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DISSERTATION ON:

THE IMPACT OF AGRICULTURAL BIOTECHNOLOGY ON BANANA PRODUCTION BY SMALL SCALE FARMERS: THE CASE OF MURARA AREA IN MANICALAND PROVINCE OF ZIMBABWE.

CEPHAS MANDIRAHWE

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Year Granted	2019
PERMANENT ADDRESS	Tsonzo Box 80 Watsomba, Mutare
CONTACT NUMBERS	+263 776160 326
SIGNED	…….
DATE	…….....

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ABSTRACT.

Agricultural biotechnology is gaining momentum in shaping production globally. It ranges from molecular diagnostics, vaccine technology, genetic modification and tissue culture. The study, however, focused on one aspect of agro-biotechnology, that is, the impact of tissue culture in banana plantlets on Banana productivity. The study contributes to the international debate on biotechnology and small scale farming. It argues that agricultural biotechnology, especially the use of tissue cultured banana plantlets has successfully improved small scale banana farming as evidenced by increases in Banana production in Murara area of Mutasa District. The study used both convenience sampling, to carry out interviews with small scale banana producers, and purposive sampling to obtain data from key informants such as extension officers and traditional leaders. The study also used observations and focus group discussions with banana producers so as to comprehend the impact of biotechnology on banana production as well as on farmers' livelihoods. The study has revealed that the introduction of tissue cultured banana plantlets has phenomenally improved banana farming in Murara area of Mutasa District and by extension, the lives of small scale banana producers. This is seen through increased access to basic needs such as income, health, food, and education. Additionally, it has resulted in women's empowerment as shown by women's dominance in banana farming. Since the adoption of agricultural biotechnology, the land under cultivation has expanded and so has banana production. By overcoming the vulnerability of banana farming under traditional ways, the adoption of agricultural biotechnologies has thus promoted the small scale banana production sector. However, the study revealed weaknesses such as lack of value addition to maximize the benefits emanating from biotechnology and thus recommends that this, among other interventions, be also made central in Murara area.

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DEDICATION

To my mother and father, and all my family members. All this was done so that they may learn the meaning of the adage: “If one of us is honoured, we are honoured together”.

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ACRONYMS

AGRITEX	Agricultural Technical Extension
FAVCO	Fruit and Vegetable Company.
M.O.U	Memorandum of Understanding
MRDC	Mutasa Rural District Council
NGOs	Non-Governmental Organizations
SNV	Stitching Nederlandse Vrijwilingers
TC	Tissue Culture
Zim AIED	Zimbabwe Agricultural Incomes and Employment Development

CHAPTER 1: INTRODUCTION

1.0 Introduction.

The research assesses the impact of agro-biotechnology on banana production by small scale farmers in Murara Area in Manicaland Province of Zimbabwe. Agricultural biotechnology is gaining momentum in shaping production globally. It takes different forms which include molecular diagnostic, vaccine technology, genetic modification and tissue culture. The research however focuses on one aspect of agro- biotechnology, that is, the impact of tissue culture in banana plantlets on banana productivity. The study is located within the context of ongoing international debates on the efficacy of biotechnology in the farming sector and in small scale farming specifically. The study argues that agricultural biotechnology, especially the use of tissue cultured banana plantlets has successfully increased the banana productivity and enhanced the livelihoods small scale banana farming in Murara of Mutasa District. The section of this study outlines the problem statement, aim of the study, objectives of the study, research questions, and delimitation of the study, justification of the study, study limitation and chapter breakdown.

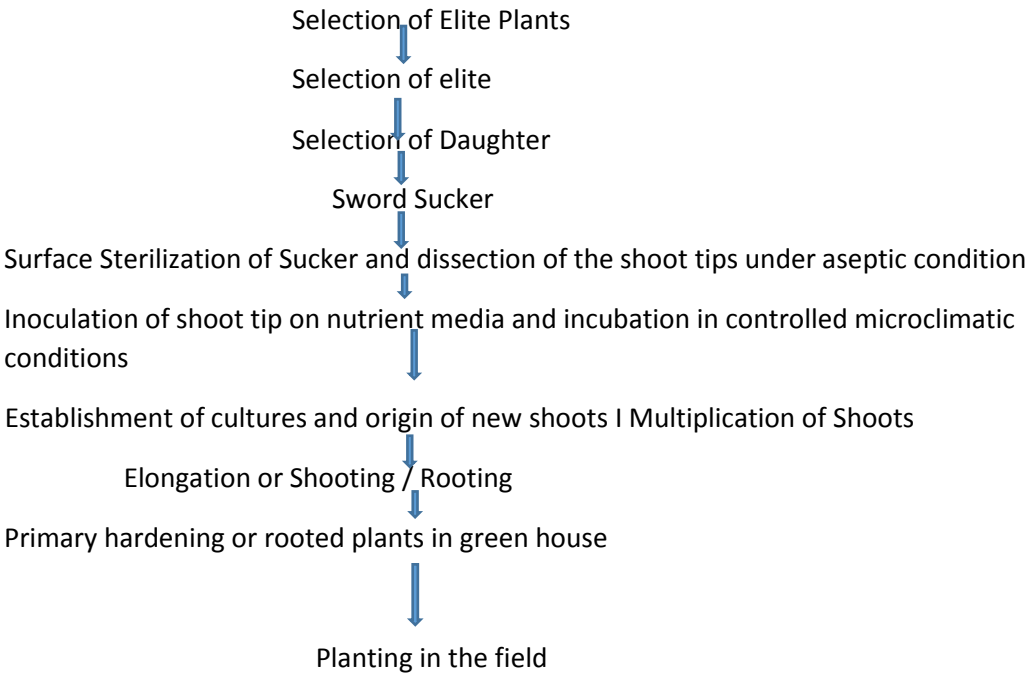
1.1 Background to the study.

Agriculture production is the backbone of the rural economy in sub-Saharan Africa. Agriculture biotechnology through the introduction of tissue cultured plantlets has been conceived and perceived as a measure earmarked on increasing agriculture production (Pinstrap-Andersen and Cohen 2000). In this study is biotechnology is defined as a technology that uses living organisms to make or modify products to improve plant and animals or to develop microorganisms for specific application. Dubois etal (2000) observed that biotechnology is a positive step towards realizing increase in the yields. To this end researchers have argued that agro biotechnology has the potential to increase banana production despite the fact that small scale farmers are resource constrained.

Agro-biotechnology takes different forms that is molecular diagnostic, vaccine technology, genetic modification and tissue culture. Molecular diagnostics involves adding up crop

production and protection. Vaccine technology involves the use of modern immunology to develop recombinant DNA vaccines for mapping control of livestock and fish diseases. Structural genomics is also part of agro-biotechnology which involves the molecular characterization of all genes in species and the related assembly of data from genomic analyses into accessible forms useful to the various breeding system. Bio-informatics include computational tools used to analyze biological data arising from structural and functional genomics. It uses data to improve understanding of the biological process in plants and animals. Sythatatic genomics which is the creation of the sythatatic cells to create designer organisms . However the study is interested on tissue cultured popularly known as Tc which is the simplest form of the Biotechnology. It consists of using parts of a plant and placing it in a sterile nutrient medium where it multiplies. The aim of the Tc is earmarked on improving banana production that through providing free diseases and clean planting material. Qaim (1999) noted that while there is an increase in yields especially in small scale farming has been substantial, adoption rates are still low. Therefore this study sought to assess the impact of agro-biotechnology through the use tissue cultured plantlets on small scale banana farming.

Flow Chart No.1 Process Flow Chart for Tissue Culture of Banana



Source: http://shodhganga.inflibnet.ac.in/bitstream (accessed on 14/03/19

Tissue culturing of bananas involve five main stages that is initiation, multiplication, shooting and rooting, semi-hardening and finally hardening being the last stage. All these stages are carried out within the laboratory set up where the conditions are involved. Initiation is as the first process involve surface sterilization of the plant growth, the ex-plant is dissected in sterile conditions and pant into initiation medium for growth. In this process the medium enhance growth due to presents of nutrients.

The second stage is multiplication. It involves multiplication of plants in sterile conditions. It is followed by transferring the plant to another medium containing growth promoting hormones that enhances cell division. In this stage the growing shoot multiplies and forms cluster of three to four shoots. In order to achieve optimum growth, some cycles are repeated for 10 to 12 times to achieve optimum growth.

The third stage is shooting and rooting. In this process, the single shoots are separated and placed into a shooting and rooting medium. At this stage hormones may or may not be required. The shoot elongates and new roots come up. Rooting takes three to four weeks.

The fourth stage is semi hardening. In this process plants are ready to sustain in the natural conditions. This process is done under the controlled conditions of the green house. The plants are taken out of bottle and media adhering the root system is washed fully. Also plants are graded according to size and then transferred singly into the seed tray containing sterile, soil-less medium. Regular spraying of fungicides, bactericide and insecticide is done to achieve optimum condition of the plants.

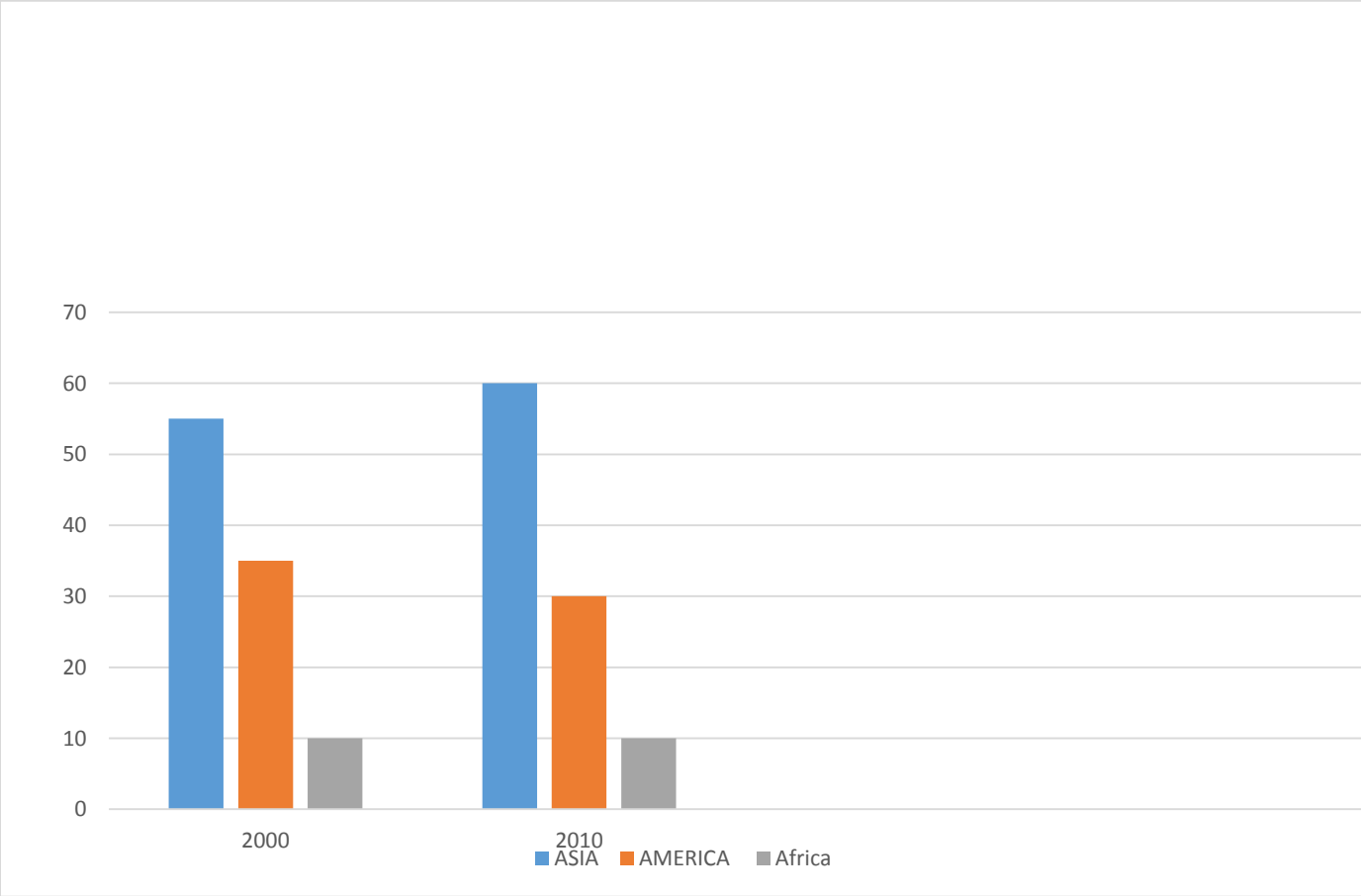
The final stage is hardening. In this process the plants from the seed trays are separated and then taken into polythene bags preferably black colored containing a mixture of sand, soil, soil rite, perlite or compost. These pants are kept in shade house where 50-75% of sunlight is reduced through the nets and entry of nets is also disallowed. Irrigation is done by drip in each polybag. The period of hardening is

