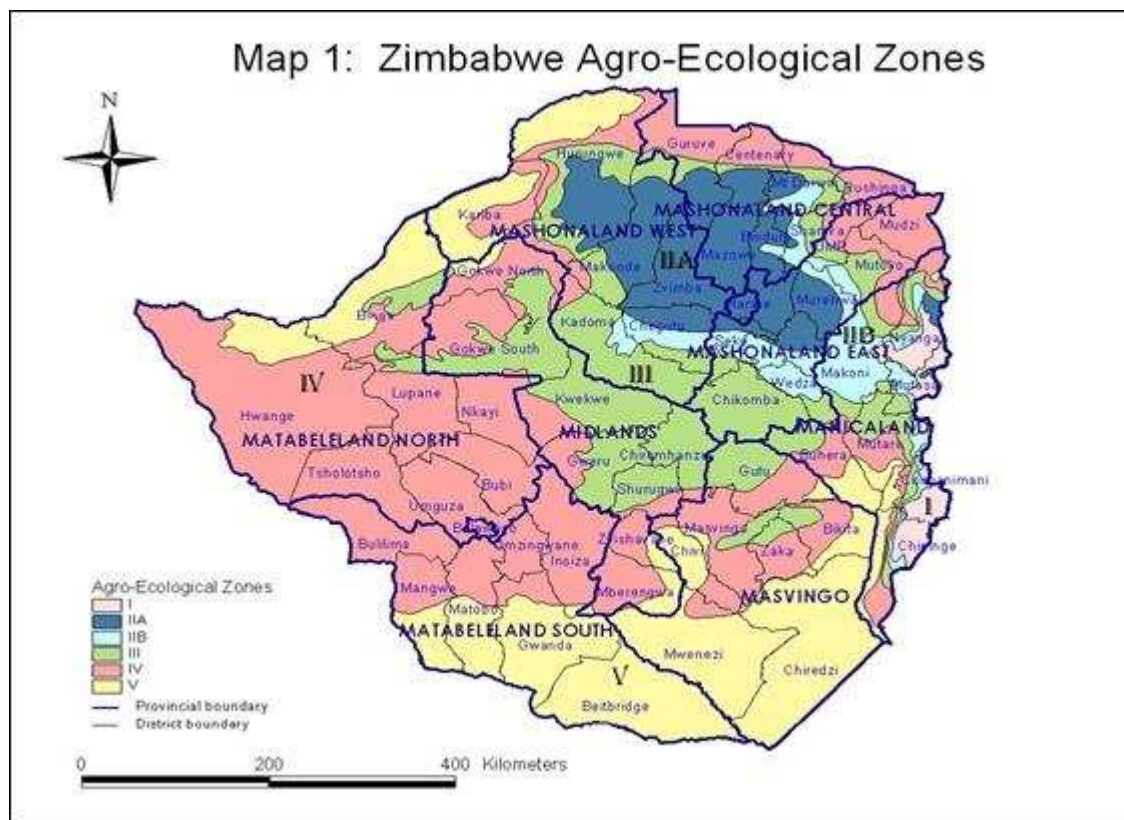


Figure 3. 2: Zimbabwe's Agro-Ecological Zones
Source: Nyamapfene (1991)

3.3 Livelihood and Socio Economic Characteristics

The major economic activity in the study area is mostly semi-subsistence agriculture, with major crops such as maize, soya beans, groundnuts, cotton, and vegetables being produced in those areas with operational irrigation systems, Figure 3.2 above portrays the scenario. However, production of the major rain-fed crops is usually affected by the unreliability of rainfall, particularly the late onset of rains in most seasons.

3.3.1 Overview of Agriculture/Crop production trends

The province has one of the most productive communal lands, producing both food and cash crops. Maize is the dominant crop; however the main sources of income include cotton, tobacco, sunflower, soya bean and sugar bean production. Employment on A1 (small scale resettlement) and commercial farms is also an alternative source of livelihood. Poor households depend equally on their own crops, daily wages from casual labour, selling of sugar cane and gold panning. In general, crop production (food and cash crops), livestock rearing or a combination constitutes the primary livelihoods in the rural provinces. These livelihood options in turn define most of the secondary livelihood options – such as employment on commercial farms and game reserves. The figure below shows the general crop production trends but gives maize as an example.

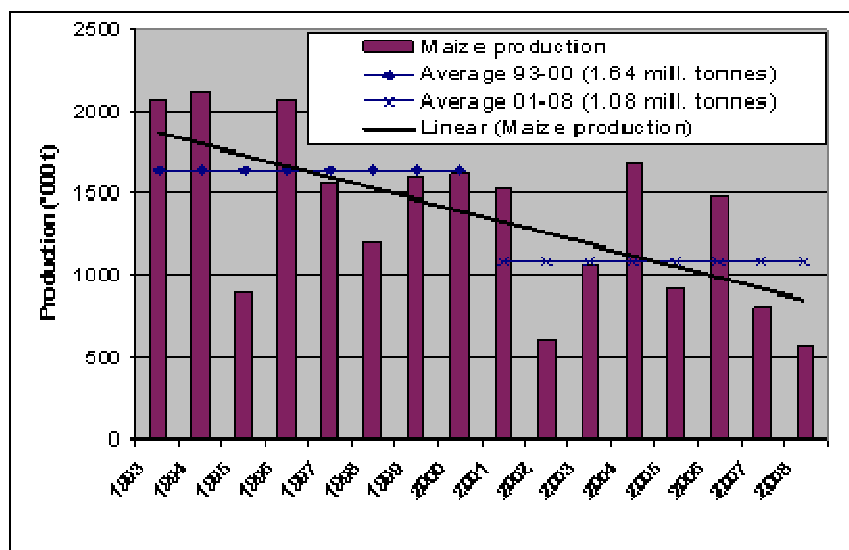


Fig 3.3 Zimbabwe's maize production pattern, 1993-2008
Source: (CSO 2007)

3.3.2 Operational Land Holding Patterns/Land Tenure Systems

Land tenure systems or ownership affect agricultural productivity. It influences productivity through security and investment in infrastructure. Gavian (1996) cited that land tenure constitutes the rules and procedures governing the rights, duties, liberties and exposure of individuals and groups to use and control of the basic resources namely land and water. In the survey area 3 types of land ownership systems were identified. These are communal,

resettlement A1 with temporary licenses and resettlement A2 with (99 year lease agreements) under the (FTLR).

3.3.3 Brief Scenario of the Mechanization Program

Traditional and improved agricultural implements are being used by the farmers for different operations in the area. Though improved agricultural machinery has been introduced under the ongoing mechanization program, little impact has been made on agricultural productivity as fuel was in short supply and at times very expensive for the farmer. In most areas animal draft power accounted for between 70 to 90% of the cropped area, tractor power accounted for between 2% to 15%, and hand tillage accounted for 5% to 15% (Arex office report, 2008). The costs are so prohibitive for most farmers hence consequently; large tracts of land are left fallow in the A2 and Large Scale Commercial Farming areas.

3.3.4 Draught Power Availability and Livestock ownership

A very small proportion of the beneficiaries of the FTLR have tractors, the rest rely on hired tractors, cattle and donkeys for tillage. As a result of the FTLR large scale de-stocking was reported by the commercial sector, with beef cattle numbers declining from 500 000 in March 1999 to an estimated 282 000, current (FAO, 2006). According to Arex (2002) the livestock will be difficult to replace hence this will have profound effects on exports of meat, which have been buoyant in recent years. Dairy cow numbers declined by 22 percent between 1995 and 1999 and have continued to decline due to disturbances on farms, and as a result the availability of milk has declined sharply (Vet Department, 2003).

3.3.5 Agricultural inputs availability

According to Arex report (2009) about 12 927 tonnes of maize seed were available for the 2008/09 season as compared to the ideal situation of 38 000 tonnes availed through Government, SADC, NGOs and other input support programmes in the previous seasons. The 12 927 tonnes were planted on 34% of the area cropped to maize. 66% of the hectareage under maize was planted using carry over seed, retained grain, grain from food aid, purchases and seed from other sources. About 19 147 tonnes of basal fertilizer against an ideal situation of 315 000 tonnes and 12 561 tonnes of top dressing fertilizer against an ideal situation of 260 000 tones were availed through support programmes. Inputs for cotton are supplied by contractors, but

in most cases the input packages are incomplete with most contractors providing seed only. The Figure below shows that maize seed production in Zimbabwe decreased from 2000-2008 hence the need assistance from the corporate world.

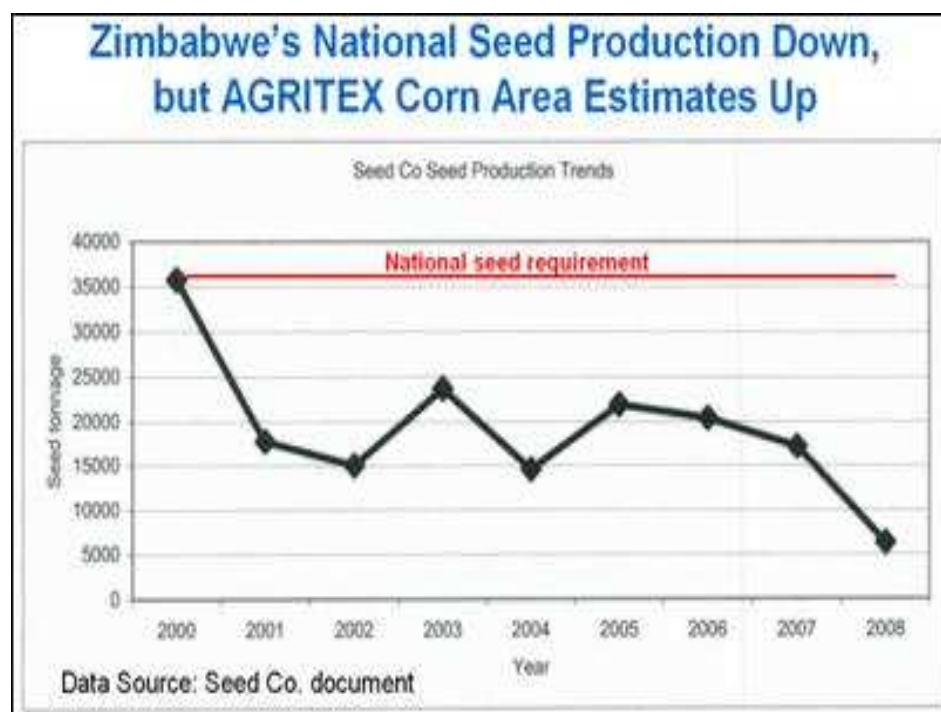


Figure 3. 3: Maize Seed Production trend in Zimbabwe from 2000-2008
Source: CSO (2007)

3.3.6 Infrastructural Facilities in the Area

Primary road system is made up of the main tarred road network which links main urban centers. The rural areas are linked to main roads by gravel or earth roads. Due to lack of funds roads are in a bad state as they are not serviced by local councils/the responsible authorities. Resettlement areas too are linked by poorly serviced roads characterized by pot holes. Buildings for curing and storage of agricultural produce are on the verge of collapsing on most farms. The general observation is that resettled farmers are not taking the initiative of maintaining the infrastructure they found in place on the farms.

Water is predominantly from groundwater sources in the villages whilst at service centers, “growth points” water is often supplied by piped line systems. The main source is therefore either surface or underground. The boreholes are generally used for primary purposes with very limited use for livelihood activities of

which the most common is livestock watering and in a few cases gardening and in isolated cases irrigation of wheat. Sanitation is basically by onsite systems such as pit latrines or their improved versions termed the Blair toilets, named after the institute, which developed them, the Blair Research Institute in Zimbabwe (WHO, 2000).

3.3.7 Marketing of agricultural produce in the area

The area under study is close to state agricultural marketing authorities. The furthest distance to the marketing depots is about 60kms (DDF Survey, 2006). Poor road network makes most farms inaccessible hence reducing their proximity to markets. Producer prices of maize and other cereals are controlled by the state which stipulates the buying price from farmers and the selling price for millers to consumers.

3.3.8 Government policies regarding food security in the area

The Government has been aware of the deteriorating food and agriculture situation in the country and has taken several measures to cope with the situation (Arex Department, 2004). The Inter-Ministerial Committee on Drought and Social Protection has been formed and tasked to review the situation and to make requests for supplementary funding for food. The Government has also initiated a maize import programme mainly from South Africa and Zambia. GMB selling points were opened in all districts to facilitate access of food at controlled state prices to all the affected population in rural communities (Gujaratti, 2004).

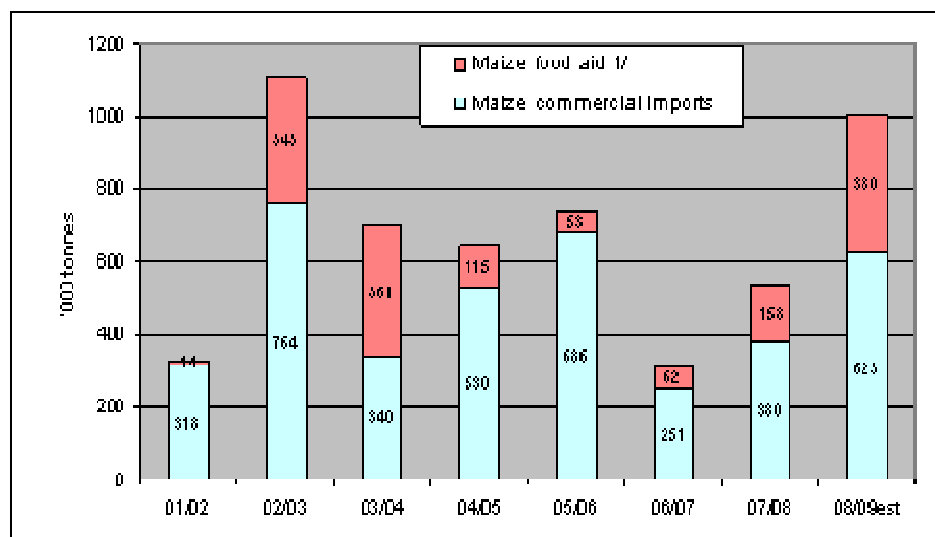


Fig 3.5 Maize - Commercial imports and food aid imports – 2001/02 to 2007/08 and estimates for 2008/09

Source: FAO (2008)

3.3.9 Mandate and Activities of Agricultural Research and Extension

The mandate of Arex is primarily extension service and regulatory activities added on during years of disruptions in Zimbabwe's economy. Advisory, technical services, farmer training, and dissemination of technologies, managing and advising on biodiversity are some of the responsibilities of Arex (Farmers' Weekly News, 1999). Some of its specialized functions in the area include;

- Recruiting and training Master Farmers skilled and resource endowed farmers
- Recruiting new staff and in-service training
- Conducting crops field days
- Monitoring Command Agriculture and Provincial yield targets
- Carry out demonstration plots on tobacco, maize new varieties, cotton weed management and pest control, limed and non-limed field etc.
- Open Pollinated seed maize production under (Zunde raMambo) plots and commercial maize production for the disadvantaged.