six weeks and the plants are get fully acclimatize to environmental stress. The plants are directly used for planting into the field

Bananas are conventionally propagated using suckers. To this end traditional way of propagating bananas using suckers increase vulnerability to pests and diseases. These diseases include BBTV- Banana Bunchy to Virus, CMV- Cucumber Mosaic Virus, BSV-Banana Streak Virus and BBMV-Banana Bract Mosaic Virus. Bananas are also vulnerable to nematodes that is Pratyenchascoffine. Tissue culture technique in Banana propagation eliminate most of the pests and reduce infestation in new plantations and this contributes to higher yield production. Conventionally a banana plant produces only five to ten suckers in year depending on the variety. Tc has more functional leaves at planting and therefore this enables them to manufacture their own food while conventional suckers use the food stored in stored in the corn to start initial growth. Additionally, it generates income and easy adoptive technology than conventional suckers.

Banana is globally ranked fourth next to rice, wheat and maize in terms of gross value production. Asia Pacific countries particularly India, China and Philippines are the most players in banana cultivation, contributing more than 45% of total world production (https://www.apaari.org accessed on 14 March, 2019). Empirical evidence has demonstrated that adoption of tissue cultured plantlets demonstrated success stories by small scale farmers. Fig 1 below also shows that, in this production rate, Asia, Africa and Latin America are among the key players

Fig. 1. Distribution of the world's banana production by the continent



Source: Singh etal (2011)

The banana's ability to produce fruits all year round makes it an important food security crop and cash crop in the tropics. According to Robinson (1996) banana supply more than 25% of the carbohydrates requirement's for over 70 million people in Africa. East Africa is the largest banana producer and consuming region in the in Africa with Uganda , the daily consumption of banana may exceed 1.6 kg per person which is

the highest in the world. Nutritionally fresh bananacontains 35% of carbohydrates, 6-7% fibers, 1-2% proteinand fat. (Robinson, ibd)Major elements such as potassium, phosphorous, calcium, iron, Vitamin A, B6 and C. Additionally bananas are used in manufacturing beer, wine, and other products and form an important part of cultural life for many people. In Southern Africa, banana are mainly grown in Angola, South Africa, Zambia, Mozambique and Zimbabwe. According to Food and Agriculture Organization (FAO)intheyear 2006, Angola had about 250000 metric tons. South Africa is currently the only country in southern Africa that is producing and exporting tissue cultured seedlings to countries such as Zimbabwe.

In Zimbabwe, banana production become very popular in 1980s soon after attainment of independence. The major banana growing regions in Zimbabwe are in Manicaland Province particularly in South Eastern Lowveld (Burma Valley, Chipinge and Honde Valley). To this extent an estimated40000 hectare is under banana production in Zimbabwe. About 1700 hectares are considered under commercial farming and about 2300 hectares are under small scale farming (University of Zimbabwe, Agribusiness Section, 2014). Production levels reached about80 000 metrictons in 2000 (FAO, 2006). In 2008, the production levels of banana in Zimbabwe fall to 8000 tons (UZ Agribusiness section, 2014). In Honde Valley one of the banana producing area, the production levels for small holder farmers fall to 4 tons per hectare (SNV, 2011). More than 4000 people in Honde Valley depend on banana for more than a third of their income, amounting to roughly $2000 per household per year, according to SNV, 2007). The study concluded that it was possible to raise these incomes of small holder farmers by up to 400% by increasing banana quality and quantity, hence the introduction of tissue cultured plantlets as a strategy earmarked on improving banana production in Murara area, Manicaland Province of Zimbabwe.

Feder etal (1985) argued that low adoption rates of agriculture biotechnology in developing countries have been associated with complex of factors inter alia lack of credit, inadequate farm size, inadequate incentives associated with fair arrangements,

insufficient human capital, absence of equipment to relieve labor shortages, chaotic supply of complementary inputs and inappropriate infrastructure. The introduction of tissue cultured plantlets has a potential to improve banana production and has substituted conventional methods of using vegetative suckers in many of the intensive banana growing region. Robison (1996) also noted advantages associated with Tc which according to him include field establishment rate, uniformity in growth ensuring synchronizing harvesting.In Kenya, tissue cultured technique was introduced 1997 to circumvent the problem of production losses due to pests and diseases and provide quantities of clean planting materials (Qaim, 1999). Nguthi (2003a) and (2008b) further highlighted that over last past ten years, the application of Tc to Kenya Banana Industry has culminated to improve yields and standard of living of resource poor farmers (Nguthi, 2008b).

Historically agro- biotechnology have played a pivotal role in increasing agriculture production. Key point to note is the rise of Green revolution in 1970s and 1980s which led to increased crop productivity thus leading to doubling of crop yields in Asia and Latin America (Brink, etal, 1998). To this end Brink etal (1998) further noticed that due to the availability and accessibility of food in the region it was observed that the proportion of the population suffering from chronic hunger had reduced from 40% to 20%. This was attributed to progress in agriculture which involved the production of High yield Variety (HYV) of major food grains like maize, wheat and rice. Of salient to note here is that it was combined with intense use of inputs such as agro chemicals as well as improved farm management practices.

The green revolution which started in Mexico in the late 1950s and spread to India and some parts of Africa in the 1960s has also explicitly demonstrated that the strategy of agriculture intensification can significantly boost output in the face of limited land supply. Deininger confirmed the fact that given technology levels, small farms are more productive and efficient than large farms because of fewer problems of supervision.(Deiningers et al, 1992 quoted in Zikhali, 2008) The above empirical evidence explicitly show that small farms can be potentially efficient and effective than large

farms depending on support despite the views of Marxist and liberal economist who have pessimistic view on the efficacy of small scale farms. It is against this backdrop that, the researcher is convinced that tissue cultured technique has a potential to modernize agriculture production on the globe as well as in Zimbabwe in particular

Even though the green revolution technologies of the 1980s achieved great gains in much of Africa in terms of improving food production, it cannot hide the fact that issue of hunger and poverty in the 20st century is still a challenge in developing countries. According to Brink etal (1998), there are still examples of green revolution technologies transforming the lives of SSA. Ogoro (2007) noted that Africa was by passed by green revolution yet majority people in Africa are suffer from chronic hunger (FAO, 1999) To this end the adoption of biotechnology by small holder farmers is expected to contribute significantly towards reducing the challenge of food production in developing countries. Asia Development Bank (ADB, 2001) report articulated that biotechnology is increasingly being applied in Asia to develop new strains of crops and livestock. Wambungu and Ogoro (2007) have faith in agro-biotechnology in transforming the lives of small scale banana farmers.

Indeed the gap between food production and food demand in third world countries will worsen the existing problems such as malnutrition, hunger and poverty. It is therefore quite unfortunate that technologies widely used during the green revolution, no longer provided the needed breakthrough in yield potential (Karembuetal, 2010). Karembu (2010) also noted that current state of agricultural biotechnology will be able to meet the production challenge due ahead, therefore new approaches are required to expand food production. To this end, this resulted to the emergence of agro-biotechnology whose aim was hinged on increasing food production.

There are two dimensions of agro-biotechnology that is the traditional and the modern biotechnology. Traditionally the use of yeast to make bread has been common in food industry. Application of modern agro- biotechnology dates back to about 50 years ago (Amula, 2004). Modern biotechnology has also three dimension that the application of genetic engineering (GE) on food production which has often generated heated public debate (ADB, 2007). The debate within scientific comedy has focused on the safety and

consumption of genetic engineering food on human health. On the other hand are the proponents of biotechnology who present the technology as the magic bullet and panacea to the multitude of problems facing African countries. The pessimist perspective have based their argument on the implication of biotechnology on the human health and the environment as reason to stop biotechnology. Numerous studies have been done to demonstrate its actual and potential role in sustainable agriculture production (FAO, 2009).

Corollary to the above, agro-biotechnology has a mixed record from scholarly literature. The record indicates intellectual cleavages in which scholars seek to understand the impact of agro-biotechnology on small scale farming on the optimism –pessimism continuum .However one of the key features on the literature on agro-biotechnology has been the staunch support for biotechnology as an important prerequisite for attaining sustainable agriculture production.

Since the dawn of independence in Zimbabwe, banana production has been declining due to the combination of production challenges and economic meltdown. Resultantly United States Agency for InternationalDevelopment (USAID) contracted private companies and NGOs such as Fintrack. and Zimbabwe Agriculture Income and Employment Development program (Zim-AIED) respectively in delivering outsourced extension services and key to these extension services was the introduction of TC technique in Manicaland province especially in banana producing areas such as Honde Valley in Mutasa district, Chibuwe and Mutema in Chipinge district.

In Kenya, 12 years since the technology was introduced , a study carried out by Mbakuetal (2008) uncovered findings contrary to the expectations. The authors stressed that farmers who had adopted the technology were discounting it and reverting to old practice of acquiring suckers from their orchard or neighbor fields. Considering that the use of conventional suckers has been demonstrated to increase diseases, it is not clear why farmers were discontinuing the technology hence this study

Outsourced extension services are relatively new in Zimbabwe, following economic meltdown in 2008 donors such as USA Agency for International Development, European Commission (EC), United Nation For Food and Agriculture (FAO) and SNV started

experimenting with outsourced extension services. To this end International NGO and local NGOs and private companies were contracted to deliver agriculture and extension services in the specific areas of Zimbabwe. These services include inter alia the introduction of new technology such as the tissue cultured platelets technique which was introduced in 2011 by Zimbabwe Agriculture income and employment development (Zim AIED) in partnership with the private company such as Fruit And Vegetable Company (FAVCO) in Mutasa district.

According to Zimbabwe National Statistics (ZIMSTAT, 2012), Mutasa district has a population of 168747 of which 47,1% are males and 52,9% are males. In this district poverty has manifested in different ways such as youth unemployment, stunting growth, and food insecurity. To this end, the district is also characterized by high morbidity as result of the prevalence of Malaria in the area. Besides rural to urban migration, youths are also involved in boarder jumping to neighbouring countries such as Mozambique, Botswana and South Africa. Climate change in the district has worsened food insecurity and most vulnerable cases are women, child headed families and elderly persons.

The situation was worsened in 2008 where there was massive exodus of youth to nearby countries such as South Africa. Many small scale farmers had abandoned their banana plantations. Resultantly the introduction of Tc was earmarked on improving the lives of small scale farmers in Murara area of Mutasa district. Many youth who have migrated to South Africa came back to venture in banana production. The technological intervention was necessary to counteract traditional ways of propagating banana which in fact had compromised production because of diseases such as nematodes. Besides technology transfer to the farmers, the Organisation linked affiliate farmers to banana markets, financial institutions, and resource management techniques.

In a bid to evaluate the use of tissue cultured banana plantlets as a way to increase production, the study focuses on Murara area of Mutasa District, which is located in Manicaland Province. Murara is chosen as the area of focus in this study given that it is one of the areas in which banana production constitutes a major economic activity among the rural residents. Located in the Eastern Highlands of Zimbabwe, in the center of the banana producing Honde Valley, and

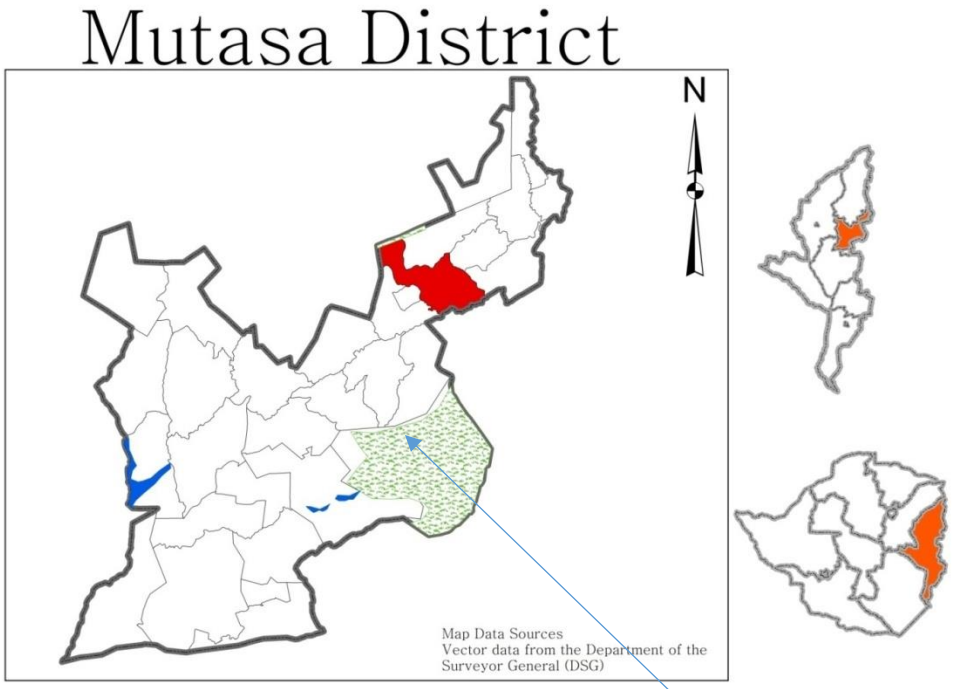
being one of the areas in which tissue cultured banana plantlets have been introduced as a strategy to improve production among the rural poor, Murara area is the best case for this study.

Table 1**. Summary of plant biotechnology research and application in Zimbabwe (adapted from Falconi, 1999; Sithole-Niang, 2001**).

Insitute	Type of technique	Crop	Purpose
University of Zimbabwe Crop Science Department	Tissue culture Molecular marker Assisted selection, Molecular diagnostics	Cassava, coffee, sweet potatoes, tomatoes Grain and legumes, Cassava, maize, tobacco, sweet potato, sorghum	Resistance to African Mosaic Virus. Resistance to sweet potato feathery mottle virus Weed resistance to Strigaasiatica
UZ Soil Science Depar	Biological nitrogen fixation	Legumes	Rhizobium-inoculant for small farmer.
UZ Biological Sciences	Biological control of pests using insect viruses Mushroom production Molecular techniques	Mushroom, Livestock	Small-scale farmers Disease detection.
UZ Vet science	Genetic engineering-vaccines, Animal diagnostic	Livestock	Animal disease treatment Animal disease detection
Africa University Grasslands	Cross breeding Biological nitrogen fixation	Maize Legumes	Dwarf drought tolerant Rhizobium-inoculan

Govt Laboratories			
Tobacco Research Board (TRB	Genetic modification Tissue culture Pollen culture PCR technique	Tobacco Tobacco Tobacco Tobacco	Herbicide tolerance, & disease resistance Virus resistance Disease resistance Damping off disease of seedlings
Tissue culture (private	Tissue culture.	Fruits and ornamental plants	Virus resistance Plant propagation (Falconi, 1999)
Agri-Biotech (private)	Tissue culture	Potato, sweet potato cassava, paprika	Virus resistance Plant propagation (Sithole-Niang, 2001)

Fig 2 Shows the Map of Mutasa District, the research area is has green dots



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Research Area

1.2 Statement of the problem

Agricultural Biotechnology is gaining momentum in shaping production globally. It takes differently forms which include molecular diagnostic, vaccine technology, genetic modification and tissue culture. Be that as it may there is intellectual cleavages on the possible impacts of agro-biotechnology on small scale farming. This has been confirmed by Qaim (1999), and Graff et al , (2000) who also echoed the same sentiments. According to Graff (ibd) the debate at international levels in recent times is earmarked on whether biotechnology can make a difference in uplifting the living standards of people in the third world (Qaim, 1999; Graff, et al 2002; Qaim, et al 2002).The study sought to contribute to international debate on agro-biotechnology and banana farming using evidence from Muraraarea of Mutasa District, Manicaland Province of Zimbabwe.

1.3 Aim of the study

- To examine the impact of agro-biotechnology, and specifically the use of tissue cultured banana plantlets on small scale banana production in Murara area of Mutasa District.

1.4 Research objectives

- To assess factors leading to the introduction and adoption of the agro-biotechnology in the form of tissue cultured banana plantlets among small scale farmers in Murara area.
- To assess whether the use of tissue cultured banana plantlets has promoted banana production and hence the socio-economic lives of small scale producers of Murara.
- To assess challenges and prospects of using Tissue cultured banana plantlets over conventional suckers on banana production in Murara.

1.5 Research questions

- What are factors which led to the introduction and use of the agro biotechnology in the form of tissue cultured banana plantlets among small scale farmers in Murara area?
- To what extent has the use of tissue cultured banana plantlets promoted banana production and socio-economic lives of small scale producers of Murara?
- What are challenges and prospects of Tissue cultured plantlets over conventional suckers on banana production in Murara Area?

1.6 Delimitation of the study.

Delimitation refers to the characteristics that limit the scope and define the boundaries of the study. To this extent, the study only focused on banana small scale producers and this included the adopters and non-adopters of agro-biotechnology in form of tissue cultured plantlets in Murara area in ward 5 Muparutsa area of Mutasa district in Manicaland province of Zimbabwe. Geographically, Muparutsa ward 5 is located in Mutasa North Constituency. According to Zimstat (2012) ward 5 has a population of 3368 of which 45, % are males and 54, 2 are female.

1.7Significance of the study

There has been diverging scholastic views on the possible impacts of biotechnology through the introduction of tissue cultured plantlets on small scale banana farming. The study does not only advance frontiers of knowledge in the field of development studies by examining the nexus between agro-biotechnology, small scale farming and rural development but also endeavors to enrich the field of development studies by revealing how agro-biotechnology can be harnessed for the betterment of small scale banana farming. This research is therefore envisioned to be valuable to policy implementers on what needs to be done in order to realize increase in banana productivity by small scale farmers. In addition, findings in this research will also provide a broader understanding of impact agro-biotechnology on small scale farming.

1.8 Study limitations.

Poor road network s in Murara area was one of the major challenge faced in this research. Small scale farmers in this area are scattered and some households are located in remote areas hence a major challenge encountered in this research. This was also worsened by lack of transport in the area and in this regard the researcher had to walk to access households who practice banana farming. Some of the households were inaccessible and only a small sample of population was interviewed. Resource shortage was also a major constrain faced in this research. Time and money proved to be limited and this delayed process of data collection. The researcher also did his internship with Mutasa Rural RuralDistrict Council and had participated the capacity building of small scale farmers particularly small scale banana producers with Zimbabwe Income and Employment Development Program (Zim-AIED) in 2015thus there was the risk that respondents may had exaggerated the situation on ground linking the research to other base line survey done by Zim-AIED.

1.2 Chapter breakdown.

To attain chronicled impact of Agricultural Biotechnology on Banana Production by Small Scale Farmers. These were articulated in the following order.

Chapter 1 outlines the introduction and the problem statement was also articulated in this chapter. Research objectives and research question were also highlighted. Justification of the study was also articulated in this chapter.

Chapter 2 is the outline literature review. The researcher explored relevant literature on what has so far been researched on problem under investigation.

Chapter 3 is the outline of the research methodology to be used. In this context both qualitative case study design was explored.

Chapter 4 is devoted to data presentation, analysis and interpretation. Results are then presented in line with objectives. This was done based on research questions

.**Chapter 5** comprises of conclusion and recommendations.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

In this chapter, literature relevant to this study is reviewed. This include socio-economic and environmental factors which led to the introduction and use of Tissue Cultured (TC) banana plantlets among small scale farmers, Contribution of the TC on banana production and hence socio-economic livelihoods and finally challenges and prospects of using Tissue cultured plantlets over conventional suckers of banana production. The study put further conceptual/ theoretical framework. In this study small holder farmer and small scale farmer will be used interchangeably.

2.1 Factors leading to the introduction and use of Tc among small scale farmers.

2.1.1 Gender and Household Head

Gender consideration in agro-biotechnology technology is important. This include aspects related to women's lack of control over production resources and social capital for example land as well as attending meetings for new knowledge and the existing of gender differences, male headed households have mobility, participate in different meetings and have more exposure to technology . Therefore male headed

households have more access to use TC than their female counterparts (Nyangetal, 2010).

In Zimbabwe, Mutasa district in Manicaland Province also is an example where women have been sidelined in development activities basing on religious bases. Therefore, gender and household head is one of the factor contributing to the use of Tc among small scale in Murara area of Mutasa district in Manicaland province of Zimbabwe

2.1.2 Education

It is also important to note that education is important in understanding information with regards to any technological intervention. It affects the ability to receive, decode and understand information relevant to make decisions (Chandlier, etal, 1998). Thus it is noted that farmers with education are likely to understand and use technology such as Tc banana technology than farmers with less education hence education is an important variable in determining the use of Tc banana technology among small scale farmers.