- Strengthening Research and Extension Linkages through workshops and competitions, shows, field days etc.
- Conducting Technology and Seed Fairs at district and provincial levels.
- Audit of land utilization plot by plot for planning purposes.

3.4 Field study phase for data collection

Prior to the commencement of the field study, the researcher undertook a reconnaissance survey with the extension officers, Land Resettlement officers and officials from the department of mechanization and the central Reserve Bank of Zimbabwe. To familiarize with the study area communal and resettlement areas were visited in order to explore the cropping programs in the area, extent of mechanization, land use and grazing systems, landscape, vegetation and water sources and resource conservation techniques practiced.

After identifying the resources in the area, the researcher planned activities of the field study. Subsequent to the planning of the field study, workshops were held in both communal and resettlement areas on matters relating to mechanization programs, Fast Track Land Reform, agricultural activities and land degradation in the area. Furthermore, interviews were conducted at household level to get individual farmer's opinions. These interactions were also made with all other identified stakeholders.

3.5 Methods of Data Collection

The study used both primary and secondary data. Secondary data were useful for background information and for the researcher to get a better understanding of the study area. The main sources of secondary data were the previous studies conducted in the study area and the data provided by the ministries of agriculture (Arex), lands and resettlement, local government and engineering and mechanization departments. Primary data were obtained from different stakeholders and farmers in both Musana and Masembura communal areas as well as selected

resettlement areas in the District. A formal method of data collection was used. Workshops were also conducted to carry out group interviews and interviewing of key informants.

3.5.1 Transect walk

The researcher and a group of farmers, local leadership of the two communal areas and extension officers in the District embarked on a transect walk. Through the walk the researcher got an overview of the area and made general observations. It was during these walks that the researcher saw physically the machinery and equipment given to some beneficiaries of the mechanization programme. The researcher also managed to talk to some household heads in the area. The key participants, that is Arex officers and village heads who were to be used as enumerators helped in identifying issues relating to land use, cultivated crops, cultivation patterns and the mechanization programmes in the area.

3.5.2 Sampling Framework and Purpose

According to (Havlicek and Peterson 1977) larger samples provide more precise estimates of parameters and smaller confidence intervals. Ninety households were therefore sampled randomly in each of the identified areas of the district. Lists of households/farmers supplied by the Agricultural Extension and Technical Services department (AREX), resettlement office and the provincial Central Statistics Office were used. The primary sampling unit in the survey was the ward (a unit into which a district, a city or town is subdivided for administration and election purposes). The choice of the sampling unit in Bindura District was based on the fact that ward boundaries are still intact.

3.5.3 Sampling methods

The sampling frame comprised of 90 farmers drawn from both communal and resettlement areas of Bindura district. Farmers were classified into three groups:

Group 1: farmers with cattle and ox drawn machinery

Group 2: farmers with tractor drawn or powered machinery and

Group 3: farmers without machinery or non beneficiaries of the mechanization program

Classification was based on the data on beneficiaries and non beneficiaries of the mechanization programme be obtained from the Department of Agricultural Engineering and mechanization, and Local government. Stratified sampling was used where farmers were clustered according to geographical location because the two communal areas consisted of many villages and the sample had to be representative of the whole district. After grouping, the farmer's location was identified and simple random sampling was used to represent each target group in each selected village. Although simple random sampling is tiresome and not usually the most convenient sampling method (Babbie, 1973), it was the most convenient in this study because it gave every farmer an equal chance of being selected.

3.5.4 Household interviews and administering of questionnaires

A questionnaire consisting of both open and close-ended questions was used to collect household data (Annexes 2). Since some information was to be collected directly from the farmers, a questionnaire was regarded a convenient instrument for the survey. The questionnaire was presented to each respondent individually. This minimized the influence of peer farmers on the respondent's response. The questionnaire was administered by the researcher to establish good rapport with the farmers and explain to household heads the purpose of the study. Interviews conducted ensured that all items on the questionnaire were considered and respondents did not omit difficult questions as they would likely do when they do not understand and interpret

questions. Although questionnaires had disadvantages of time and costs, they were still regarded as the most convenient survey instrument for the study.

The interviews focused on size of the household, number and type of people's machinery, crops grown, livestock owned, income sources and people's perceptions on what could be done to increase income from agricultural production. Households' perceptions on machinery distribution techniques under the ongoing mechanization program, the Fast Track Land Reform and causes of land and resource degradation in the district, relationship between livestock and cultivation of crop fields, the role they play as households in determining who benefitted under the mechanization program and contributions of communities in resource conservation as a way of curbing land degradation for sustainable agriculture were also asked. In resettlement areas where Arex is active, the interviews also focused on what role the Arex department play. For the interviews, two months were allocated for the whole study area as illustrated under annex 1.

3.5.5 Focus groups

In the first month of the study, the researcher conducted workshops with crop and livestock farmers in the resettlement area. In these workshops, focus groups were used to explore the views of the farmers at village level on their perceptions on mechanization, resource and land degradation, socio-economic organizations and agricultural production systems. Focus groups according to (Kitzinger, 1995) are organized group discussions with groups discussing given topics.

The farmers were organized into different groups based on age and gender. Three groups were formed: Group A, males above the age of 35 years, Group B, females above the age of 35 years, and Group C, both men and women whose ages were below 35 years. Farmers were also grouped according to their machinery ownership, crop and livestock production systems. These groups interacted on common issues on the questionnaire.

The focus groups actually helped farmers to explore and clarify their views through interacting in ways that would not have been possible in household interviews. Although focus groups were

helpful in bringing out several perceptions, attitudes, beliefs, reactions and feelings, the main disadvantage was the difficult role of working with large groups of the facilitators. Another challenge was in grouping farmers according to their similarities, which was the number and type of machinery owned by an individual without creating a sense of being discriminatory or ranking according to status.

3.5.6 Stakeholder interviews

All stakeholders identified as relevant in this study were also interviewed, using semi-structured questionnaires relevant to each one of them. The stakeholders identified in this study are shown in Table 3.1 below. The table shows the position of the representative interviewed and also the number of individuals representing a particular stakeholder.

Table 3. 1: Stakeholder interviewed

Stakeholder	Position	No. of persons interviewed
AREX Department	Arex District Officer	1
Lands Department	Chief Lands Officer	1
Mechanization Department	Chief Officer	1
ZFU	Project Officers	4
Department of Local Gvt	Assistant DA	1
Department of Natural resources	Provincial natural resources Officer	1

Source: compiled during the field study (2009)

3.5.7 The key variables considered for the model

A dependent variable for machinery and equipment ownership is explained by a situation where the farmer either benefitted under the mechanization program or not. Failure to access machinery and equipment in the study is hypothesized to be principally a result of other variables such as land availability.

In this study, as shown on the table below the variable for determining machinery and equipment ownership is denoted as 1 and 0 indicating mechanically and technically constrained farmers. The independent variables of the study are hypothesized to have associations with the dependent variables. Specifically, the existing theoretical explanations and findings from several studies relating to technical aspects farming systems have been used to select 12 potential explanatory variables, hypothesized to indicate existence and non existence of machinery/resource constraints.

Table 3. 2: Definition and units of measurements of key variables modeled

Dependent variable	Definition	Value
Machinery and equipment ownership	beneficiaries and non beneficiaries of the mechanization program, assumed machinery constrained and non constrained farmers	Coded 1 for beneficiaries (non constrained) and 0 for non beneficiaries (constrained)
Independent Variables	Definition	Value
AGE	Age of the household head in years	Actual age in years
EXP	Farming experience	Years of farming
OFFINC	Off-farm income	A Dummy variable = 1 if the farmer earns off farm income; 0 otherwise
LANDSEC	Land security of land ownership rights	A Dummy variable = 1 if the farmer has secure land rights; 0 if the farmer is insecure
MKTDISTANCE	Distance to output market	Actual distance in kilometers
EXTC	Extension contact	A dummy variable = 1 if the farmer is being assisted by an extension officer; 0, otherwise
LABOR	Farm labour	A dummy variable = 1 if the farmer employs labour; 0, if not
INPUT	Technical farm inputs	A dummy variable = 1 if the farmer gets all the necessary technical inputs in time; 0, otherwise
INFORMATION	Technical, price, market, demand and supply information, contact with extension services and other technical support from public/private sectors	Coded 1 if the farmer is satisfied with level of information available and 0 otherwise
Equip and Machinery	Machinery and equipment such as tractor, ploughs, from other sources	Coded 1 if farmer owns or has ready access and 0 otherwise
INFRASTRUCTURE	Publicly-provided infrastructural facilities including road network, power, water, etc	Coded 1 if the farmer is satisfied with the available infrastructure, and 0 otherwise
TOTALINCOME	Gross value of annual farm production from crop and livestock	US \$ value of gross annual production

Source: compiled during the field study (2009)

Variable specification

The relationships of dependent variables presented in the table above are explained below.

(a) Age (AGE): this variable measures the actual age of the household head in years. Younger farmers are expected to be mechanically constrained than older farmers who are perceived to have acquired access to resources. Therefore, it is hypothesized that age of household head and machinery access are positively correlated. This is supported by an observation by Belete and Fraser (2003) that older farmers are likely to have more resources at their disposal.

(b) Farming experience (EXP): this variable measures the number of years a farmer has been engaged in farming. It can be hypothesized that the lesser the number of years the farmer is involved in farming, the higher the probability of being resource constrained because certain farming resources are assumed to be associated with experience. Thus, there is a positive correlation between machinery and equipment access and farming experience.

(c) Off-farm income (OFFINC): this variable measures whether or not the farmer is receiving off-farm income. Off-farm income can help farmers in acquiring resources as they have alternative capital inputs. Farmers who lack off-farm income are likely to be affected by financial constraints. This is supported by Mashatola and Darroch (2003) who say that it can be hypothesized that there is a positive correlation between off-farm income and machinery or equipment access.

(d) Land security (LANDSEC)/ Property Rights: this variable refers to the security of land ownership rights, not common among beneficiaries of the Fast Track Land Reform. Land security is likely to be one of the major causes of resource constraints because the absence of property rights inhibits farmers from capital investments (Enki, Belay and Dadi, 2001). Therefore, in this study it is hypothesized that land security inversely affects machinery access or capital investment.

(e) Distance to markets: refers to the distance to output buyers. The greater the distance to the market, the higher the transport costs and remote located farmers are likely to lack favorable markets and access to machinery and other resources.

(f) Extension contact (EXTC): this variable measures whether farmers are in contact with extension officers or not. Extension service is an important source of information and advice to smallholder farmers (Enki, Belay and Dadi, 2001). Thus, it can be hypothesized that lack of extension support inversely influence, levels of income and machinery or resource access.

(g) Labour shortage (LABOR): refers to the household head's opinion on labour availability. It is hypothesized that smallholder farmers heavily rely on human labour and that its shortage negatively affect production leading to lack of resources.

(h) Farm inputs (INPUT): this variable refers to farm inputs such as hybrid seeds, pesticides and chemicals. It is hypothesized that farmers with inadequate inputs are less likely to achieve higher levels of production leading to lack the purchasing power for machinery and equipment.

(i) Infrastructural facilities (INFRASTRUCTURE): this variable is referring to physical and market infrastructural facilities such as good road network. It is hypothesized that farmers with inadequate infrastructural facilities lack information and market access hence may fail to access other resources such as machinery.

(j) Technical information (INFORMATION): this variable is referring to information which the farmer needs to improve production, and marketing of produce. Farmers with inadequate technical information are likely to lack resources.

(k) farm equipment (EQUIPMENT): this variable is referring to the presence or absence of equipment such as ploughs, planters, etc. which the farmer needs to improve production. Farmers with inadequate farm equipment are likely to have low production levels and lack other resources.

(l) Total gross income in 2008 (TOTALINCOME): Gross value of annual farm production from crops and livestock. It is hypothesized that low values signify lack of machinery, finance and access to vital input resources.

3.6 Data analysis

Since the objective of the study is to assess and quantify the impact of mechanization on agricultural productivity, sustainability and food security, the farmers' ability to maximize production on increased cultivated land post FTLR as a result of the mechanization programme and farmers' access to machinery, with availability of other inputs assumed constant, will be assessed. Farmers' Gross Margins for the two crops namely maize and soya bean over a period of two seasons and the socioeconomic data had been established to identify the viability of the mechanization programme. Yield levels (total physical products) for the two crops were also

established. Thereafter the Cobb Douglas production function was used to establish efficiencies in agricultural productivity after implementation of the mechanization programme.

3.6.1 Description of the Analytical Framework

The Stochastic Frontier Production Function was independently proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977). The original specification, involved a production function specified for cross-sectional data which had an error term with two components, one to account for random effects and another to account for technical inefficiencies. The Cobb Douglas Model, one of the widely used Stochastic Frontier methods was employed in this research to establish the relationship between resource/machinery ownership and production efficiencies. To estimate a Cobb-Douglas production function, one has to log all input and output data before creating the data file for the programme use. The Cobb Douglas production function was assumed to be in version 2.0, data had therefore to be supplied in original units since the program would obtain the logs of the data supplied.

The principal aim of using the Stochastic Frontier Production Function was to address the set objectives and research questions as stated in chapter one. The stochastic frontiers were used to predict farm-level efficiencies using the estimated functions and to regress the predicted efficiencies upon farm-specific variables, highlighted above in an attempt to identify some of the reasons for differences in predicted efficiencies between the two farming sectors producing the two crops.

The Model used solves two general parameters, and the error components can be formulated as

$$Y_{it} = X_{it} \beta + (V_{it} - U_{it})$$

Where Y_{it} is the (logged) or assumed obtained output obtained by the farmer in the t-th or stipulated time period; X_{it} is a (kx1) vector of (transformation of the) input quantities of the i-th firm/farm in the t-th time period; β is a (kx1) vector of unknown parameters or variables; and V_{it} are assumed to be iid $N(0, \sigma_v^2)$ random errors, and $U_{it} = U_i \exp(-\eta(t-T))$, where U_i are assumed to be iid as truncations at zero of the $N(\mu_i, \sigma_u^2)$.

If $h > 0$, the inefficiency term, U_{it} , is always decreasing with time, whereas $h < 0$ implies that U_{it} is always increasing with time. That could be one of the main problems when using this model, hence technical efficiency is forced to be a monotonic function of time.

The second model included in the FRONTIER package is the Technical Efficiency (TE) effects model (Battese and Coelli, 1995). It can be expressed as $Y_{it} = X_{it} b + (V_{it} - U_{it})$, where Y_{it} , X_{it} , b and V_{it} are as defined earlier and $U_{it} \sim N(m_{it}, s_u^2)$, where $m_{it} = Z_{it}d$, Z_{it} is the vector of firm/farm's-specific variables which may influence efficiency. FRONTIER offers also the solution of the model of Stevenson (1980) which is a particular case of the previous model that can be obtained for the cases in which T is equal to 1 (for cross-sectional data).

There are two approaches to estimating the inefficiency models. These may be estimated with either a one step or a two step process. For the two-step procedure the production frontier is first estimated and the technical efficiency of each firm/farm is derived. These are subsequently regressed against a set of variables, Z_{it} , which are hypothesized to influence the firms'/ farms' efficiency. A problem with the two-stage procedure is the inconsistency in the assumptions about the distribution of the inefficiencies. In the first stage, the inefficiencies are assumed to be independently and identically distributed (iid) in order to estimate their values. However, in the second stage, the estimated inefficiencies are assumed to be a function of a number of firm/farm's specific factors, and hence are not identically distributed unless all the coefficients of the factors are simultaneously equal to zero (Coelli, Rao and Battese, 1998).

The production possibility frontier for a given set of inputs is illustrated in Figure 3.6,1 below (i.e. an output-orientation). If the inputs employed by the firm/farm were used efficiently, the output of the firm/farm, producing at point A, can be expanded to point B. Hence, the output oriented measure of technical efficiency ($TE_o(y,x)$), can be given by OA/OB . This is only equivalent to the input-oriented measure of technical efficiency under conditions of constant returns to scale. While point B is technically efficient, in the sense that it lies on the production possibility frontier, higher revenue could be achieved by producing at point C (the point where the marginal rate of transformation is equal to the price ratio p_2/p_1). In this case, more of y_1 should be produced and less of y_2 in order to maximize revenue. To achieve the same level of revenue as at point C while maintaining the same input and output combination, output of the firm would need to be expanded to point D. Hence, the revenue efficiency ($RE(y,x,p)$) is given by OA/OD . Output locative efficiency ($AE_o(y,w,w)$) is given by $RE(y,x,w)/TE_i(y,x)$, or OB/OD as shown in Figure 3.6,2 (Kumbhaker and Lovell 2000).

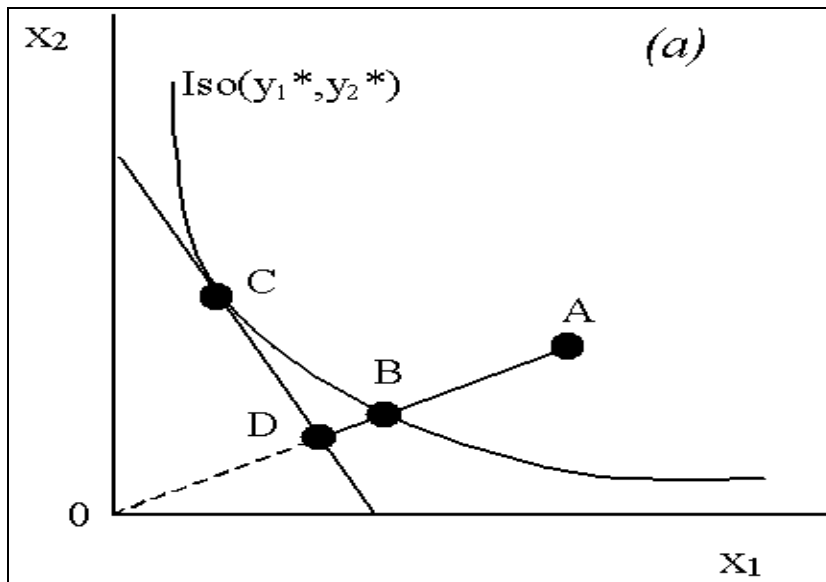


Figure 3. 4.1: Input (a) and output (b) oriented efficiency measures
Source; Kumbhaker and Lovell (2000)

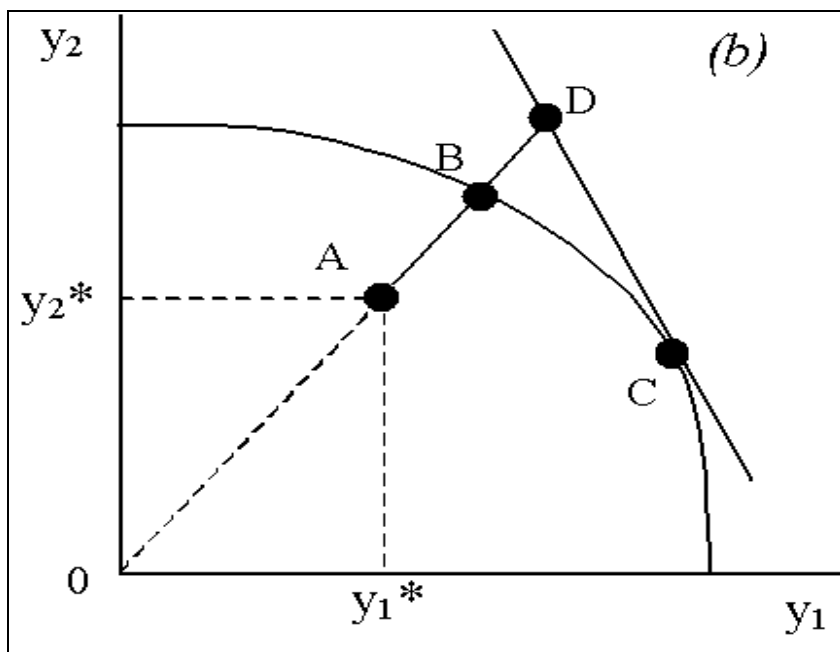


Figure 3. 5.2: Input (a) and output (b) oriented efficiency measures
Source; Kumbhaker and Lovell (2000)

3.6.2 Application of the Cobb Douglas Production function

In economics, the Cobb-Douglas functional form is widely used to represent the relationship of an output to inputs. It was proposed by Knut Wicksell (1851 - 1926), and tested against statistical evidence by Charles Cobb and Paul Douglas in 1928. They considered a simplified view of the economy in which production output is determined by the amount of labor involved and the amount of capital invested such as mechanizing the agriculture sector. While there are many other factors affecting economic performance, their model proved to be remarkably accurate.

Cobb-Douglas production function shows physical output as labor and capital inputs; that is:

$$Q = A L^a K^b$$

Where Q is output, A, α , b are constants, and L and K are labor and capital, respectively.

Capital can be interchanged with labor without affecting output. Or

$$P(L, K) = b L^a K^b$$

Where:

- P = total production (the monetary value of all the produce or goods produced in a year)
- L = labor input (the total number of person-hours worked in a year)
- K = capital input (the monetary worth of all machinery, equipment, and buildings)
- b = total factor productivity
- The a and b are the output elasticities of labor and capital, respectively. These values are constants determined by available technology.

Output elasticity measures the responsiveness of output to a change in levels of either labor or capital used in production, *ceteris paribus*. For example if $b = 0.15$, a 1% increase in capital/machinery and equipment would lead to approximately a 0.15% increase in output. Furthermore if $a + b = 1$, the production function has constant returns to scale, that is if L and K are increasing by 20% the P is also increasing by 20%. The function is homogenous of the degree, $a + b$, if $a + b > 1$ there are increasing returns to scale; $a + b = 1$ indicates constant returns to scale and $a + b < 1$ indicates diminishing returns to scale.

According to Battese and Coelli (1988) the productive efficiency of a firm/farm after long term capital investment is witnessed in the long run. In the short run returns decrease at an increasing rate, reach a constant level and start to increase but at a decreasing rate. So the argument is that it might be early to anticipate very positive upward curves in the output production as a result of mechanizing the agricultural sector in Zimbabwe. Positive upward curves may be witnessed in the long run. The figures below show the behavior of a firm/farm in the short and long run after a long term capital investment Coelli (1988).

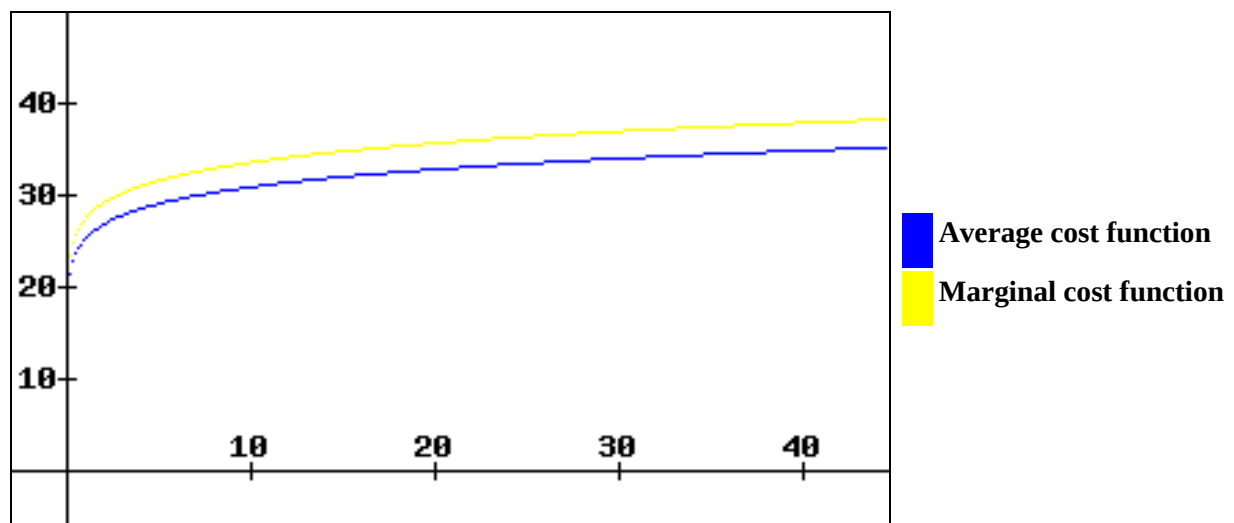


Figure 3. 6: Decreasing returns to scale; of the Cobb Douglas Function
Source; Sandilands (1999)

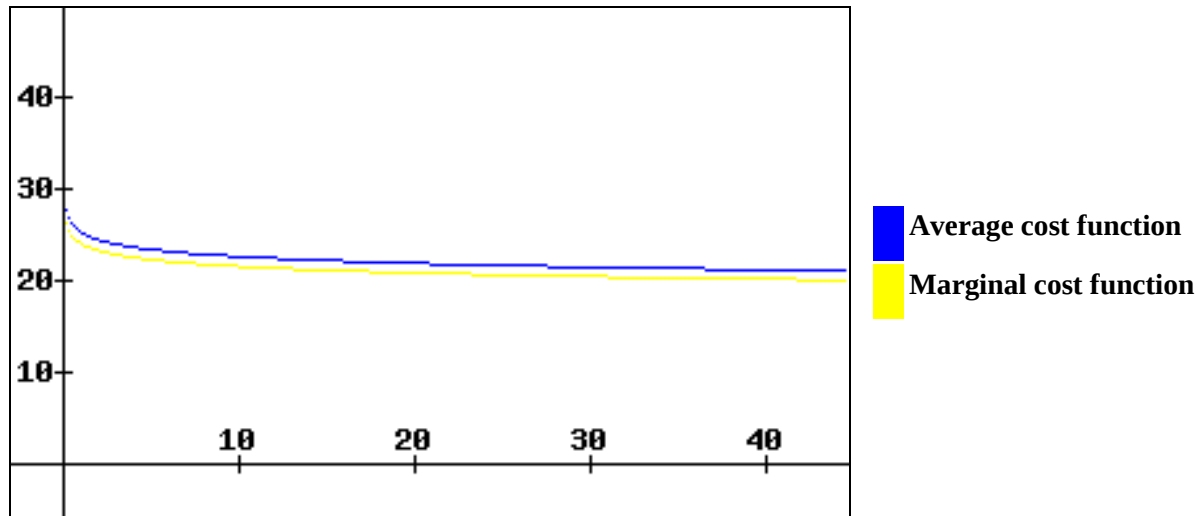


Figure 3. 7: Increasing returns to scale
Source: Sandilands (1999)

The graphs show that both average and marginal costs are increasing, and marginal cost is greater than average cost. These results are the consequence of the Cobb-Douglas production function having decreasing returns to scale. The cost functions don't look like the U-shaped cost functions.

3.6.3 Short run - capital fixed - decreasing returns to scale

We usually assume that capital is fixed in the short run. Suppose the firm/farm is to operate efficiently (using the cost minimizing combination of inputs) producing product in the 25 - 35 unit range (using the decreasing returns Cobb Douglas production function). It might set its capital $K = 35.56$, which is the amount of capital associated with producing $q = 30$ units of product.