Farmers with education are herewith assumed to know to read and write and hypothesized to have more exposure to the external information and therefore accumulate knew knowledge on agricultural innovation like Tc because banana because they have ability to analyze cost and benefits of new technology (Forsonetal, 2001). Rural education contributed to the use of technologies like irrigation technologies as well as banana fertilizer and chemical technologies (Nyangetal, 2010). Sani etal (2014) explained that for increase in the utilization of technology level, expansion of agriculture knowledge oriented education system is indispensable in rural areas of Bangladash.

From conventional theories perspective farmers' education and utilization of technology is a catalyst, henceforth education is one of the factors which is also important in the use of technologies such as the Tc banana technology (Perret etal, 2001). This has been supported by the Endogenous growth model by Mandaetal (2015) who stressed the importance of knowledge stock for human capital. Barrette, (2003) explained that

education acts as an input for production with technology utilization being a catalyst. He also stressed on four factors production into account that is capital, unskilled labor, human capital and an index of level of technology. It is believed that the farmers' ability to produce more output from given bundle of resources depends on knowledge stock of a farmer. Henceforth education increases the information acquisition ability and adjustment ability of the farmer, thereby providing awareness about real world possibilities and rational expectation of decision making. Therefore, education is critical in helping a farmer to decide to utilize modern technology and thereby increase the output (Lideaetal, 2012)

Corollary to the above, Conventional economic theories treat education as a catalyst for production (Uttam, etal 2006). It is an input for production. The study done by Uttametal (2006) recommends that farmers be educated to understand and appreciate the advantages of TC banana technology, hence the role of education in influencing the use and the introduction of technologies has been explicitly noted. It is also imperative to note that the potential risks or disadvantages be communicated and carefully explained to farmers. In this case the possibility of encountering problems should be always made clear (Mbogo, etal 2003). Without proper communication and transparency, the potential of the technology to change positively the lives of rural farmers can be lost (Uttam, 2006)

2.1.3 Household Family labor

The use of TC banana technology is labor intensive. TC plantlets required deep holes as compared to conventional method of banana farming hence an expense to family labor. In this context family can be viewed as the member of people available at household who work on farm. The family is therefore relevant factor to labor availability and reduces labor constraints faced in banana production (Uttametal, 2006). Impact on access, adoption and cultivation of Tc bananas is also affected by availability of labor. Seasonal specific cultivation of farm crop enterprises often create periodic labor shortages. Is also imperative to note that new knowledge require labor inputs during labor scarce

seasons (Thorp etal, 2007). A case study of bush ad fallow agriculture system in Peruvian Amazon illustrates how seasonal labor shortages lead to farm management trade-offs that affect the prospects of technological adoption (Thorp etal 2007).

Corollary to the above, hired labor may influence the utilization of new banana technologies and its availability affects the labor constraints faced in banana production (Avontinde, etal 2012). Therefore utilization of banana plantlets is hypothesized to demand agriculture labor in hole digging, planting, weeding, and harvesting including packaging for sale. It was also noted that the probability of a farmer to utilise technology increased if the farmer was more integrated with farmer's organization, had contacts with Non-governmental Organizations (NGOs), was aware of negative effects of chemicals on health, environment, and had a farm located in an area with better soil conditions (Thorp etal, 2007). On the other hand, the probability of utilization of a high value technology such as Tc plantlets was reduced by an increase in farm size with reduced chance of availability of hired labor (Awotinde etal, 2012)

2.1.4 Marital status of the Household Head

Uane etal (2012) explained that marriage is equally hypothesized to influence utilization of TC banana plantlets. Man or woman in a given family will have different perception on the utilization of TC. There is a mixed perceptions on Genetically Modified Organism (GMOs) amongst member in a family with married women more aware of the GMOs. Individuals in a marriage relationships have varying perception with regards to GMOs and some benefits affect the utilization of agro-biotechnology in the form of tissue cultured plantlets.

2.1.5 Extension Services contact to the Household

According to Andesina etal (2005) the utilization rate is directly related to persuasion and persistent information passage of famers about the technology. Basing on the innovation- diffusion literature (Anderson and Forson, 2005). It was hypothesized that extension visit to farmer is positively related to utilization by exposing farmers to new information and technical skills. Pit etal (2003) explained that although farmers may be experts in wat they do, intensified production requires information and

training on methods and scientific properties of the inputs and application (Pit etal, 2003) and Ngululuetal (2014)

Therefore there is still opportunity for increased production for this crop in area hence poverty reduction through the use of improved agriculture technologies. (Wambunguetal, 2012). With regards to extension services researchers have remained the main link through extension staff in the dissemination of technology to bring the materials to the farmers (Wambunguetal, 2012).

For household to participate in the growth of Tc banana plantlets, the household head could be expected to have good knowledge on the benefits of TC technology thus utilization easily (Nyangetal, 2010). Therefore it is believed that farmers who are members of the group could have more access to new technologies like Tc banana technology (Qaimetal, 2010)

2.1.6 Household Age and Experience in Banana Farming

Number of years are also important in determining the use of TC banana technology. Farmers who are having more experience in banana farming have a tendency of using new technologies and vice versa (Chandlier, 2005). This implies that the oldest farmers are more likely risk averse and less likely to be flexible than younger farmers thus have a lesser likelihood of utilizing new technologies like tissue cultured banana technique (Qaim etal, 2012). Bandierra etal(2009) argues that age is a significant contributor to technology utilization like TC. This implies the number of years the household head has been involved in banana production.

2.1.7 Economic factors

Household economic factors are also critical in influencing the utilization of TC among small scale farmers. Economic is the key determinant for the application of molecular markers in genetic improvement programs (Andesina etal, 2005). The main factors that slow down the using molecular technologies in third world countries include infrastructure inadequacy, and lack of enabling policy (Dekkers , 2002). In spite of these challenges

some developing countries are making progress in using biotechnology in Musa Spp (Courosetal 2003). Thorp etal (2007) maintained that countries like Uganda , beer, wine and bananas are found to be lucrative. Elsewhere banana marketing is an economic activity as the fruits are sold to local markets and major markets. Bananas are grown both for subsistence and for commercial purposes but the potential benefits of TC material is yet to be fully realized among small scale farmers due low utilization (Rodgers etal 2005).

According to Wambungu(2004) banana is crucial in many lives of Kenyan communities. The same can be also said in developing countries where banana have sustained livelihoods in countries such as Zimbabwe in Manicaland Province as demonstrated by Murara area. Qaim etal (2010) gives in-depth social economic study through analyses that could be brought about by the dissemination and utilization of TC banana plantlets to resource poor small scale farmers in Kenya. The study unraveled that if TC if well utilized it could transform food access, availability, affordability, and adequacy in the long run turning food deficit in arid and semi-arid regions (Qaim, 2012). To this extent adoption theory sates that following a period of rapid growth , the innovation rate of adoption will gradually stabilize and finally decline. That is innovation go through a period of slow gradual growth before experiencing a period of relatively dramatic and rapid growth (Bandierra etal, 2002). Extension services and training to the farmers can accelerate the utilization level of technology, the analyses of the study herein was based on the adoption theory in extension services as it corresponds to the TC bananas in study area which include different stages.

Awareness and knowledge stage involves a stage where individual or group gets the idea about the TC to be adopted for the first time but lacks sufficient information about it , this limits the attempts to adopt (Rodgers, 2005). This is then followed by the interest stage whereby this group or individual becomes interested with the new idea and seeks more information about it prior to adopting or knowing it (Rodgers, etal 2005). This stage is then followed by the evaluation stage. The individual or group weighs the pros and cons of the new idea before deciding to use it or not. The group or the

individual accept the new idea on small scale to find its utility. This is followed by accepting the new idea and is made part of their lifestyle (Rodgersetal, 2005). Compatibility is another stage which refers to the degree of consistency of the new idea with the existing values of the people intended to utilize it.

The distance to the market both for inputs and outputs has been found to be a key issue in productivity analyses. Mbogoetal (200) note that distance to the market and related transport cost affect crop choice decision and even utilization of the technology. According to Tegemeo study by Barrette, (2003) farmers can only invest their time and money in dairy production if they are assured of making profit thereof. Profit levels therefore affect as well the utilization of TC technology.

2.1.8 Off Farm Income

The availability of off farm income can affect the possibility of technology utilization positively since it can increase the financial capacity to pay for improved inputs like buying Tc seedlings, chemical and fertilizers (Thorp etal 2007). There is need to adopt the proven agricultural technologies so as to heighten productivity and thereby living conditions through improves incomes of the rural poor (Rodgers etal 2005). Furthermore for developing countries to catch up with developed countries there is need of agricultural diffusion and adoption (Foster etal, 2010). Pitt etal and Uaneetal (2009) noted that since the needs of rapidly grown population could not be met by expanding area underutilization, developing , employing and dissemination yield increase agricultural technology is imperative.

Since improved banana material like TC banana are more expensive as compared to conventional suckers and cost of planting material is hypothesized to negatively influence the utilization of TC banana technology. Cost is subjective to availability of funds and property and therefore lack of purchasing power significantly affects the procurement of TC (Wanyamw, 2007).

2.1.9 Environmental Factors

Environmental factors are also critical inasmuch as use and the introduction of TC banana technology is concerned. Karemboetal (2002) explained that TC banana technology is an appropriate technology intervention for the persistent decline in banana production due to infestation of pests, diseases and environmental degradation. The effects and economic importance of diseases are further cited by Thorp etal (2007). The benefits of the utilization of TC banana technology to the transformation of youth and women in agriculture through horticultural farming in Kenya is well elaborated by Rine etal (2009). The environment within semi-arid and areas has a potential for establishment of banana plantations that could create income, food, and employment if only water harvesting can be done (Robibsonetal 1996). The same can be also said about the conducive environment in Mutasa District, Murara area which has promoted banana production.

In less privileged environments, prolonged droughts , undeveloped infrastructure, over reliance on rain fed agriculture, limited employment opportunities, week market systems, inaccessibility to credit facilities, continued environmental degradation and poor agricultural practices are some of the factors affecting utilization of agro-biotechnologies that include the use of Tc banana plantlets.

Factors which include physical and natural characteristics such as the location and areas under cultivation, soil fertility status and access to water all year around are important in affecting the utilization of TC technology (Andesina, etal 2002). Geographical location of areas for banana farming positivelyand significantly influence TC banana plantlets uptake. This implies TC technology suits well in farmers areas where soil are fertile and where there is water to practice irrigation such as Murara in Honde Valley area in Mutasa District, Manicaland Province of Zimbabwe.

Furthermore agro-ecological zones are have shown to be central inasmuch as utilization and introduction of Tc banana technology is concerned (Barrret, 2003). This trade orientation significantly contributes farm revenue and probably livelihood in using Tissue cultured banana plantlets (Mbogohetal, 2003). Soil fertility especially from variable of farm fertility level experiment were negative and significant implying that the lower the period of soil fertility level, the higher the banana intensification and vice

versa (Langaletal, 2003). Since cultivation of banana is suitable in soils which are fertile, if the farms are relatively low in soil fertility, then expansion of TC bananas is likely to be higher but probably with relatively enhanced manure application. This could be also attributed to low yield of the TC banana technology under low fertility regions hence production is enhanced through the use of inorganic and inorganic fertilizers (Mataschke, 2009).