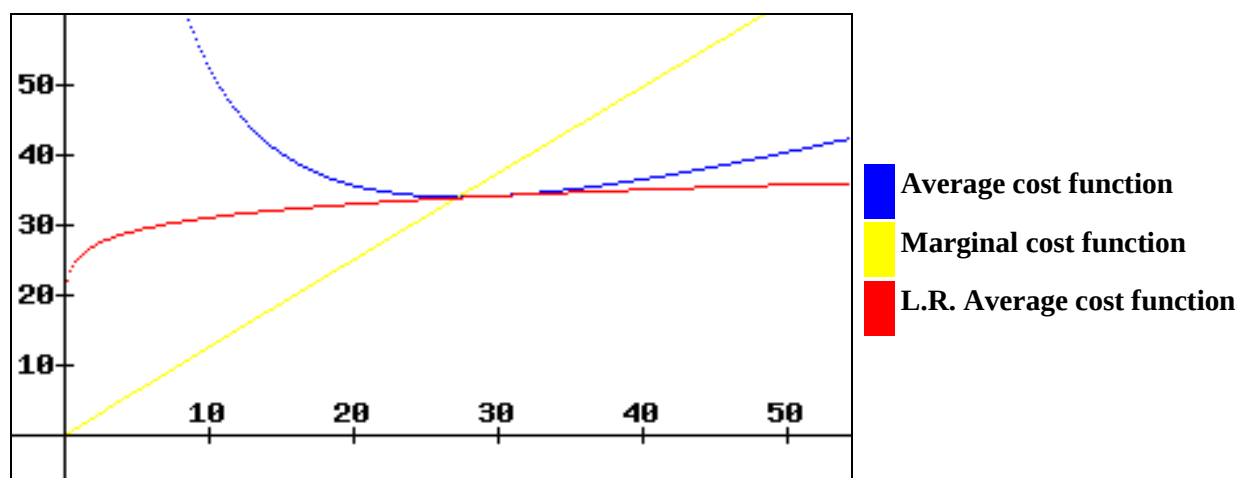


Figure 3. 8: Decreasing economies of scale
Source Hillary (1997)

Now we get the traditional U-shaped average, short run cost curve, with a minimum to the left of $q = 30$. Because marginal cost is virtually a linear function of q , total cost (with capital fixed) is virtually a quadratic function of q (since its derivative, marginal cost, is linear).

3.7 Summary of the chapter

This chapter described methodologies, selection of the study cite and analytical models used. It focused on aspects such as location, physical settings, socioeconomic settings and agricultural production or economy of the district and province under study. The soils and vegetation types of the district and province under study reflected the relevance of the types of farming activities mainly intensive cropping and livestock production practiced in the area which portrayed the seriousness with which they should be considered for support by both the external (development and donor organizations) and the government. It spelt out the sources of data used in the evaluation of the socio-economic impact of mechanization on the livelihoods of farmers in the district. Justification of the use of data analysis tools was based on the previous studies that focused on the impact of mechanization on productivity, sustainability and food security in the country. The study therefore took the form of a comparative analysis of the two groups of farmers namely beneficiaries and non beneficiaries of the programme in terms of their productivity focusing on maize and soya beans which are the two major crops grown in the area

CHAPTER 4 PRESENTATION OF RESULTS

4.1 Introduction

The overall objective of the study is to determine the impact of Agricultural mechanization on agricultural productivity in Zimbabwe. More specifically the study aimed to identify the impact on productivity of two principal crops; maize and soya beans. It went further to identify the participation of both government and private entities in mechanization and recommend other programs compatible with strategies for sustainable agricultural development. This chapter therefore presents the results of the analyses of the survey data based on such set objectives and the specified research questions. The chapter begins with an analysis of the impact of mechanization on productivity, based on productivity levels of specified crops, farming systems in relationship to farmers' constraints and evaluation of the participation of government and the private sector in mechanizing agriculture. Factors such as demographic and socio-economic setting which are assumed to be influencing farmers' activities are also viewed. The Stochastic Frontier Production Function/Cobb Douglas Model was employed to identify differences in productivity and production efficiencies of the farmers to identify the impact of mechanization. Variables incorporated were those influencing agricultural productivities. The chapter also presents results of the key technical constraints affecting the smallholder farming sector.

4.2 Demographic and socio-economic characteristics

This section presents the results of the demographic and socio-economic characteristics of the survey farmers. Summary tables of descriptive statistics are also presented; Tables 4.1, 4.2 and Fig 4.3. The demographic characteristics are important in determining the extent to which they influence farmers' responses. The statistical results of the demographic data comprising age, household size, and educational levels are presented in Table 4.1.

Table 4. 1: Summary statistics of demographic variables (age, household size, education and farming experience)

		Communal			Resettlement			
Variable	Sampled Farmers' Group	Mean	Min	Max	Mean	Min	Max	Std Deviation
Age(years)	1 A1 Farmers	58	25	91	59	17	80	14.63
	2 A2 Farmers	61	42	77	60	21	75	12.43
	3 Communal	60	30	78	60	24	82	13.12
Household size	1 A1 Farmers	6	1	14	5	2	8	3.04
	2 A2 Farmers	6	1	12	5	1	14	4.00
	3 Communal	6	3	12	6	3	8	2.34
Education (years)	All	8.5	0	17	12.5	7	18	3.65
Experience (years)	1 A1 Farmers	25	0	59	15	1	53	3.42
	2 A2 Farmers	28	3	47	25	1	46	3.24
	3 Communal	25	9	50	13	7	29	3.56

Source: Field survey data (2009)

Table 4.1 above shows the age group category of sampled farmers both beneficiaries and non beneficiaries of the mechanization programme. The results in both cases show that older farmers benefitted more from the programme than the young farmers. The observation shows that young farmers spend much of their time on off farm activities which are their main source of income.

There is a significant proportion of young farmers as indicated by large values of standard deviations of 14.63, 12.43, and 13.12 showing the extent to which this age group is not participating in the programme. Still with reference to age there are no significant differences in the average age of the three groups of farmers within each village and between similar groups across the three study villages, the average age is about 60 years. The age distribution of farmers in the three target groups in both areas follows the trend that very few farmers are therefore below the age of 30 and most of them are above 60 years. The age groups between 41 and 67 show a successive increase in the number of farmers at each level this has proved to be a common feature in the A2 Resettlement farming communities. In line with the foregoing statement the age group 34 to 55 years shows a marked increase in the number of farmers especially in the newly resettlement areas and these are the majority of the beneficiaries of the mechanization programme.

Household size as a parameter of significance shows that bigger families are now found in the resettlement areas where a maximum of 14 is recorded. This confirms that labour can be readily available hence machinery can be the limiting factor in agricultural productivity. A high value of standard deviation 3.65 on education shows the gap between the communal and the newly resettled farmers. The preceding findings show that more educated farmers have moved on to resettlement areas to take up new farming ventures.

4.3 Age categories and major farming activities

Figure 4.1 presents the link between age, farming activities and machinery resource endowment among farmers. As shown on the Figure below the age group 45 to 60 years reflects a declining trend in the number of people involved in productive farming. The escalation in numbers of young people who resort to farming is assumed to be due the fact that farming is regarded as the only stable source of income and livelihood in the area. Taking cognizance of the fact that life expectancy in Zimbabwe due to the current poverty levels, is declining (World Bank, 2007) one therefore expects fewer aged people in farming and to be in possession of machinery resources.

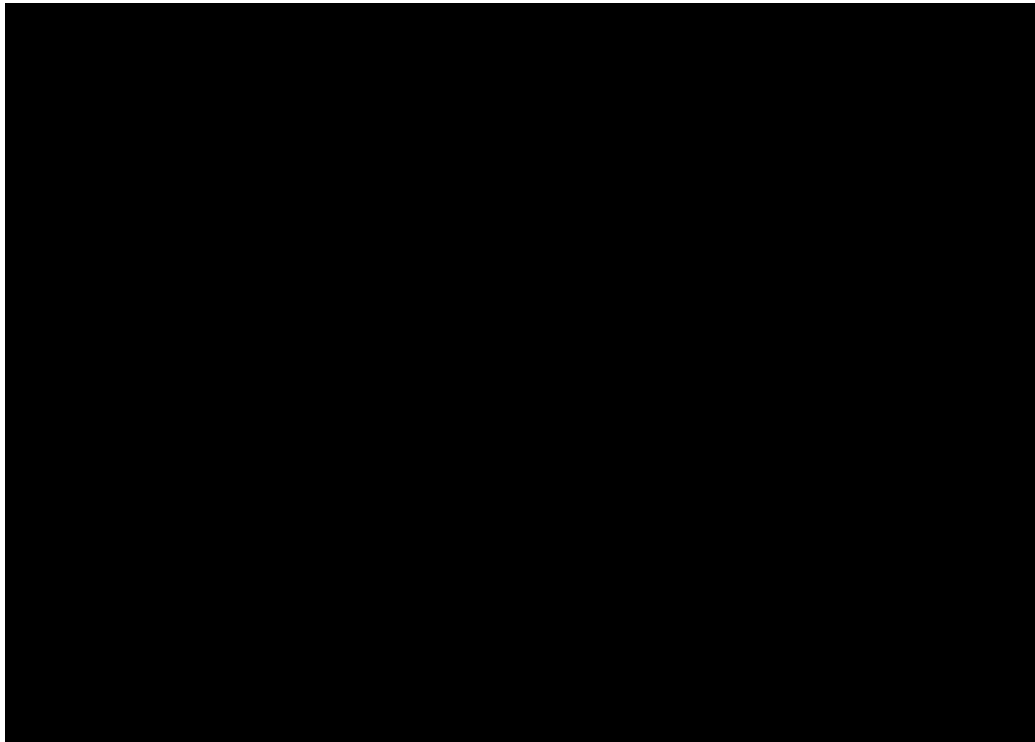


Figure 4. 1:Age categories and major farming activities
Source: Arex district office Bindura (2008)

4.3.1 Marital status of respondents and duties of household heads

Sample farmers were classified based on their marital status. The marital status is classified in three categories namely: single, married and widowed. Figure 4.2 shows that the distribution of households by marital status portrays a general trend of male dominance in most households. As illustrated by figure 4.2 below most household heads about (61%) are married, while the rest are widowed, divorced or single.

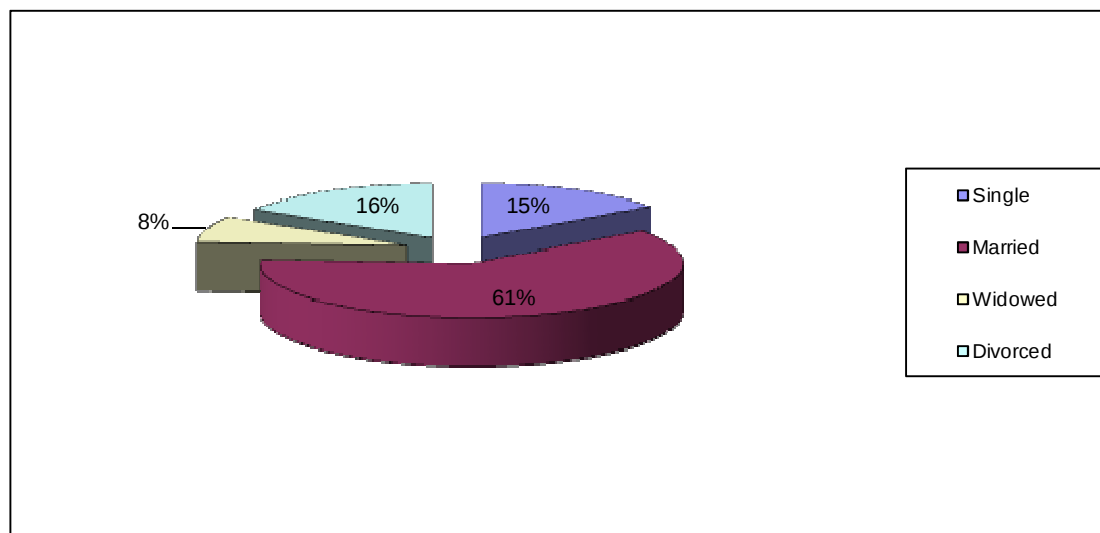


Figure 4. 2: Distribution of respondents/ heads of households
Source: Field survey conducted (2009)

In African family set-ups, the husband and wife play complementary roles. For instance, while the wife performs the day to day household chores and small scale farming activities such as gardening for food security. However regardless of gender most household heads are involved in income generating activities such as farming at a larger scale and other non farming activities such as formal employment. In the absence of household heads children and the elderly can encounter a situation where they have to perform duties on behalf of the heads. In this regard, the extent to which they are expected to undertake farming activities would differ. The implication is that a household with a head is better off than a child or elderly headed household in terms of farming which may require specialized skills for high productivity.

4.3.2 Level of education and farming experience

Literacy has been noted to be one of the factors that limit development especially in under developed nations. Educational levels influence adoption of new innovation by farmers (Bester et al 1980). It enables farmers to acquire and process relevant information effectively. Sebotja (1985) in researches conducted at Dheli University argues that although some empirical diffusion

studies indicate that literacy enhances adoption of innovations there is not much evidence of improved productivity as a direct attribute of schooling experience.