Additionally, farm size is another factor to consider as explained by Kabunguetal (2012). Farm in hectares is the total land size owned by the household and it is a variable inasmuch as the introduction and the utilization of TC banana plantlets is concerned. Henceforth, the large the farm size, the more likelihood of allocating more land and resources to TC bananas. The main argument is that farmers who cultivated large size of land can utilize more capital and will demand TC bananas more.

The superiority of TC over conventional method of banana farming is one of the factor leading to the introduction and use of Tc among small scale farmers on the globe. Tissue culture banana production technology is a superior technology over traditional method (sucker propagated) of banana production with respect to optimal yield, uniformity, diseases free planting material and true to type plants. Use of biotechnology in banana production also reduces the time taken for the crop to mature (FrisonandSharrock1999).Mass multiplication of tissue culture plants could be done in a short time. In recent years, the growing of tissue cultured plants is becoming popular on the globe. Agricultural biotechnology has been touted to offer increased production in developing countries. Recent studies about the agronomic impacts of biotechnology demonstrates that an average farmer benefit high income increase through reduced pests.

According to Fintrac(2014),the farmers who are in tissue culture banana were fully convinced of the superiority of the tissue culture banana in several ways including:(a) the availability of large quantities of clean superior planting material enabling them to reclaim their old orchards (a)increased productivity (c)a shorter maturing period and (d)uniformity of bunch sizes resulting in easy coordination of marketing. This has been confirmed by several studies which have

demonstrated that on average farmers benefit from high income increases through reduced diseases and pests control and higher effective yields through the adoption of agro-biotechnology (Ismael etal,2001).

To this end TC plantlets are less vulnerable to pests and diseases hence the introduction of TC among small scale farmers was an attempt to reduce incidence of diseases associated with conventional method of banana farming. According to Thope tal (2007) small pieces of TC can be used to produce hundreds and thousands of plants in continual process. A single plant can be multiplied into several thousands in a relatively short time period and space under controlled conditions irrespective of the season and whether on a year round bases. Therefore, small scale farmers were convinced about TC plantlets' potential to increase banana production.

2.2 TC banana Technology and productivity.

It has been noted that technology has a great impact on production. To this extent, technology improves quality, efficiency, output and lower costs (Gittinger, 1982). Investment in technology through research and development lead to high production. Empirical evidence in continents such as Asia, America and Europe has shown that agro-biotechnology through tissue cultured plantlets has improved production in these continents.

Currently bananas are grown in about 150 countries across the world on an area of 4.84 million hectares. On this total area, production ranges around 95, 6 million tons as shown on table 2. As well demonstrated in table 2 below, production in India, China and Indonesia has increased phenomenally from 2001 to 2009 and this increase in production levels has been attributed to agro-biotechnology, which includes the adoption of tissue cultured plantlets even among small scale farmers. Alston etal (1995) further explained that technology is vital for production and its drawbacks are insignificant. Henceforth, it is clear to note that agro-biotechnology through tissue culture has the potential to increase banana productivity.

Table 2. **Area, production and productivity of banana in major banana producing countries**

Country	Area		Production		Productivity		%global
	000 ha		Millions tones		t/h		Production
	2001	2009	2001	2009	2001	2009	2009
Brazil	510.29	511.64	6.18	7.19	12.10	14.06	7.52
Cameroon	66.35	86.0	0,83	0.82	9.52	9.53	0.87
China	253.95	311.11	5.48	8.21	21.56	26.38	8.59
Columbia	51.06	74.11	1.46	2.02	28.78	27.26	2.11
Costa Rica	44.52	42.59	2.06	2.13	46.30	49.94	2.23
Ecuador	228.99	216.12	6.08	7.64	26.54	35.34	7.99
India	466.20	709.00	14.21	26.22	30.58	37.00	27.43
Indonesia	277.00	105.00	4.30	6.27	15.52	59.74	6.56
Mexico	71.05	-	2.02	1.80	28.54	27.52	1.98
Philippines	386.50	446.40	5.06	9.01	13.09	28.19	9.43
World	4317.03	4843	66.84	95.60	15.48	19.74	

Source: FAOSTAT (2011)

Bananas are predominantly produced in Asia, Latin America and Africa. The biggest producers are India, which produced 29 million tonnes per year on average between 2010 and 2017, and China at 11 million tonnes. Production in both countries mostly serves the domestic market. Other large producers are the Philippines with an annual average of 7.5 million tonnes between 2010 and 2017, and Ecuador and Brazil both at an average of 7 million tonnes.

Precise figures on total global banana production are difficult to obtain as banana cultivation is often conducted by smallholder farmers and traded in the informal sector, which is often untraceable. For example, some 70-80 percent of production in Africa are local bananas that have been present on the continent for over 1 000 years. These are mostly cooking bananas that are a popular and important staple food. Available data indicate that between 2000 and 2017, global production of bananas grew at a compound annual rate of 3.2 percent, reaching a record of 114 million tons in 2017, up from around 67 million tons in 2000.

The major cause in the decline in production is pests and diseases. Therefore TC was introduced as way of improving small scale banana farming since tissue cultured plantlets are resistant to pests and diseases. To this end Tc ensures production of clean planting materials which in turn led to increase in banana yields to the adopters of the technology (Muyanga, 2008).

The study done by Mbogoetal (2002) pointed out that modern methods of banana propagation were capital intensive but tends to have higher input while the traditional methods required less capital with low yields. What it means then is agro-biotechnologies have the potentialto increase. According to this study, higher output was realizedas a result of TC. This also resonates well with the study done by Hanamantaraya (2007) who did a comparative economic analyses of TC banana production in Kamataka. According to the findings, the technology ensures high yields per hectare (50,04 tonnes per hectare) comparing to the conventional ways of banana farming whereby the yields were 40.05 tons per hectare.

Additionally findings of this study also established that the technology was effective in production of clean and health plantlets which were free from pests and diseases. Therefore, it is clear that TC banana plantlets have the potential to increase small scale banana production on the globe, however there is still a debate on the impact of agro biotechnology on banana productivity by small scale farmers hence the study seeks to rationalize the discussion by providing an assessment of tissue cultured banana technology on the banana productivity by small scale farmers in Murara area, Mutasa district of Zimbabwe.

Mwangi etal (2008) stated that over the past two decades, decline in banana production was noted from a global perspective. According to the findings, the major findings attributed to the decline in banana production were pests and diseases. To this extent, the major banana pests include banana weevil and the major diseases are found to be fusarium wilt and sigatoka. The introduction of agro-biotechnology in the form TC banana technology was meant to reverse the production decline through the provision of clean and healthy plantlets which resists pests and diseases.

Other factors that have contributed to the decline in production are poor agronomic practices, decline soil fertility, lack of clean material among others. The same can be said about Zimbabwe, where decline in production was a result of pests and diseases which

were occasioned by conventional ways of banana production. The era 2008 was characterized by low production due to a number of factors which include pests and diseases. The yields were as low as 4toones per hectare and prices were as low as $0,10 per kilogram. To this extent many famers had left their land since banana farming had proved to be unviable.

2.3 Social Economic Transformation Associated with Tc technique on Small Scale Banana Farming

Several recent studies have analyzed the impact of biotechnology in third world countries for ex ente and ex post angles. (Andre, etal, 2009, Sesenyanga, 2005, Qaim, 1999, Pray etal, 2009, Nyamori, 2009). Significantly to note here is the fact that the results constantly show that TC crops in rice, sweet potato, and banana has a potential to bring positive impacts on the livelihoods of small scale producers thus having the potential to transform social economic livelihoods of the community. The study argues that the introduction of TC banana technology has also the potential to improve the livelihoods of small scale farmers in Mura, in Mutasa district of Zimbabwe. However there is still a debate among scholars who seeks to comprehend the impact on TC from optimisms- pessimism continuum. The question weather , the TC has brought about positive impacts on the livelihoods of small scale farmers remain inconclusive.

Corollary to the above, the impact of agro biotechnology inform of tissue culture done by (FAO, 2005) in countries such as China, Kenya, Vietman, and Benin on sweet potato, banana and rice showed that the technology had increased yields and income from agriculture, had high internal rate of return compared to capital investment, led to availability of affordable seeds as well as the creation of rural micro enterprises, improved health standards, shorter growing seasons and resistance local stress. Henceforth, it is clear that agro-biotechnology has the potential to improve the livelihoods of rural communities hence a positive step towards achieving rural development.

Banana is often considered to be an export crop of third world countries and it is often dominated by transnational companies from counties in United States of America and Europe. In Asia, subSaharan Africa, the crops sometimesgrown for subsistence purposes. In East Africa, it is grown for subsistence purposes and for commercial purposes. (ISAAA, 2003). Biotechnology as explained in an International Symposium organized to assess its economic impacts on modern vegetable production in Tropical Asia (Jayamangkala, 2009) established that the technology resulted to in improvement of farmers' incomes, facilitated industry reconstruction, and enhanced industry professionalism, focusing on market development and increased consumption. In Philipines , Manoka (1982) explained that land reform and improved biotechnology are significant factors that influenced the society economically and socially.

The technology is alsoassessed by Wambungu, (2009). She notedthat the technology hadpositive impacts on farmers who adopted it. According to the study the benefits include potentially unlimited multiplication of selected plant lines, elimination of pathogens, production of true to type multiplication of desirable plant trees and indefinite storage of genetic resources through long term maintenance.

The study carried out by Adrea, etal, 2009) assessed the social impact of the application of agro-biotechnology in Zimbabwe. This was done through the lens of Sustainable Livelihood Framework (SLF) by Chambers and Cornaway (1991), DFID, (2001). SLF was apt for the study as it manage to capture ecological, agricultural, economic, social cultural, political factors affecting the technology use and outcomes. The study was carried out it Chigodora ward in Hwedza district of Zimbabwe. The survey showed rise in adoption rates. It was noted that the majority of households grew the crop on 0,5 acres or less. Significantly to note about this study is the fact that sweet potato is a secondary risk spreading income generating activity.

Andrea etal (2009) carried out similar study to assess the economic impact in Uganda. The study established that there was rise in adoption rates which were characterized by improvement of incomes among small scale farmers. The households reinvested their

increased earnings in livelihoods assets such as improved houses, schools fees, and cattle. The study concluded by recommending that projects earmarked at diffusion of technology should be include service package to technically assist the adopters. Impact should be considered ex ante in the projects in order to maximize social economic benefit impact.

Qaim (199) also did the same study by assessing the impact of agro-biotechnology on banana farming in Kenya. The aim of his study was to establish the benefits of adopting technology by small scale farmers in Kenya selected communities. To achieve this, the study employed the Economic Surplus Model aggregate, benefits and distribution incomes were analyzed using ex-ante conceptual framework. The study established a potential increase in yields and improvement of incomes among small holder farmers. The study also found out that increase in per unit cost of reduction in production and high internal rate of return compared to capital invested in the banana enterprise. The findings by Qaim (1999) also concluded that the technology would change the livelihoods of small scale farmers, hence according to him, there is need for capacity building of small scale farmers and financial empowerment.

Mbogo (2002) conducted a baseline survey on the implication of agro biotechnology inform of Tissue culture in Kenya. Findings of this study pointed out that the adoption of agro biotechnology in form of TC among small scale banana producers resulted in increase in farm income, women participation in farming activities and high trade margins. Therefore, it can be concluded that from empirical studies TC has the potential to transform the livelihoods of poor resourced small-scale farmers on the globe. The same can be also said on the Murara area in mutase district, Manicaland Province of Zimbabwe whereby Tc was introduced to reverse decline in banana production and as strategy to revitalize the livelihoods of people .