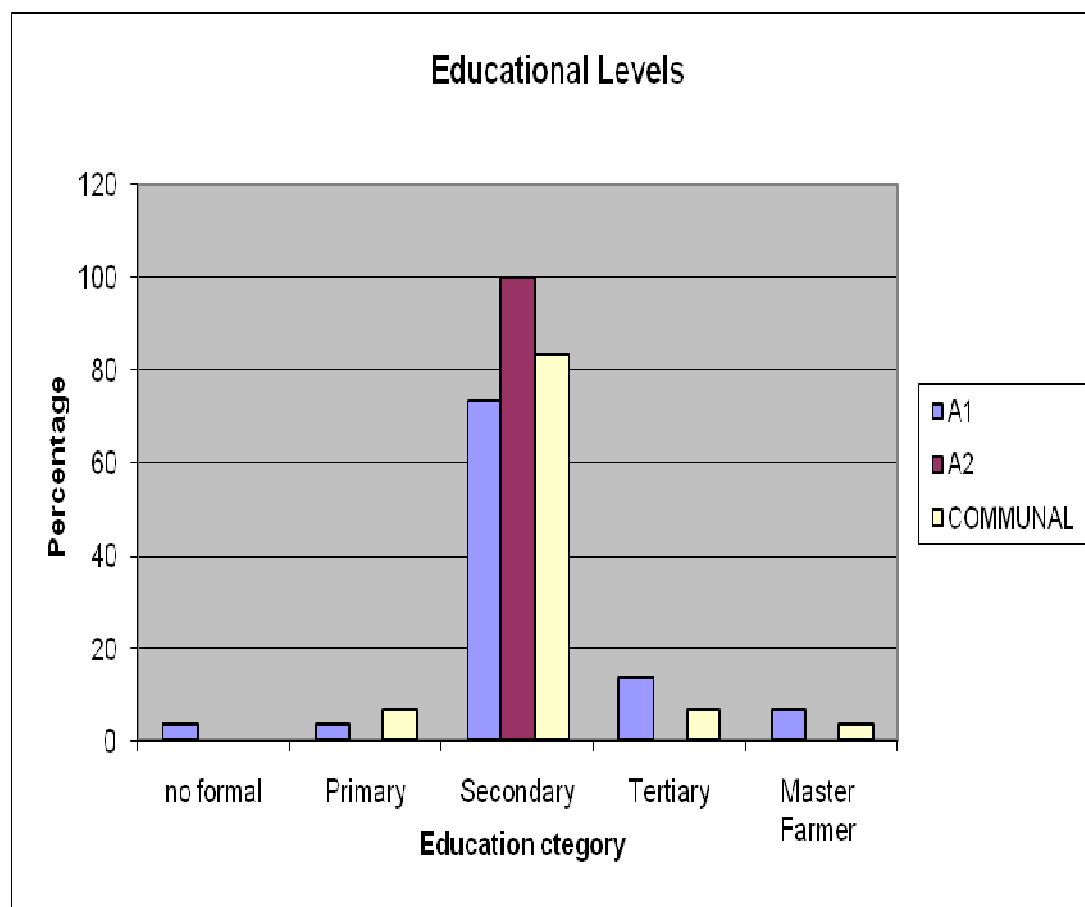


Figure 4. 3: Educational level of household heads/ respondents
Source: Survey 2008

In Zimbabwe formal education begins with a seven year primary cycle. Secondary education consists of a six year programme after which people go to tertiary institutions. In the sampled households educational level was determined by the number of years of schooling completed by the head of household, as shown above. Farming experience refers to the number of years the respondent engaged in farming. It is hypothesized that farmers acquire more farming experience as they get older. Chiremba and Masters (2003) cited that farming experience is a predictor of good farming performance. On that basis, other factors held constant, older farmers are less likely to be resource constrained as experience would mean better farming techniques and higher

yields for purchasing machinery. The implication of the observed result is that as farmers grow older, they are likely to acquire more farming experience.

4.4 Socio-economic characteristics

The respondents were assessed on different aspects of their socio-economic characteristics. This section presents different socio-economic characteristics of sample farmers which include machinery or asset ownership as a result of the ongoing mechanization programme, cultivated area, crop production trends specifically maize and soya beans and their production efficiencies based on, farming experience, farm income, various farm inputs and market related variables. Tables 4.2 and 4.3 present the summary statistics of socio-economic factors of the survey farmers.

Table 4. 2: Summary statistics of socio-economic variables of sampled 45 respondents, communal

Variable	Minimum	Maximum	Mean	Std Deviation
Area Cultivated	0.5	724	2.6	4.9
Training requirement	1	4	2.4	1.1
Educational Level	1	5	3.1	0.5
Labour employed	1	8	2.1	1.8
Mechanization	1	5	1.3	0.8
Production (Kgs) maize	500	16200	5647. 8	4740.2
Crop Income (US\$) 2008/09	1000	32500	819	24790.3
Livestock Income (US\$) 2008/09	250	8125	9416.6	19989.1
Total Income (US\$) 2008/09	0	108500	11205. 6	29287.2
Market Distance (km)	4	60	18.9	36.0

Source: Field Survey, 2008.

As shown on Table 4.2 the gross value of farm produce from the 45 communal household heads ranged from zero to as much as US\$ 108500 in a year. It should be noted that these data were not analyzed for purposes of estimating household incomes but merely as a means of classifying the households under socio-economic categories. The data shows that about half of the respondents earned far much less than US\$11205.6 during the 2008/09 season. High standard deviations of both asset value and gross farm income variables further confirm the huge disparities in socio-economic status within the smallholder communal farmers, reflecting that this is by no means a homogeneous category.

There was evidence that some farmers supplemented their income by undertaking non-farming activities. It was clear from the data that the majority of the surveyed farm households had been in the farming business for some time, with some having length of experience spanning up to half a century. The data also picked up new entrants into farming activities especially in the resettlement areas.

Table 4. 3: Access to economic resources by sample farmers

Modeled Variable	Number of farmers	Percentage (%)
Fertilizer Use and Access	19	21.1
Access to Tillage services	21	23.3
Assets/ Machinery through Mechanization.	48	53..3
Infrastructure availability	18	20
Information availability	35	43.7
Credit Need	58	72.5
Credit Access	12	15.0
Equipment ownership	38	47.5
Unsold produce	71	88.7
Non-farm employment	10	11.1
Land ownership (title deeds)	6	6.6
Source of information	16	17.7
Extension services	52	57.7
Market guaranteed in 2007	16	17.7
Selling problem in 2007	76	84.4

Source: Field Survey, (2009)

The results reveal other areas of inequalities in the smallholder sector and the serious constraints that this segment of the population faces. For instance, the results show that a large number of smallholder farmers both in communal and resettlement areas did not apply fertilizers probably because they could not afford them, or those being distributed through the government's ongoing Champion or Target Farming (Maguta Programme) would not reach them. Only 21.11% of the respondents had managed to use fertilizers during the 2007/08 season. The situation is linked to the fact that, despite an overwhelming need for inputs credit by the survey farmers estimated at about 72%, only 15% as shown above benefitted under the credit facility during the 2008/09 season.

Evidence drawn from the table above shows that the majority of smallholder farmers were constrained in terms of access to infrastructure as their farms are characterized by poor road network and information systems. Many also lack the capital investment to expand on their productive activities. It is obvious that most of the survey farmers had a long-term commitment to farming, with as many as 80% of them having prepared for the ensuing seasons. The consequences of the above mentioned constraints seem to justify that only 17.78% of the households were able to market their surplus maize and soya beans they had intended to dispose of during the 2008/2009 season.

4.4.1 Land Tenure Systems and Ownership Patterns

This study examined the patterns of land ownership in the smallholder communal, A1 and A2 resettlement sectors. In this case, farmers' situation regarding deeds and property rights were assessed. The study also investigated whether farmers were satisfied with the sizes of land they farm and reasons for their responses. Figure 4.4 and presents the findings regarding the distribution of farm types and tenure systems among survey farmers.

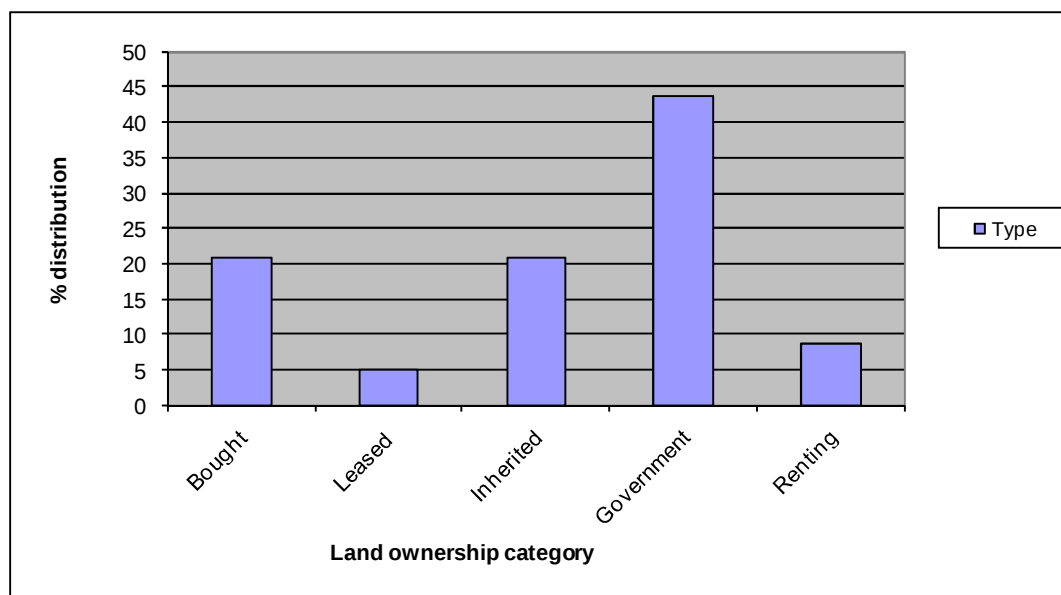


Figure 4. 4: Type of land ownership, survey farmers, Bindura district, 2008
Source: Lands department Bindura district (2008)

Findings concerning gender of household heads reveal that most households in the rural areas are headed by women due to migration of male members to urban areas in search of employment. However in resettlement areas most households are headed by males. This may stem from previous legislation which did not allow African women to have property rights on land resulting in mainly males applying farms even under the Fast Track Land Reform Programme.

The results show that 6.7% of survey farmers have title deeds. The largest proportion of the survey farmers carry out their farming activities on state/ government owned land which is held either under communal land tenure or the current (FTLR) tenure where beneficiaries are given temporary licenses commonly known as Offer Letters or 99 year Lease Agreements, in case of A2 farmers. Significantly, some of the farmers have either inherited portions of land and this is common in the communal lands, or bought land in case of the few remaining White commercial farmers as indicated by 20% in figure 4.4 above.

4.4.2 The Impact of Machinery and other inputs on Production Efficiencies

In relation to the availability of farm machinery and equipment obtained through the ongoing mechanization programme, the results show that farming types carried out by the farmers in the area is determined by the type and capacity of machinery and equipment possessed by the farmer. Rukuni (2004) argues that machinery and equipment are essential in agricultural productivity which enables production at larger scales. The impact of machinery and availability of other complementary inputs on agricultural productivity is shown on the Table below.

Table 4. 4: Cobb-Douglas Model for finding production efficiencies

Response Variable	Predictor Variable	Coefficient Estimate	Probability
Equipment	Farming type	1.7269	<.0001
	Credit	-0.7153	0.0314
Information	Risk	0.5780	0.0857
	Future planning	0.8396	0.0095
Complementary inputs	Loan Access	1.2413	<.0001
	Labor	-0.3339	0.2795
Infrastructure	Credit	0.5421	0.0777

Source: Analysis of results of data collected during the Field Survey, (2009)

Note: significance tests were carried out at the 10% level and variables such as complementary inputs consisting of labour and loan access are significant as their high coefficient estimates of 1.24 and -0.33 are greater than the set level of significance.

The observed predictor variables have coefficient and probability values that are statistically significant. Greater values those which do not deviate much from the set level of significance indicate that there is a strong correlation between the variable and the level of production obtained by the farmer. Again on the basis of the values of the coefficient estimate of 0.446 and a standard deviation value of 0.892. The results justify the literature reviewed which acknowledges that farm machinery and equipment relate to farming technology and, other factors assumed constant, farmers who possess machinery and equipment are likely to be more productive

(Machethe, 2004; Amani, 2004). Availability or absence of farm equipment shows that the type of farming carried out by the respondents is an indicator of the extent to which farm equipment can be constraining in the smallholder farmers. This result seems to be statistically significant on the basis of the values of the coefficient estimate (1.7269) and the probability value ($p=0.0001$).

The results also show that farmers who indicated that they did not need credit proved to be less likely constrained in terms of farm machinery and equipment probably because they were already well-capitalized and therefore in a position to meet equipment needs from their own sources or savings. About 48% of the respondents were missing crucial equipment and machinery for agricultural production and marketing purposes. The proportion of respondents missing equipment and machinery is significant enough to influence the agricultural activities practiced in the area.

4.4.3 Mechanization and agricultural productivity/maize and soya bean production

Tables 4.5 and 4.6 below give estimates of agricultural productivity as a result of Mechanization using the Stochastic Production Frontiers.

Table 4. 5: impact of mechanization on maize production

Variables	Mean	Median	Minimum	Maximum	Standard deviation
Output (Y) Maize (kg) (2009)	21 929.75	14 035.25	594.72	70 771.91	2,0 171
Seed (kg)	208.00	146.40	0.00	1163.20	2,44
Ferts (kg)	9585.35	3049.91	15.14	40 056.41	1,2 4
Capital (K1) (US\$) capital	17 287.38	536.13	14.90	110 484.29	3,2 046
Capital (K2) (US\$) machinery/fuel	5107.37	220.88	32.56	34 342.07	1,0 309
Labour (ldys)	400	180	12	24000	2,48

Source Field Survey (2009), Arex Department Bindura District (2008)

Table 4. 6: Impact of mechanization on soya bean production

Variables	Mean	Median	Minimum	Maximum	Standard deviation
Output (Y) (kg) Soya bean	20 800	10000	420	64000	1,8 264
Seed (kg)	200	136	000	1100	2,36
Ferts (kg)	8585	2049	13.2	40 056	1,2 4
Capital (K1) (US\$) capital	18 287	536	16.42	110 484	3,2 046
Capital (K2) (US\$) machinery/fuel	5107.37	220	32.56	34 342	1,0 309
Labor (lds)	280	168	168	1800	1,84

Source: Field Survey (2009), Arex Department Bindura District (2008)

The cost associated with machinery ownership indicated by cost of fuel on Tables 4.5 and 4.6 above shows a that there is a strong relationship between machinery availability, farming activities carried out by farmers and crop productivity. The high costs are an indicator of the extent to which farm machinery and fuel can be constraining in farming and reduce production. The results therefore confirm the literature in that with machinery and fuel, other factors held constant, farmers are likely to be more productive (Amani, 2006). The results are statistically significant on the basis of the values of the standard deviations of the total yields of the two crops, 2, 0 2 and 1, 82 respectively. The deviations of machinery and equipment usage portray high values of 1, 0 309 and 1, 0 309 showing the effectiveness of machinery on crop productivity.

Table 4. 7: Results of the Logistic regression on the relationship of productivity and total assets which represent machinery and implements owned by household heads.

Parameter	Maximum Likelihood Estimates						
	Coef.	SE Coef.	Z-value	P-value	Odds Ratio	95% CI of odds ratios	
						Lower	Upper
Intercept	-7.640	2.173	-3.52	0.000			
Information	4.174	1.558	2.68	0.007	65.00	3.06	1378.80
Total assets	4.209	1.350	3.12	0.002	67.32	4.77	949.36
Total income	2.768	1.226	-11203,	0.024	15.93	1.44	176.05
Extension assistance	0.6298	0.3027	4.3300	0.0374	3.524	1.076	11.541

Source: Field Survey, (2009)

Note: significance tests were carried out at the 5% level. Values obtained through the Cobb Douglas Model were regressed using the Logistic Regression to find the relationship between machinery usage and total production/productivity

The general observation was that production efficiencies were high (if $a + b > 1$ there are increasing returns to scale) within the resettlement farmers who have access to machinery and fuel. This could be revealed by lower P values for the total output. The high coefficients of total assets and total income indicated diminishing returns to scale ($a + b < 1$) as shown on the Table above. The other quality of the data; returns being constant not showing a significant response to the input/machinery usage ($a + b = 1$) is never demonstrated as there is a very wide gap between the production levels of those with machinery and those without. Crop production, other non- farm activities and the ownership of tangible valuable assets in the study area are therefore a strong determinant factor on production levels of farmers in the area.

The strong positive coefficient noticed confirms the concept that agricultural productivity is being influenced by machinery availability. According to Makhura (2001) market barriers are reduced when farmers possess machinery. The situation in respect of machinery ownership may reflect a complex environment in which the smallholder and resettled farmers operate.

Machinery enumerated included implements and farm machinery such as tractors, harvesters and shellers accessed through the mechanization programme.

4.4.4 Sources of credit for survey farmers

Despite the presence of other agricultural credit institutions in Zimbabwe, only government initiated contract or agricultural cooperatives and commercial banks are the only reputable sources of credit.

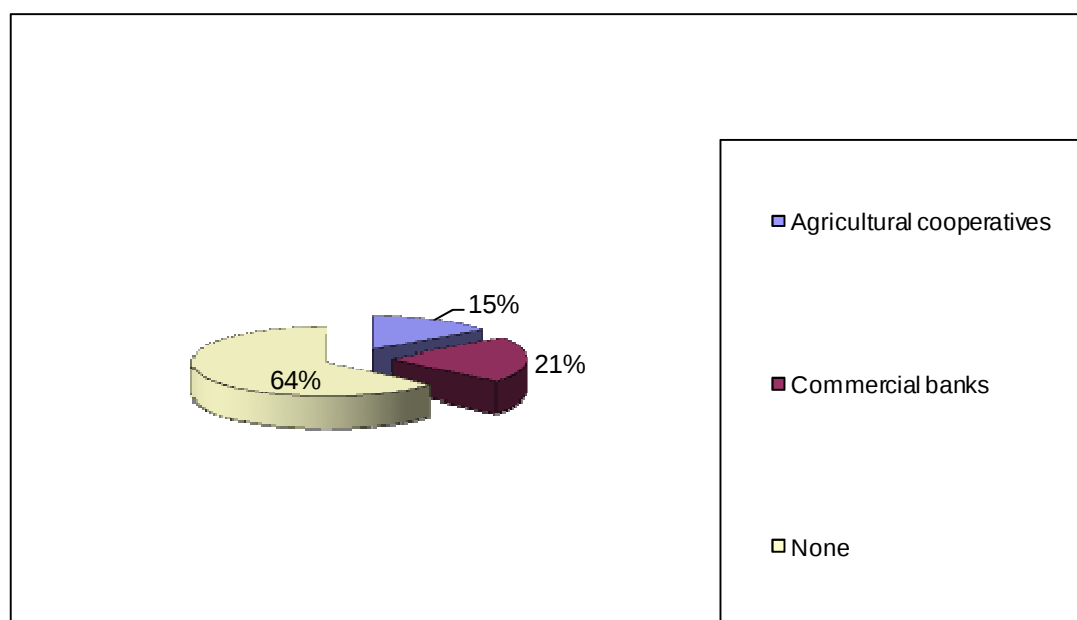


Figure 4. 5: Sources of credit for Household heads/ respondents
Source: Arex district Bindura (2008)

In total, 15% indicated that they had access to input credit facilities through cooperatives or farmers' organizations such as the Zimbabwe Farmers' Union (ZFU) in the small scale farming sector. Most of the newly resettled farmers obtain credit/ input loans from either commercial banks or government sponsored agricultural schemes. The other source of credit which is government initiated, contract farming is impacting less on agricultural productivity. The remaining 64% represents farmers who though in need of credit do not use it as they do not have access to the facility hence use own funding.

4.5 Services offered by extension officers to survey farmers

According to Machethe (2004) extension plays a crucial role in empowering farmers with farming knowledge, techniques and skills. It is therefore critical to assess the availability of extension services. The respondent farmers' evaluation of the quality of services and frequency of visits by extension officers has therefore been assessed in this study to establish the significance of research and extension to farmers. The basic function of extension is to extend research findings or information transference from research to the intended beneficiaries or farmers (Rukuni, 2004). The Figure below shows the farmers' rating of the services they get from extension.

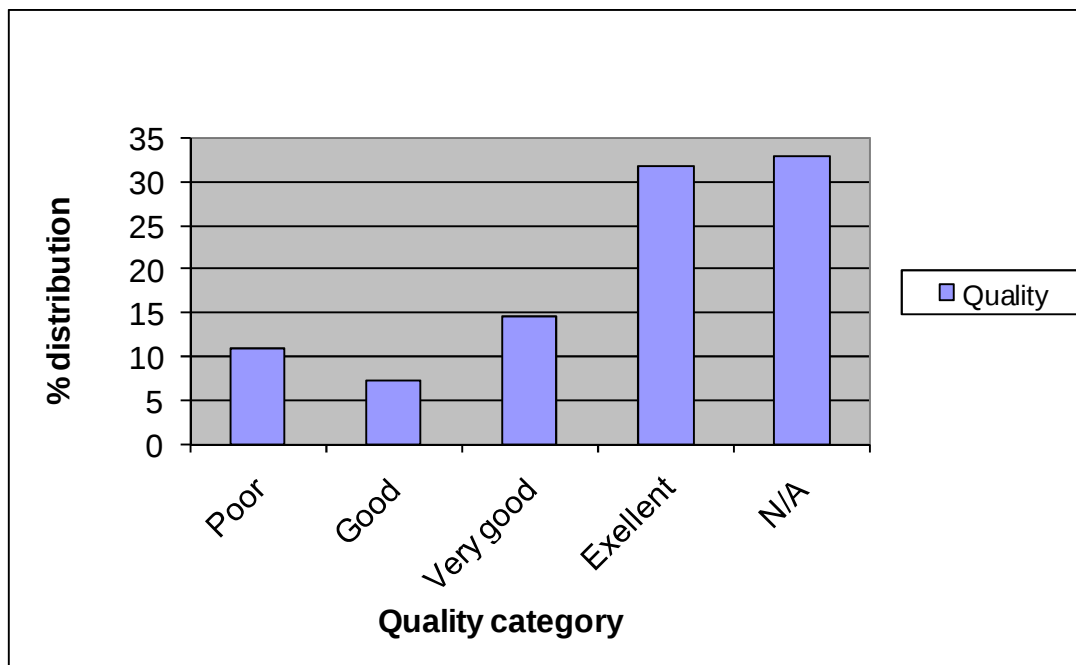


Figure 4. 6: Assessment of services offered by extension to respondents
Source: Survey work (2008)

Note: The category “N/A” stands for those farmers who did not receive extension visits or services

Farmers who have contact with extension services are generally impressed with the quality of service delivered as most responses are within the range of good, very good and excellent. Many survey farmers find the extension service to be excellent. The fact that there are few farmers who indicated poor quality of service by extension officers is still a cause for concern.

The majority of farmers in the District indicated that they are getting extension services as shown in Fig 4.6 above. However, a sizeable number of about 38 farmers representing 42.2% of the sample were not receiving extension support. Possibly, such farmers would be having other sources of information or might not be interested in accessing the service. However, the situation needs to be viewed as a cause for concern considering that farmers need to keep abreast with the dynamics in farming and this is only facilitated by extension. Alternatively, some farmers might be failing to access extension services due to poor delivery systems of the department. The frequency of visits by extension officers has also been assessed on survey farmers to determine the extent to which they are in contact with extension services. Many of the survey farmers indicated that they receive extension services once per month.

4.6 Labour availability

The employment of family labor by communal and resettlement farmers could be linked to the farmers' scale of operation and the technology of production being used. This finding is also linked to the argument by Dorward (1999) that smallholder farming is characterized by usage of family labor. However, the fact that communal and resettlement farmers employ family labor might suggest the scarcity of labour in the district. Neighbors and visiting relatives constitute a fraction of about (6%) which is an indication that neighboring households could be having surplus labor to spare.

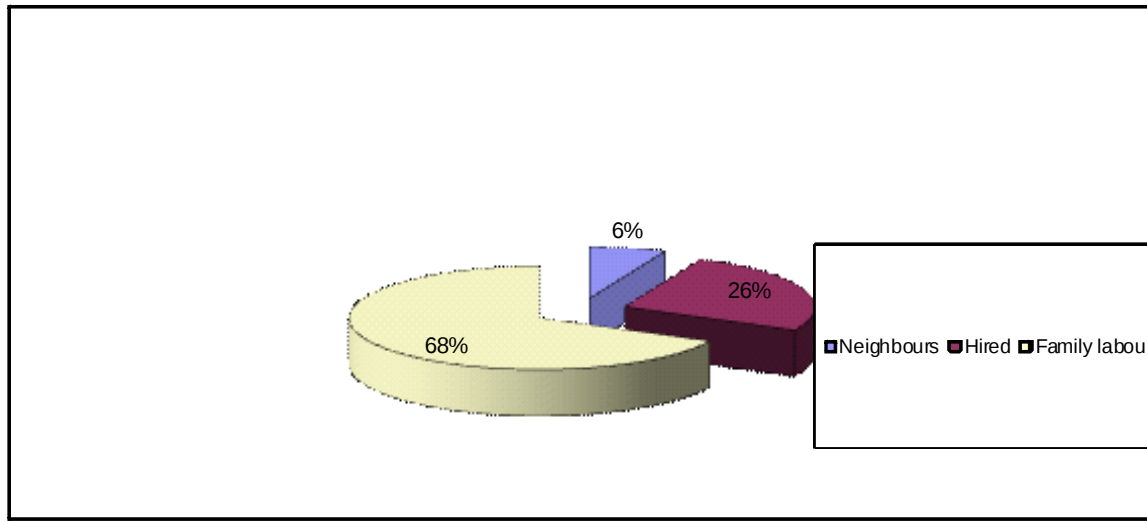


Figure 4. 7: Type of labour available for communal and resettlement sample farmers
Source: Arex Bindura district (2008)

4.7 Chapter Summary

The results presented highlight that most household heads in resettlement areas are male showing dominance of men in this farming sector. The trend is different in the communal where almost 40% are female. All farmers regardless of gender have had at least one year of formal schooling with the majority having attained between six to eight years of formal education. Bembridge (1987) says age may have an impairing effect on physical abilities and several research studies in recent years have indicated that little or no mental deterioration occurs as a result of age. However research conducted in some parts of Southern Africa reveals a negative relationship between age and farming efficiency (Sebitja 1985).

The human resource component of a farming enterprise forms an indispensable ingredient in agricultural production. It is through man's ability that production inputs are integrated and made compatible with one another in order to produce desired results. Man is therefore considered as the origin and destination in the production process. De Klerk (1980) says in human element, education and literacy has been noted to be one of the factors that limit development especially in under developed nations. Educational levels influence adoption of new innovation by farmers

(Bester et al, 2000). It enables farmers to acquire and process relevant information effectively. Sebotja (1985) however argues that although some empirical diffusion studies indicate that literacy enhances adoption of innovations there is not much evidence of improved productivity as a direct attribute of schooling experience. Zimbabwe though ranked among countries with the highest literacy levels in Africa; it has been experiencing a decline in her agricultural production levels for the past eight years.

Zimbabwe's formal education begins with a seven year primary cycle. The secondary education consists of a six year program and the tertiary is characterized with universities, teacher training colleges, technical colleges and agricultural colleges (CSO, 1997). In the sample population, educational level was based on the number of years of schooling completed by the head of the household, as shown above. Educational level is regarded as a key factor in agricultural and rural development due to its importance in decision making. Bembridge (1987) asserted that the biological, social, economic and psychological aspects of a farming community influence the efficiency of farming operations and dictates the communication patterns and technology transfer for agricultural development.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter gives conclusions arrived at basing on the findings of the study and puts forward some recommendations which are believed to be of benefit to development of governmental organizations which may intend to embark on similar programmes of mechanization at varying levels. Recommendations made can be used as a referral point to improve ways of implementing future mechanization programs.

5.2 Summary

This study is concerned with the assessment of the impact of agricultural mechanization on sustainable agriculture and food security after the Fast Track Land Reform programme in Zimbabwe. It focuses on components of agricultural productivity based on production levels of maize and soya bean crops among the newly resettled farmers under the A 1 model; farmers allocated fragmented plots ranging from four to ten hectares, A 2 model; those allocated farms bigger than ten hectares and the communal farmers. This research documents the trends and sequential patterns in the adoption of mechanical technology, assesses the evidence on the productivity and equity impact of mechanization.