Furthermore, (Nyamori, 2003) analyzed thesocio-economic background of TC banana production inNyana. The aim of the study was at identifying the empirical social economic factor that influence the adoption of TC technology in the region and identify

constraints to adoption. The study demonstrated that main social economic factors influencing the adoption were gender, price of plantlets, food culture, yield and information dissemination. From the study it was established that banana provided an average of Kshs 500 per month that constitutes 20% of income generated from farm activities. It was also established that land handling in the three districts was found to be 1,8 acres, with approximately 0,153 acres devoted to TC and 0,223 non TC banana production.

Furthermore, Lefranc etal (2007) also carried out study on micro propagation as an innovative technology. The study established micro propagation technology resulted to improve in quality and quantity of banana planting materials. According to him the technology can lead to foster multiplication of plantlets that is three months of plantlets can be multiplied to 8-20 times the number of plants with better quality. They also established that that costs associated with this technology are within the reach of manysmall holder farmers. Therefore it was found out to be a cost effective method of banana propagation.

Ogusuni etal (2005) analyzed the social economic impact of maize production technology to the farmers' welfare in South West Nigeria. From this study (Ogusuni ibd) noted that there was internal higher rate of internal return compared to initial capital outlay pointing out that maize technologies had contributed positively to the livelihoods of communities. The study concluded by recommending that technologies should be pro-poor, farmers driven and the should be encouraged to grow maize crop as it had proved to be highly remunerative crop.

Agriculture is conceived an perceived as a key driver of social economic transformation as it contributes immensely towards poverty reduction. Thus the introduction of agro-biotechnology through tissue culture plantlets is meant to improve banana farming thereby improving the standard the livelihoods of small scale farmers on the globe. This has been confirmed by Nkamleu et al. (2003) who calculated changes in agricultural productivity in 10 countries in sub-Saharan African countries between 1972 and 1999. In contrast with significant progress in Asia, Nkamleu et al (ibd) found that, on average, total factor productivity decreased in that period by 0.2% annually. They suggest that, whilst efficiency was constant, technological

change was the main cause of the failure of total factor productivity to increase. Around 75% of those surviving on less than US$1 a day - the internationally agreed definition of absolute poverty – live in rural areas (IFAD, 2001) and agriculture is an important livelihood source. It is estimated that 70% of sub-Saharan Africa's labour force and 67% of South Asia's, works in agriculture (Maxwell, 2001).

Improvements in agricultural productivity have a powerful knock-on effect to the rest of the economy by: creating jobs in neighboring sectors such as food processing and input supply as well as directly in farming; increasing the supply of affordable food; and stimulating and supporting wider economic growth and development. To the extent that technology raises agricultural productivity, it should be the major factor in creating these positive effects. Thirtle etal (2003) explored the relationship between agricultural productivity and poverty. They drew on observations between 1985 and 1993 in 48 developing countries and found that a 1% improvement in crop yields reduced the proportion of people living on less than US$1 per day by between 0.6 and 1.2%.

However there is still diverging on scholarly views concerning the implication of agro-biotechnology through Tc on resource poor small scale farmers. Therefore the study will therefore seeks to harmonize international debate on the implication of agro-biotechnology through Tc on small scale banana producers in Mutasa District, Manicaland Province of Zimbabwe

Bananas form a staple food crop and source of daily carbohydrates for more than 10 million Africans (SharockandFrison,1998).Most bananas are produced for local consumption and per capita consumption in most African countries is considerable, with consumption of bananas in Uganda approaching 250kg/person/year (Simmonds,1966).Banana occupies a distinct place in the national as well as the household economy of Zimbabwe. Nutritionally banana stands out among other fruits because of its richness in carbohydrates, vitamins and minerals (Wambungu and Kiome, 2001).Apart from being a source of nutrition, banana is a reliable and regular source of cash in come to more than75% of households in Honde Valley in Mutasa District of Zimbabwe. Therefore, the Impact of the revival of the banana sector in Zimbabwe through the

introduction of tissue culture banana technology in tackling problems of poverty, food insecurity and malnutrition has been considerable. The has been confirmed by Lipton (2001) who noted symbiotic relationship between agriculture and poverty alleviation. Henceforth it is the writer's contention that adoption of Tc technique is a positive step towards poverty alleviation.

Corollary to the above, Zimbabwe's banana production increased 186 percent over two years to 45 775 tons in 2017, from 16 000 tons in 2015. According to a Confederation of Zimbabwe Industries (CZI) report for Manicaland — a major banana producing region — the province produced 81 percent (396 975 tons) of the total output, with the balance of 29 percent (8 800 tons), coming from the rest of the country. Despite the sharp increase in national production, the country only managed to export a mere five percent (2 000 tons) to South Africa and Zambia, while the remainder was consumed locally.

The direct economic impact of tissue culture banana in Honde Valley can be assessed by the area under tissue culture banana, estimated at 0.5ha/household and the average net income of tissue culture banana is about$5400-00and that from traditional varieties is about$1500-00(Fintrac,2014) The estimates of costs and returns from traditional varieties and tissue culture plantations show that the establishment of annual recurring costs of tissue culture banana plantations are considerably higher than that for traditional banana plantations, but that the gross income of tissue culture banana considerably exceeds that traditional varieties, resulting in higher net income from tissue culture bananas (Mbogohetal, 2002)

2.3.1 Tissue Culture Technology in poverty reduction and Food Security Alleviation.

In many countries in Africa, yields of major crops including banana does not increase in line with escalation human population (Cheke, 2006, Chopra, 2004, Eicheretal, 2005, Pehu and Ragasa, 2008, Pellissier, 2008, Tittonnel and Giller, 2013. Therefore it is widely acknowledged that investment in agro-biotechnology through TC will go a long way in poverty alleviation as well as in achieving food security. In Africa, it has been noted that the primary cause of food insecurity will continue to be poverty rather than

inadequate food production (Wichelns, 2015). A number of studies have be done relating to food security and biotechnology specifically on Tc technology (Desta, 2011, Gahakwa etal 2012, Izquuierdo and de la Riva 2000, Mago 2011, Odame, etal, 2003, Ogero etal 2012 and Panyika etal (2004).

Mago (2011) conducted a study to establish whether the income for TC banana growers are significantly increasing in comparison with conventional ways of banana production in Nyamira North. Findings from this study pointed out that TC banana growers had relatively higher incomes as compared to small scale farmers who relied on conventional ways of banana production. Finding also established that TC banana growers outcompete the conventional ones. Henceforth despite the fact that, TC banana plantlets are costly, they have proved to be superior to conventional practices which rely on banana suckers as planting material.

Gahakwa etal (2012) also established that biotechnology has the potential to increase world's food output and ameliorate cases of food insecurity in Rwanda. According to this study agro-biotechnology through TC has successfully contributed to increased productivity and food security through improvement in yields and quality levels.

Agro-biotechnology debate which may result to myths on TC banana technology (Nyande, 2012, Qaim, 1999) and generally GMOS banana type (Kikuliwe etal 2008) demand seeking stakeholder (small holder farmers) views as regards its uptake. Tissue cultured banana technology was perceived to contribute significantly to poverty reduction of food insecurity as demonstrated by the study carried out by Qaim (1999) and Mbogo etal (2002). The study also established that there is need to conduct follow up on how benefits have trickled down to the targeted population in this case is the small scale farmers including challenges and opportunities.

Desta (2009) also did a study on the role of agro -biotechnology in ameliorating food insecurity and its impact on small holder farmers and biodiversity as perceived by key stakeholders in Ethiopia. The results however had divergence of ideas on the potential

impact of agro biotechnology on food security. Delta (ibd) concluded by explaining that the potential of agro-biotechnology to address food insecurity is highly questionable and it may even intensify such problems. However TC banana technology is not GMOs based but a micro-propagation technique using plant tissues.

Table 3 **Shows Potential effects of banana tissue culture (TC) technology at the farm level**

	Small scale Farmers		Medium scale farmers		Large scale farmers	
	Without TC	With TC	Without TC	With TC	Without TC	With TC
Production cost (US$/ha)	248	571	300	652	413	792
Yields (t/ha)	10.7	26.9	13.9	32.2	18.7	36.1
Income (us$/ha	983	2517	1212	2967	1572	3242
Cost	130			118		92
Yield	150			132		93
Income	156			145		106

Source: Qaim (1999).

From the table 3 above it can be noted that farmers who has adopted Tissue cultured banana technology had high yields as compared to non-adopters of TC banana technology. The same can be also said on income which was so high for small holder farmers,medium holder framers and large scale farmers. However production cost were high for the farmers who relied on agro-biotechnology in form of tissue cultured plantlets (Qaim, 1999)

Table 4: The approaches for assessing the impact of biotechnology applications

Level	**Scope**	**Impact**	**Indicator stated**	**Time Frame**	**Approach / Model**
Micro	Village	Agronomic	Yield Cost of production factors	Ex-ante Ex-post	Effects on production function.
		Social and Economic	Workload, Additional Time Family income, health of worker, additional	Ex-ante	Household approach

			time	Ex-post	
	Market of a single product in single country		Benefit Cost Ratio Internal Rate of return	Ex-ante	Dynamic Research evaluation for management (DREAM) Scenario analysis
			Net Present Value		Aggregate economic welfare Analysis, single market partial equilibrium models)
Sector		Econo mic	Distribution of benefit between operators of the production chain	Ex ante	Economic surplus Model
Macro	Market of many products in a single country market of a single product in many countries multi commodity market in many countries	Econo mic	International price of distribution of benefits between regions or countries (Non adopters and adopters) Distribution of benefits between society categories	Ex ante Ex Post	Partial Eqiuribruim model (few commodity computable general Equribrium (CGE) models (cross commodities and sectors) Dream Multi-market analyses.

Table 5. **Comparison of Tissue Culture versus Conventional Sucker** at national Horticultural Research Centre Thoka Central Kenya (Wambungu and Kome, 2001)

	Days to Harvest	**Yield, t/ha/year**
Tissue Culture	**341**	**49.9**
Conventional suckers	**414**	**41.9**

2.4 Challenges and Prospects of using Tissue Culturing Plantlets among small scale farmers

Like all other technologies Tissue cultured banana technology has both positive and negative impacts on banana production among small holder farmers. It is imperative to note that although TC has been characterised by technical impediments they have proved that they have potential to improve the livelihoods of small holder farmers. Wambungu and Kiome (2001) noted that although TC have demonstrated that they are free from pathogens, they were not resistant to pests and diseases and this would negatively affects production. Viruses such as Bunch Top and banana streak could be also be transmitted through plantlets. (Wambungu and Kiome, 2001). According to Wambungu and Kiome, ibd) precaution measures should be taken which include virus indexing. In this regard virus indexing has been defined by Molina (2002) as a lab technique which involves growing plant cells under adverse conditions to select resistance cells before growing full plant. Henceforth, according to the research done by Wambungu and Kiome (ibd) TC have proved to be vulnerable to pests and diseases, thus affecting the banana production among small scale farmers. In this income and yields from TC would be also negatively affected.