This research used data on beneficiaries of the mechanization programme and a control group of communal farmers to investigate the impact of mechanization on the agricultural productivity. The data reveals significant differences between the two groups; beneficiaries and non beneficiaries, not only in household production levels and income generation but also in input usage. The results suggest that mechanization and FTLRP beneficiaries are more productive than communal farmers. The source of this productivity differential is found to lie in differences in machinery ownership and complementary input usage.

The study also examined the impact of machinery constraints in smallholder resettled farmers and their implications on sustainable agriculture and food security in Zimbabwe at large. This research is therefore aimed at providing a comparative analysis among machinery and tractor-using farmers and non-tractor and machinery-owning farmers. It is expected that the results will provide a platform for policy makers to come up with a sound policy essential in uplifting the living standards of smallholder farmers in the province.

Masembura, Musana communal and the surrounding resettlement areas in Bindura were selected because of their wide range of biophysical and socioeconomic characteristics dominated by semi-subsistence farming, which is typical in most of Zimbabwe's rural landscape. The rapid land use and vegetation cover change occurring in Zimbabwe may be attributed to imbalances in land distribution, demographic pressure, agricultural expansion, government policies and environmental factors such as drought (Chimhowu and Hulme, 2006).

The research/dissertation is divided into five chapters, which covered an overview of the study, highlighting the background and problem context, objectives and justification of the study. Under the background to the study policies and strategies on the implementation of mechanization were outlined. Furthermore the relevant literature reviewed tried to investigate on the scenario of mechanization in Zimbabwe, its impact on agricultural productivity and production efficiencies. References were made to case studies where such programmes were a success.

The methodologies and analytical models used proved to be effective in determining the relationships on identified variables. The reviewed literature in chapter 2 provided a guide to data collection methods and analytical tools used during the course of the research. The presented results were a justification on the impact of mechanization on productivity and production efficiencies. The Stochastic Frontier model/Cobb Douglas and the Logistic Regression used to determine coefficients of modeled variables proved that a mechanized agriculture performs efficiently or better than the one that is not. However an academic gap still exists as some heavily mechanized agricultural economies are on a declining trend.

5.3 The impact of mechanization as an input in agriculture

Overallly it has been established that appropriate choice and subsequent proper use of mechanized inputs in agriculture have had a significant effect on agricultural production and productivity, the profitability of farming, and on the environment (Barrow, 1995). The results obtained in the research justify the literature which acknowledges that farm machinery relates to farming technology and, other factors assumed constant, farmers who possess machinery and equipment are likely to be more productive (Machethe, 2004; Amani, 2004). Availability or absence of farm equipment can be an indicator of the extent to which farm equipment can be constraining in the smallholder farmers.

The cost associated with machinery ownership indicated by cost of fuel on Tables 4.5 and 4.6 above showed that there is a strong relationship between machinery availability, farming activities carried out and crop productivity. The high costs are an indicator of the extent to which farm machinery and fuel can be constraining in farming and reducing production. The results confirm the literature in that with machinery and fuel, other factors held constant, farmers are likely to be more productive (Amani, 2006). The results are statistically significant on the basis of the values of the standard deviations of the total yields of the two crops, 2, 0 2 and 1, 82 respectively. The deviations of machinery and equipment usage portray high values of 1, 0 309 and 1, 0 309 showing the effectiveness of machinery on crop productivity. Again the results seemed to be statistically significant on the basis of the values of the coefficient estimate (1.7269) and the probability value ($p=0.0001$).

5.4 A review of the agricultural mechanization in Zimbabwe

The mechanization program in Zimbabwe is a government initiative which is being implemented through phases. Though a measure to boost production, the implementation of the programme in Zimbabwe is being opposed by opponents of the innovation. There is however uncertainty as to how much longer the program will continue. Though Zimbabwe's agriculture is being mechanized to enhance productivity and efficiency, the general trend of crop production has shown a declining pattern over the years. The only

positive change noticed was on land productivity, there was an increase on the hactorage cultivated for crop production.

Mechanization influences other factors such as market access, quantity and quality of output, physical and infrastructural development, marketing information, asset ownership, good agricultural practice, contract farming, land tenure security, technical capacity, extension services, labor and skills, value addition and credit. As it was discovered that in most areas animal draft power accounts for between 70% to 90% of the cropped area, tractor power accounts for between 2% to 15%, and hand tillage (chibhakera) ranges from 5% to 15%. It is recommended that Farm Mechanization Programme, which is not segregatory but cuts across all the sectors of the agricultural industry, benefiting deserving farmers, depending on the size of their farms should be done even at a quicker pace.

5.5 The choice of appropriate machinery and equipment

The level and appropriate choice of agricultural mechanization has direct effects on land and labor productivity, farm income, environment, and the quality of life of farmers in Africa. Hence, basic farm mechanization requirements to cater for the farmers' needs must be met. This includes suitability for use in small farms as most farmers own small portions of land as a result of fragmentation effected by the (FTLR) in Zimbabwe. Simple design technology, appropriate for use in different farm operations should be prioritized. Each country's effort on small-farm mechanization must be anchored on a coherent strategy based on the actual needs and priorities of the small-scale farmers if sustainable agriculture and food security are to be achieved.

5.6 Food Security

For food security the recommendation is that the government and the international community enter into a policy dialogue to mobilize the economic and other assistance needed to promote sustainable food production and overall food security by way of development assistance for investment in farm mechanization and farm-level infrastructure (for example, improved tractor availability and rehabilitation of irrigation facilities) to enhance productivity and allow full capacity utilization by the newly resettled farmers (FAO 2007).

5.7 Long Term solution to declining agricultural production trends

Reduced viability of crop production due to high production costs resulting from machinery shortage and inefficient payment systems of farmers' produce resulted in significant drop in areas planted to crops. It is therefore recommended that machinery availability and better crop payment systems be put in place to restore viability of the enterprise. Producer and market prices influence to a certain extent the area planted for most commercial crops. It is therefore recommended that pre-planting pricing policy on commercial crops should be pursued. Contract schemes under some cropping ventures were providing incomplete input packages to farmers resulting in reduced areas planted to crops. Contract farming should be regulated, effectively monitored and ensure mutually beneficial relationship between the farmers and contractors.

5.7.1 Input availability

Whenever input support programmes are to be implemented they should be on time, provide a complete package and should be co-ordinated well to ensure synergy. Conditions that promote sufficient quantities of seeds, fertilizers and fuel to be placed on the market in a manner that adequately rewards the inputs suppliers should be put in place. To encourage household level food security, input support programmes should prioritize smallholder farmers who depend mostly on own production for their subsistence requirements.

5.7.2 Livestock schemes

For the purposes of draft power measures should be put in place to promote restocking in smallholder farming areas and development of the commercial cattle herd in the A2 and large scale commercial sectors through improved livestock husbandry (management) as most farmers have ox-drawn implements.

5.7.3 Extension services

There is need to enhance the capacity of agricultural extension personnel through addressing the following areas: mobility, communication, training, incentives and operational resources for efficient dissemination of information on new technologies such as the mechanization programme.

5.8 The Future of mechanization

There is a lot of idle farm equipment and farm infrastructure that has not been utilised due to various reasons. One of the reasons being that beneficiaries might not have the capacity to utilise the infrastructure. The Government has put in place programmes to assist farmers acquire the equipment so that they continue farming and improve farm utilisation and their production levels. Some of the farms needed re-planning so that the infrastructures on farms become fully utilised. It was also discovered that there are disputes concerning shared infrastructure and the Ministry of Lands, Land Reform and Resettlement has drafted policy guidelines on general shared infrastructure including irrigation. These guidelines will assist technocrats to resolve general conflicts on shared infrastructure and ensure efficient utilization of irrigation infrastructure such as centre pivots, water pumps and continuum of hydrants.

By taking a systems approach, in which we consider a system in terms of its actions, interactions and implications, we can develop a new mechanization system that collectively deals with all the crop's agronomic needs in a better way (Bak and Jakobsen, 2003). Most of the current machinery is weather dependant. Tractor mobility on wet soils is difficult; sprayers cannot work in high winds etc. Perhaps it will be possible to develop smaller, less intrusive machinery that can allow more tasks to be carried out in marginal conditions (Leede, and Longstaff, 1994). For Farmers mechanization may be a means of freeing women and children from agricultural work to more rewarding occupations. Safety is another important factor; the chance of catastrophic failure should be minimized within the design process. A small light vehicle is inherently safer than a large one (Søgaard and Heisel, 2002). Redundant, self checking systems should be built into the system architecture to allow graceful degradation.

Rural development programs must take into account (the future) needs of agricultural mechanization. Thus, the design of irrigation and drainage systems and the field size and layout must take into account the access of machines to fields, the width and strength of bridges. However, when formulating an agricultural mechanization strategy, the different options for enhancing land and labor productivity, as well as their economic and financial implications must be well understood: Sometimes, rather than advocating for mechanization of certain operations, alternative options may be more attractive.

5.9 The role of government in future mechanization programs

Unlike in a centrally planned command economy, in a free market economy the supply and type of technology, including farm power will, and should be demand driven. Governments must refrain from making decisions which will stipulate by which means and to which extent agriculture will be mechanized. This will be decided by the farmer to best suit the farming enterprise, taking into consideration many factors, including the farm household composition. Choice on farm power input will just be one of a number of choices the farmer has to make. Decisions made will be based on a mix of factors and possible options, with economic rationale remaining paramount. Thus a farming systems approach is needed when formulating agricultural mechanization strategies AMS. The government's responsibility is to create an enabling environment which will ensure that the farmers' needs for inputs and for farm power can be met. In case national considerations require that farmers use more efficient or productive inputs (for example using pump sets to increase food production and food security; using more environmentally friendly pesticide application technology), then the government should provide the incentives for the farmers to make the investments and for the suppliers to provide and service this technology.

After uncovering the barriers surrounding the transfer of small farm mechanization technology and citing possible strategies to break down these barriers, what is needed now is the implementation of the strategies that were suggested. The commitment of all the stakeholders to uplift the conditions in our small farms through appropriate mechanization schemes can be the starting point. This will definitely be a long ride but from here on, we will only progress and

realize our goal if we will all cooperate and accept responsibilities and be accountable to the farmers who need the help.

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APPENDIX 1. 1: FIELD STUDY WORK PLAN

Date	Activities	Persons	Venue
MONTH ONE			
02 May 2009	-Welcome meeting with the Aid Team	Arex and resettlement officers	Distric Arex offices Bindura
	- Develop a tentative work plan for the study	Researcher and aid team	Distric Arex offices Bindura
03 May 2009	- Meeting with the village leadership and Lands committee for introductions	All	Manhenga business centre Masembura communal area
04 May 2009	-Transect walk in Msana communal area	All team members and Msana headmen	Msana communal area
05 May 2009	-Transect walk in Masembura communal area	All team members, Masembura headmen and extension officers	Masembura communal area
	- Planning for the focus groups workshops	All	Distric Arex offices Bindura
06 May 2009	-Planning for the focus groups workshops	All	Distric Arex offices Bindura
	-Making an outline for the workshop	Researcher and aid team	Manhenga business centre Masembura communal area
	- Discussing guiding	All	Manhenga business centre Masembura communal

	questions for the workshop		area
	Transect walk in Matepatepa resettlement areas	All team members, Matepatepa farm chair persons and extension officers	Matepatepa resettlement areas
07 May 2009	-Planning for the focus groups workshops	Researcher and aid team	District Arex offices Bindura
	-Making an outline for the workshop	Researcher and aid team	District Arex offices Bindura
	- Discussing guiding questions for the workshop	Researcher and aid team	District Arex offices Bindura
12 May 2009	Capturing maize and soya bean production data	Researcher and Arex and Lands District officers	Provincial Arex offices Bindura
	Capturing (FTLR) resettlement data	Researcher, Arex and Lands District officers	Provincial Arex nad lands offices Bindura
	Capturing mechanisation data	Researcher, Arex and mechanisation department officers	District Administrator's offices Bindura
14 May 2009	Capturing livestock and resource conservation data	Researcher, Arex, Vet and Natural resources conservation specialists	District Arex and Vet offices Bindura
18 May 2009	Capturing data on NGO programs in the area	Researcher, Arex, NGO representatives and Local government representatives	District Administrator's offices Bindura
	-Making final arrangements on workshop logistics	Researcher and aid team	District Arex offices Bindura
22 May 2009	-Facilitating a focus group workshop on mechanisation program, farming under the FTLR, causes of land and resource degradation, Socioeconomic organizations and crop and	All	Municipality hall Bindura

	livestock production systems		
	-Reflecting on the workshop to improve on following workshops	Researcher and aid team	Municipality hall Bindura
	Making arrangements for the workshop in Matepatepa resettlement area	Researcher and aid team	Municipality hall Bindura
25 May 2009	- Facilitating a focus group workshop on mechanization program, farming systems, food security status, causes of land degradation, Socioeconomic organizations and livestock production systems	All	Matepatepa Country Club
	Reflecting on the workshop to improve on following workshops	Researcher and aid team	Matepatepa Country Club
	-Making final arrangements for the workshop in Msana communal area	All	Matepatepa Country Club
26 May 2009	- Facilitating focus group workshop in Masembura communal area	All	Masembura communal area
	-Reflections on workshop proceedings	Researcher and aid team	Masembura communal area
27 May 2009	-Developing households questionnaire for Matepatepa farmers	Researcher and aid team	Matepatepa Country Club
30 May 2009	- Preparing village guides and interpreters for household interviews	Researcher and aid team	Matepatepa Country Club

31 May 2009	-Discussing the developed household questionnaire with the Arex and resettlement officers and sending invitation letters to stakeholder through Arex department	Researcher, Arex, NGO representatives and Local government representatives	District Administrator's offices Bindura
	-Incorporating suggested ideas in the questionnaire	Researcher and aid team	District Administrator's offices Bindura
MONTH TWO	- Arranging logistics for household interviews	Researcher and aid team	Matepatepa Country Club
01 June 2009	-Administering the household Questionnaires in Msana communal area	All	Msana communal area
	Entering data on household interviews	Researcher and aid team	Msana communal area
	-Reflecting on the interview proceedings	Researcher and aid team	District Arex offices Bindura
02 June 2009	-Administering the household Questionnaires in Msana communal area	All	Msana communal area
	Entering data on household interviews	Researcher and aid team	Msana communal area
	-Reflecting on the interview proceedings	Researcher and aid team	Msana communal area
03 June 2009	-Administering the household Questionnaires in Masembura communal area	All	Masembura communal area
	Entering data on household interviews	Researcher and aid team	Masembura communal area
	-Reflecting on the interviews	Researcher and aid team	Masembura communal area

	proceedings		
04 June 2009	-Administering the household Questionnaires in Masembura communal area	All	Masembura communal area
	Entering data on household interviews	Researcher and aid team	Masembura communal area
	-Reflecting on the interviews proceedings	Researcher and aid team	Masembura communal area
05 June 2009	-Entering of data for the households interviews	Researcher and aid team	District Arex offices Bindura
07 June 2009	-Administering household questionnaires in Matepatepa resettlement area	All	Matepatepa resettlement area
	Entering data on household interviews	Researcher and aid team	District Arex offices Bindura
08 June 2009	-Administering household questionnaires in Matepatepa resettlement area	All	Matepatepa resettlement area
	Entering data on household interviews	Researcher and aid team	District Arex offices Bindura
09 June 2009	-Administering questionnaires for Stakeholders in Msana communal area	All	Msana communal area
	-Preparing for the preliminary findings workshop	Researcher and aid team	District Arex offices Bindura
	-Writing summaries on interviews Conducted	Researcher and aid team	District Arex offices Bindura
10 June 2009	-Administering stakeholder questionnaires for	All	Masembura communal area

	Masembura communal area		
	-Finalizing the preparations for the preliminary findings workshop	Researcher and aid team	District Arex offices Bindura
12 June 2009	-Administering stakeholder questionnaires for Matepatepa resettlement area	All	Matepatepa resettlement area
13 June 2009	-Administering stakeholder questionnaires for Non Governmental Organization (NGOS)	All	District Administrator's offices Bindura
14 June 2009	-Administering stakeholder questionnaires village leadership and Matepatepa Ward Councilors	All	Matepatepa resettlement area
15 June 2009	- Preparing the presentation and arranging the logistics for the preliminary findings workshop	Researcher and aid team	District Arex offices Bindura
18 June 2009	-Workshop on presenting preliminary findings workshop and facilitating the process of finding the options for mechanisation for sustainable agriculture and food security in the district	All	District Administrator's offices Bindura
20 June 2009	-Reflecting on the workshop Proceedings	Researcher and aid team	District Arex offices Bindura
26 June 2009	-Incorporating the workshop findings	Researcher and aid team	District Arex offices Bindura

	into a report		
12 August 2009	-First draft of chapters 1, 2,3and 4 of the report	Researcher	University of Fort Hare
12 September 2009	--First draft of all chapters of the report	Researcher	University of Fort Hare
	-Revising the report outline and adding of omissions	Researcher	University of Fort Hare
18 September 2009	-Working on results and discussions	Researcher assisted by Bridget	University of Fort Hare
20 September 2009	- Discussing the report outline Editing chapter 1,2,3 and 4	Researcher and Internal Supervisor, Dr Obi	University of Fort Hare
	-Discuss conclusions for report	Researcher and Internal Supervisor, Dr Obi	University of Fort Hare
21 September 2009	-Editing and compiling of the whole report	Researcher and assistants	University of Fort Hare
22 September 2009	- Discussing outline of the annexes	Researcher and Internal Supervisor, Dr Obi	University of Fort Hare
	-Preparing the annexes	Researcher	University of Fort Hare
	- Writing executive summary of report	Researcher	University of Fort Hare
24 September 2009	-Meeting with the report reviewers	Researcher and internal Supervisor	University of Fort Hare
26 Sept 2009	Consolidating comments of the internal Supervisor	Researcher	University of Fort Hare
27 Sept 2009	-Preparations for final document	Researcher	University of Fort Hare
30 Sept 2009	Submission of final document	Researcher	University of Fort Hare

14 Oct 2009	Consolidating the comments of the external Supervisor	Researcher and internal Supervisor	University of Fort Hare
16 Oct 2009	-Incorporating the corrections and inputs made by the external Supervisor	Researcher and internal Supervisor	University of Fort Hare
18 Oct 2009	-Finalizing the document	Researcher	University of Fort Hare
20 Oct 2009	Submission of the final document	Researcher and internal Supervisor	University of Fort Hare

APPENDIX 1. 2: THE HOUSEHOLD QUESTIONNAIRE

UNIVERSITY OF FORT HARE

FACULTY OF SCIENCE AND AGRICULTURE

Department of Agricultural Economics and Extension

QUESTIONNAIRE FOR IMPACT OF FARM MECHANISATION PROGRAMME ON AGRICULTURAL
PRODUCTIVITY: A CASE STUDY OF BINDURA DISTRICT, MASHONALAND PROVINCE IN ZIMBABWE.

All information provided will be treated as **STRICTLY CONFIDENTIAL**

Contact: fchisango5@yahoo.com



Researcher at work

BACKGROUND INFORMATION

Date.....

Interviewer.....

Name of village.....

Name of respondent (Optional)

Relation to household head

A. DEMOGRAPHIC DETAILS

Fill in the relevant information and where possible mark with an X.

A.1 GENDER		A.2 AGE (Years)						A.3 MARITAL STATUS				A.4 HOUSEHOLD SIZE			
M	F	<19	19-29	30-39	40-49	50-59	≥60	Single	Married	Widowed	Divorced	<6	6-10	>10	Total

A. 5. What is the highest educational level the head of household has completed? (Mark with an X)

No formal education	Primary school only	Secondary/High school	Tertiary education	Other (specify)

A. 6. Indicate the number of employees who assist with farm work

Type of employee	Full-time employees	Part-time employees	Unpaid family members	TOTAL
Number				

A. 7. What is your employment status and under which income class do you fall in? (Mark as appropriate)

EMPLOYMENT STATUS		INCOME CLASS (Rand per month)					
	Tick	<700	700 - 1500	1500 - 3000	3001 - 5000	5000 – 10000	>10000
Full time farmer							
Part time farmer							
Formally employed							
Pensioner							
Unemployed							
Other (Specify)							

--	--	--	--	--	--	--	--

A. 8. Where do you get money (capital) to invest in farming?

SOURCE	AMOUNT
Borrowing from bank	
Borrowing from friends	
Borrowing from your family	
Your own saving	
State aid	
Other (such as:)	

B. LAND AND FARMING

B. 1. Which types of farming are you involved in and indicate the amount of land in use? (Tick only one)

TYPE OF FARMING	Crops /and vegetables	Cattle	Other (specify)
AMOUNT OF LAND			

B. 2. Indicate the land tenure system on the land in use and how you acquired it?

LAND TENURE SYSTEM			HOW YOU ACQUIRED THE LAND			
Communal	Rent/Lease	Privately owned	Bought	Inherited	Resettled	Other (specify)

B. 4. Where do you get the production inputs that you use?

List input	Place you get it	Distance (km)	Reason for using the market

For crop/and vegetables and tree farming only

B. 5. List crops/fruits you farm with

.....

.....

B. 6. How do you cultivate your land? (Tick as appropriate)

	Own	Borrowed	Hired	Cost
Tractor				
Animal drawn				
Hand				
Other (Specify)				

B. 7. Indicate the production inputs that you use

INPUT	AMOUNT per ha	COST per ha
Treated Seeds		
Fertilizer		
Pesticides		
Insecticides		
Other (Specify)		

C. 1. ASSET STATUS AS A RESULT OF THE MECHANISATION PROGRAM

1 Under which farming sector does the house hold head fall

- a) Communal
- b) A1 Resettlement
- c) A2 Resettlement

2 According to the farmer's inventory what assets does the household possess_____

3 Any machinery or equipment benefitted through the mechanisation program

4 Who is the beneficiary in the household_____

Apart from being a farmer what other position does the beneficiary occupy in society_____

Is the beneficiary's farm or plot located in Bindura District

For those who benefitted but with plots elsewhere please specify their Districts_____ an possible reasons_____.

5 Under which phase of the mechanisation program did the farmer benefit

6 How do you view the way the program was handled in the area

7 How are farmers using the machinery mainly tractors distributed to them under the mechanisation program

8 In future for effective and efficient execution of the program who should handle or control it

9 Farmer's knowledge on machinery or equipment distributed.

10 Are spares for distributed machinery readily available for the beneficiaries?

11 How do you assess the effectiveness of the program on your production practices.

C.2. MARKETS

C2. 1. Which markets do you usually use for selling your produce?

MARKET	Reason
Formal markets	
Informal markets	
I do not sell	

C2.3. Do you always find a market for all the goods you produce?

Yes		No	
-----	--	----	--

Lose to spoilage	Eat (family and friends)	Sell at low prices	Store and sell later	Process it

D. HUMAN CAPITAL ENDOWMENTS

D. 1. For how long have you been farming?years

D. 2. How do you rate the farming knowledge applied on your farm?

Farmer knowledge	Poor	Average	Good	Employees knowledge	Poor	Average	Good
How knowledge was acquired	Experience			How knowledge was acquired	Experience		
	Education				Education		

D. 3. Is there any household member with any of the following skills?

SKILL	Yes	No	Where they studied
Animal/ Crop production			
Financial management			
Marketing			
Risk management			
OTHER (Specify)			

D. 4. What specific training do you need at your farm?

	Reason why you think it is important
Marketing	
Budgeting	
Record keeping	
Other (specify)	

--	--

D. 5. Do you attend workshops to learn about farming practices?

YES	How often?	NO	Reason for not

D. 6. Indicate your proficiency on the following languages (speaking)

LANGUAGE	Good	Poor
English		
Shona		
Ndebele		
Any other specify		

D. 7. Which farm records do you keep?

Costs	Sales	Other (such as :)

E. EXTENSION SERVICES

E. 1. How do you rate the services provided by extension officers in your area?

Unavailable	Not helpful	Helpful enough

E. 2. Do you contact extension officers during the marketing period?

Yes		No	
-----	--	----	--

E. 3. What services are provided by extension officers?

Advice on marketing	Advice on record keeping	Other (Specify)

E. 4. Are the extension officers always available when you need help?

Never available	Available sometimes	Always available

E. 5. List the problems that you face in contacting extension officers?

.....

.....

.....

.....

.....

F. INSTITUTIONAL SUPPORT SERVICES

F. 1. Are you aware of the role played by organizations in marketing?

Yes	No	
-----	----	--

F. 2. Do you think that public institutions (such as local administration, national government, public organizations) are willing to help and to support your farm business? Explain

.....

.....

.....

.....

.....

F. 3. Are you a member of any organization?

NO	Reason for not joining	YES	Name of Organization

F. 4. What are the main challenges that you face in running your farming business?

	Minor challenge	Major challenge
a) The search for information b) Lack of support by the government c) Lack of trust in the institutions d) Bureaucracy e) Financial f) Problems associated with crime g) Uncertainty of property rights h) Corruption problems		

F. 5. What influence do the following have on your farming business?

	Influence
Norms and values Beliefs and tradition Family and friends	

THANK YOU VERY MUCH FOR YOUR TIME – ENJOY YOUR DAY

APPENDIX 1. 3: DEPARTMENT OF AGRICULTURE QUESTIONNAIRE

Name of the organization-----
Dept. of -----
Division-----
Location-----
Date Position-----

LAND AND RESOURCE DEGRADATION

1. What does the department view as responsible causes for resource and land degradation?
2. Do you see resource and land degradation problems being addressed? Yes No
If yes what are the roles of your organization in that regard?
3. What are the bottlenecks in achieving the objectives?

CROP AND LIVESTOCK PRODUCTION SYSTEM

4. What are the objectives of your organization in terms of improving crop and livestock production systems?
5. What are the current activities of this organization that aim to address sustainable agriculture for food security in the area?
6. What are the options for sustainable agricultural production?
7. Does your organization have any partnerships with the government in its mechanization program? Yes No if yes
a) What is the nature of the partnerships?
8. Is there any relationship between new farming systems and land degradation? Yes No if yes what is the relationship?

LAND AND RESOURCE CARE

- a) What are the interventions that you are engaged in?
- b) Lessons learnt from previous interventions
 - i. Has the organization learnt any lessons from those interventions?
Yes No List them if any
 - ii. Has the organization used the lesson learned in implementing the Land and Resource Care project?
Yes No
 - iii. How did they use them?
15. Was there any capacity building program that was specifically given to the district mechanization committee? Yes No
16. If yes what type of capacity building program was given to the committee?
Is there any form of support given to this committee e. g. management and fair distribution of machinery and equipment?
Yes No if yes what type
17. Were there any awareness campaigns before? Yes No if yes a) who were the target group?

THANK YOU VERY MUCH FOR YOUR TIME

APPENDIX 1. 4: THE STAKEHOLDERS AND NGOS' QUESTIONNAIRE

Name of the organization-----
Position Name of interviewer-----
Name of interviewee-----
Date-----

LAND AND RESOURCE DEGRADATION

1. What does the department view as responsible for food insecurity in the district?
2. What are the roles of your institution in relation to curbing the problem?
3. How do you see land and resource degradation problems being addressed in Bindura district?
4. What are the current activities of this organization that aim at addressing land and resource degradation?
5. What are the bottlenecks in achieving these activities?

CROP AND LIVESTOCK PRODUCTION SYSTEMS

6. What are the objectives of your organization in terms of crop and livestock production systems?
7. Does your organization have any partnerships? Yes No if yes
 - a) With which organizations?
 - b) What are the organization's commitments in those partnerships?Are you aware of the mechanization program being conducted in the district? Yes No
If yes what are you roles in that program?
8. What do you think are the options for sustainable crop and livestock production in the communal areas Msana and Masembura?
9. What do you see as your role in the on going mechanization program?

THANK YOU VERY MUCH FOR YOUR TIME – ENJOY YOUR DAY

GOD BLESS