Furthermore, the other challenge with regards to use of TC technology among small scale farmers is the fact that Tc require extra attention and care as compared to conventional

ways of banana farming among small holder farmers. To this extent Tc require extra resources and high level of technology management practices especially in digging holes, de suckering, watering, applying manure and to some extent fertilisers (Karembu, 2002). It also important to note that unlike conventional varieties, TC banana plantlets have high affinity for water hence a burden to small holder farmers who are resource constrained.

The other challenge associated with the continued of technology is relate to the social and economic environment in which it is being adopted. Scholars have noted that adopters who do not receive assistant or help from technological providers or extension services are likely to revert back to conventional ways of farming whenever faced with challenges. (Miller and Mariola, 2009). Henceforth small holder farmers who opt for TC banana technology should be provided with capacity building skills with regards to the use of Tc banana technology and this may come inform of extensions services.

However, it is also imperative to note that tissue cultured plantlets is likely to increase banana production among scale banana producers on the globe. Tissue cultured plantlets made to resist pests and diseases. Common pests in banana production include banana weevil, common diseases include Banana Bunch Top Viruses (BBTV), Cucumber Mosaic Viruses as well as Banana Streak Viruses (BSV). To this end the decline of banana production has been attributed to prevalence of pests and diseases. A case in point is Honde valley in Mutasa district where the continual use of conventional varieties necessitated the transmission of pests and diseases. This has been confirmed by the study carried out by Qaim (1999). According to this study carried out in the Kenyan soil, TC plantlets are free of most of the pests and diseases that exist in Kenya, notably weevils, nematodes and fungi.Henceforth the introduction of Tissue Cultured varieties has a potential to revolutionised small scale banana production on the globe. Fundamental note here is the fact, TC plantlets are resistant to pests and diseases henceforth production increase is likely to be realised among small scale farmers. This is also a positive step towards transformation of small scale subsistence farming to commercial banana production on the globe.

Table 7: below shows major pests and diseases

Pests	Diseases
Weevils Cosmopolitis sordidas	Fusarium Wilt (Panama diseases) Fusarium oxysporium f.sp cubense
Nematodes Radopholus similis Pratylenchus goodeyi	Black sigatoka leaf spot Mycosphaerella figiensis
	Yellow Sigatoka Leaf spot Mycospherella musicola
	Ciga end rot Verticillium theobromae Tracksphaera fructigena

Source : World Bank (1996)

Additionally, Tissue cultured plantlets are likely to boost yields as compared to conventional varieties hence there is potential of high yields in using and adopting tissue cultured banana plantlets. According to a South African study yields are 20 per cent higher in the first year, then slightly decreasing, but still measurable after the third year. In conventional ways of banana production, the production of suckers is highly seasonal and it compromised the production of bananas due to unavailability of suckers in off seasons. To this end the production of tissue cultured plantlets has been a foundation of high quality diseases free plantlets henceforth, with tissue cultured plantlets there is likelihood of high yields as compared to conventional ways of banana production. Development of tissue cultured plantlets is also associated with uniform growth and one time harvesting, hence TC have the potential to increase banana production among small scale farmers. This has been confirmed by Qaim (ibd) who articulated that In -vitro plantlets are uniform and this may simply orchard management compared to conventional material

Corollary to the above, Tissue cultured plantlets matures fast than conventional varieties hence production is likely to be realized among small scale banana farming. Traditional

varieties attain maturity 24 months after planting. However maturity of tissue cultured plantlets is within 12 months. Additionally TC plant has a bunch weight of 30-45 kg. In this context the average yields of TC per hectare is 30-40 tones twice the yield of conventional varieties hence they are productive and commercial as compared to the traditional varieties. It is also imperative to note that conventional varieties have known to carry pests and diseases from the mother plant though there are ways to reduce diseases before planting. TC on the other hand, are free from pests, fungal and most bacterial pathogens. To this extent, development of Tc is associated with indexing which is a process of making TC plant resistant to viruses. It should be noted also that TC are also easily infected with pests and diseases if transplanted to infected soil. Be that as it may, the development of TC has a great potential in improving banana production among small scale farmers on the globe.

2.5 Theoretical Framework/ Conceptual Framework

This study employed modernization paradigm which was supported by sustainable development approach in shading light on the subject at hand that is the impact of biotechnology through the application of Tc technology on small scale banana farming . It is critical to note that biotechnology is referred to a broad area of biological science. It is understood as the use of knowledge of biological system to produce goods and services. However the study was interested one aspect of agro-biotechnology that is the application of tissue cultured plantlets on small scale banana farming. Willis (2011) defines modernity to mean "being modern, new or up to date"; she goes on to elaborate that modernity is often used to discuss certain forms of the economy and society.

Modernization of agriculture involves the application and transfer of science and technology from experts to farmers (uni-directional) as understood in the developed world in pursuit of increased production and productivity (Harrison, 2001). This is apt for this study as it stresses the application and transfer of technology. Focusing on small scale banana farming, agro-biotechnology through the introduction of TC plantlets was an outsourced

technology in Zimbabwe. To this end it was donor funded and private companies were contracted to deliver outsources extension services and one of the aspect of outsourced extension services was the introduction of tc technology on banana farming in some parts of the country. However while scholars like Qaim (1999) focused extensively on the adoption of such technology, the impact is of Tc technology on small scale banana farming is under researched.

The transfer of knowledge and technology is one important aspects of modernization paradigm. In this regard biotechnology which was introduced in banana production involves the use of tissue culture banana plantlets with the aim of increasing production. Traditional way of propagating bananas proved to be vulnerable to diseases which resulted to loss in yields, therefore the introduction of tissue cultured bananas was meant to boost production. In Zimbabwe the technology was adapted by communities in Honde valley and there was boom in yields as compared to traditional means of planting bananas using suckers (www.fintrack.com, 2016)

Kuhnen (1987) further postulates that extension of technological services to traditional societies can effectively address the challenges of development in these areas or societies. It is thus apparent that there is need to modernize production apparatus, by adapting efficient technology which in many instances is symbolized and enabled by modern services. Not only will this lead to increased productivity but will also result in improved livelihoods. The improvement of small scale farming practices that will not only raise farm income and average yields but also effectively absorb underutilized rural labor through adaptation of effective labor intensive farming offers their major immediate avenue towards achievement of real people oriented rural development (Todaro,1979:238). In the study, small scale farmers are those with limited factor production including land, capital, skills and technology. Additionally, they have challenges in accessing adequate inputs to allow them to harness available technology. However as a result of short comings of the modernization theory in articulating the concept of development, this theory was supported by sustainable livelihood approach.

2.6 Sustainable development Approach.

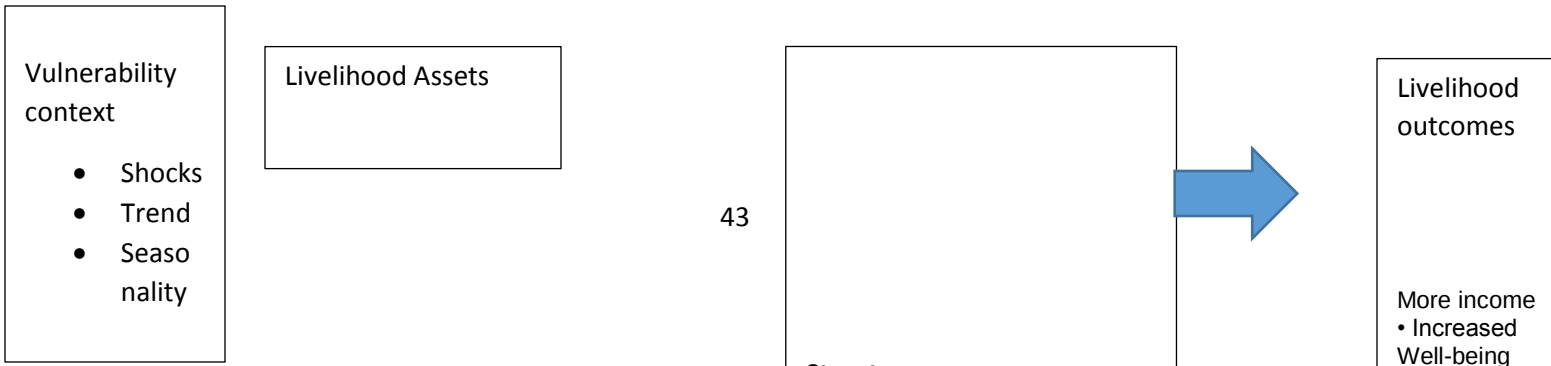
The approach proved to be apt for this study due weaknesses inherent in modernization theory for example it is rooted in eurocentric ideologies. Wiser (1993) notes that such approaches have

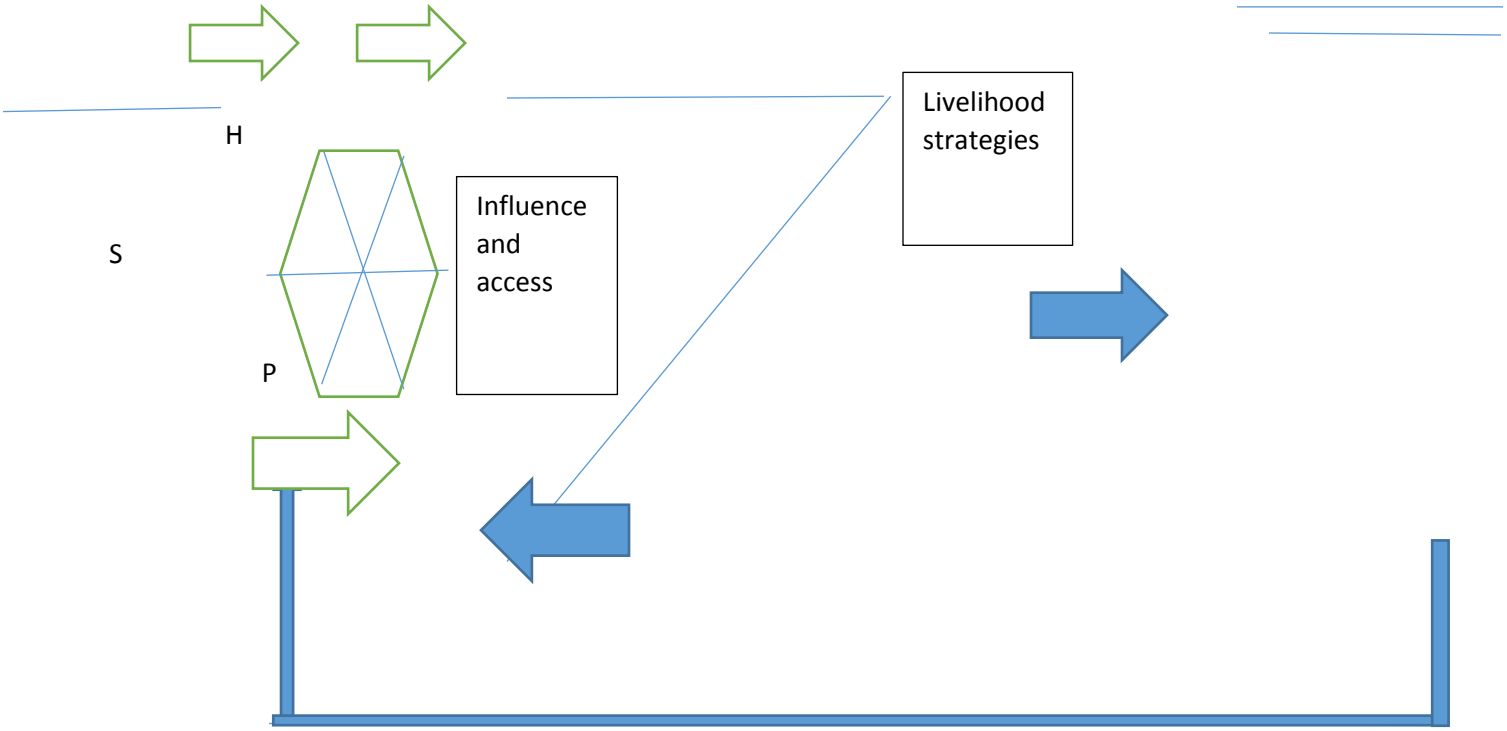
beneficial impacts enduring beyond their original time frame. The approach involves application and transfer of science and technology from experts to farmers in pursuit of increased production and productivity (Harrison 2001; ADB 1991; World Bank 2001 and 2002). The sustainable development approach emulates the transformation of natural resources in ways which benefit local communities. Wiser (2005) argues that the approach has a more orientation towards the empowerment of people to make the most out of their own natural resources. Matthews and Hammill (2009) view that once people have mastered the process of making the most out of their environments, then they can start to develop in other spheres of their lives. Estes (1993) mentions that in the context of sustainable development, the well-being of the environment, economies and people's welfare is inextricably linked

The sustainable livelihood framework is apt for this study because it enlighten understanding of poverty and food security by analyzing the relationship between relevant factors at the household, community and regional level. The sustainable livelihood approach explicitly examines the context in which people live in rural community. Including concepts vulnerability, assets, and empowerment the sustainable framework goes beyond conventional social and economic measures of income or nutrition. The fig 3 below illustrates the overall sustainable livelihood framework. The framework is dynamic and recognize changes due to external fluctuations of the results of people's own actions.

The starting point of the framework is the vulnerability context within which people live. The vulnerability context is affected by external influences such as the weather and price changes. As shown on the Fig below the framework recognize five types of assets that Human (H), Natural (N), Financial (F), physical (P). These assets interact with policies, institutions, and processes in shaping the choice livelihood strategies. These in turn shape outcomes of livelihoods which are types of livelihoods.

Fig 3 below is the Sustainable Livelihood Framework





Agro -biotechnology

The sustainable livelihoods framework

Source: Adapted from DFID (1999:11)

Key H-Human Capital

S – Social Capital

N- Natural Capital

F-Financial Capital

P- Physical capital

Many factors may intervene in sustainable livelihoods approach. Agriculture is only one part of people's livelihoods and agriculture research and technologies affect only part of farming system. Understanding other factors that impinge on livelihoods can be critical for improving the ultimate impact of agro biotechnology.

2.7 Conclusion

It was noted that, there is a general consensus among scholars that agro biotechnology through tissue cultured plantlets has the potential to transform the livelihoods of small scale banana producers on the globe. Since agriculture has proved to be the backbone of rural economy, the introduction of tissue cultured plantlets to small scale farmers is vital not only for rise in productivity but for the improvement of livelihoods.

CHAPTER 3: RESEARCH METHODOLOGY.

3.0 Introduction

This research is interested in the generation of knowledge concerning the impact of biotechnology on banana production by small scale farmers in Murara Area, ward 5 of Mutasa district of Zimbabwe. Therefore the study was located in qualitative research paradigm to achieve objectives of the study. A desk review of existing data was conducted before field data collection to gain appreciation on the impact of agro -biotechnology inform of Tissue cultured on small scale banana farmers in Mutasa district. Such reviews helped to guide the direction of primary research and cross checking the information collected in the field (Holzmann and Boudreau, 2008).

3.1 Research Design

The research design is the blue print for fulfilling objectives and answering questions (Saunders et al 2000). The study is essentially based on a qualitative case study research design. This is because both the case study and qualitative approaches enabled the researcher to obtain the in-depth data necessary to meet the study's objectives. The researcher thus applied a mixture of qualitative sampling techniques, that is convenience, snowballing and purposive sampling techniques to obtain data through general as well as key informant interviews with small scale banana producers, extension officers and traditional leaders. As a banana producing area, most households in Murara are into banana production. According to Creswell (1998), qualitative research provides a rich source of information leading to theories, patterns or policies that help to explain and inform the phenomenon under study. Therefore what and how questions are answered in-depth by qualitative research.

According to Yin, (2014) a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context. According to Tracy, (2013), a case study is an in depth study of a particular situation rather than a sweeping statistical survey. It is a method used to narrow down a very broad field of research into one easily researchable topic .

Saunders et al, (2015) aver that one major strength of the case study design is that it allows the researcher to have an in-depth study of the problem in a more focused approach. A case study

research highlights the embeddedness of a phenomenon in its real-life context. Some of the advantages of using case studies are that an entity can be investigated in depth; more attention is given to details; the data is strong in reality due to being based on people's experiences; generalisations are allowed; and data can be achieved for further research work (Yin,2014) Therefore, this study benefited immensely from the use of the case study design

3.2 Data Sources

Primary data was gathered from small scale producers, MRDC, DA's Office, department of Social Welfare where NGOs performance report were submitted to. AGRITEX officers as well as traditional leaders constituted also primary sources. Secondary data sources were used essentially concerning the information on size of the ward. The District Agriculture and Extension Officer and Mutasa Rural District Council reports were the major secondary data sources consulted in this research. Additionally, reports from Fintrack, Zim-AIED, Practical Action also constituted secondary data sources in this research. The researcher also extracted information from banana marketing companies operating in the area which include Brandfresh, Matanusika, as well Gemfeb. Ward 5 of Mutasa district has a population of 3368 households of which 45, 5% are men and 54, 2% are women (ZIMSTAT, 2012.

3.3 Study Population

The population in this study was small scale farmers who have harnessed tissue cultured banana technology in banana farming that is the adopters of TC banana plantlets and Non adopters of TC banana plantlets. Population in this study also comprise women who are practicing banana farming as a means of living in Murara ward 5 of Mutasa District, Manaicaland Province of Zimbabwe.

3.4 Sample Size.

Murara area is one of the leading banana producer in Mutasa District, Therefore, the researcher conveniently sampled 30 households in the area. The researcher also employed convenient sampling and snowballing sampling in selecting 60 female headed households. Total of seven key informants were also sampled that is two agronomist from Brandfresh, Two Agritex Extension Officers, one representative from Mutasa Rural District

Council, one representative from EMA and finally one traditional leader in the area of study.

3.5 Sampling Procedure

The researcher conveniently sampled 30 households out of an approximate total of more than five hundred households in the area. However, because the researcher sought to also obtain the perspectives of women in female headed households, they then shifted to snowball sampling, thus getting directions to female headed households. A total of 60 households out of over 500, were thus selected using convenient and snowball sampling. For convenience sampling, the researcher approached any household in their path of inquiry, out interviews only in the households household members agreed to be interviewed.

3.6 Data collection Procedure

This study mainly used interview guide as a data collecting instrument. The researcher carried out in-depth interviews with adopters of TC and non-adopters of TC in banana farming. Key informants were also interviewed key informants. To enhance validity of data collected other instruments were also used to complement major. These include, focus group discussion and field observation. Interviews were used to gain views from staff who work with local people and these include AGRITEX officers as well as MRDC officials. Due to weaknesses associated with interviews in collecting data, focus group discussion were also partially important in gaining views of small scale farmers who are practicing banana farming. Field observation through transact walks were also carried out to gain appreciation concerning the impact of tissue cultured plantlets on banana production by small scale farmers.

The researcher also utilized focus group discussion to collect data. He put together only one group with ten discussants, that is, five women and five men. The researcher purposively included non-adopters of the tissue cultured (TC) technique, that is, two women and three men, while the other five, that is, three women and two men were adopters of TC. The researcher then used the observation technique hereby they used an observation guide focusing on how the TC

was being applied and comparisons of this with where it was not being applied, the extent of fields under production per household, the quality of products as well as the socio-economic conditions in the households of this banana producing area.

All this involved extensive transect walks for a week as the researcher sought to cross check the validity of the data obtained through other data collection techniques. The researcher then consulted written records on the subject under study. These sources included the archived Fintrac reports and the review of literature obtained in various libraries and online.

3.7 Data Analyses

The collected qualitative data was presented and analyzed to make inferences through a series of operation involving editing to eliminate inconsistence, clarification on the bases of similarities and tabulation to relate variables. Data gathered was also analyzed through the use of themes focusing on issues emerging from interpretation of emerging patterns of data coming out of different data collection methods. Also some of the qualitative analytical techniques and tools in the study included the use narratives and interpretation of the observed events.

3.8 Ethical considerations

The researcher pledged to ensure maximum possible precaution in handling matters of the research including safety, human treatment, and freedom of participation on participants. Participation in interviews was done through a written informed consent such that the participant would feel declining from interview at any given moment without any fear.

In this regard the researcher had a responsibility to ensure maximum security. As a measure of security, participants were not asked to disclose their full names as they participated anonymously and code names were used. More so, people's right and freedom implies that they are not made part of the process in which they are involved in deception (Churchhill, 1991: 1039). Therefore deception in this research was not used. All information relating to nature, goals, and possible implication of the research was made available.

Sobocan et al, (2018), states that the goal of ethics is to ensure that no one is harmed or suffers adverse consequences from research activities. Stevens, (2013), maintains that ethics can be thought of as the study of good conduct and on grounds for making judgements about what is good conduct or wrong. Ethics is a code of conduct which the researcher is supposed to obey when conducting the study (Govender,2016; Dogre,2016).

To this end; the researcher had a responsibility to protect the rights, dignity, health, safety and privacy of research subjects, researcher also made efforts to comply with any relevant legal and regulatory standards, as well as professional codes and local guidelines for conduct. Issues of confidentiality, objectivity sensitivity and anonymity were highly prioritized throughout the study and these were upheld by means of ensuring:

- That prior authorization with relevant organizations and individuals was sought before conducting the study.
- Informed consent, affected individuals will be fully appraised on the research thrust, harm and benefits.
- Confidentiality: issues of privacy and sensitivity will be highly prioritized and agreements of nondisclosure were not violated.
- Desist from bias and participation by respondents will be free of duress, participants can choose to withdraw at any time.

3.9 Conclusion

This study was located in qualitative case study research paradigm to produce comprehensive and detailed information on the impact of tissue cultured banana plantlets on banana production by small scale farmers in Murara Area, ward 5 of Mutasa District. The study employed a mixture of qualitative sampling techniques that is snow balling, convenience sampling as purpose sampling. Validity in this research was enhanced through the use of multiple data collection tools.

CHAPTER 4: DATA PRESENTATION, AND ANALYSIS INTERPRETATION

4.0 **Introduction**

In this chapter research findings were analyzed in line with objectives for this study. This section also covers factors leading to introduction and use of the agro biotechnology in the form of tissue cultured banana plantlets among small scale farmers in Murara area, contribution of TC on banana production as well as socio-economic lives of small scale banana producers and finally disadvantages of Tissue cultured plantlets over conventional suckers on banana production in Murara Area.

4.1 **Factors leading to the introduction and adoption of the TC technique of banana production among small scale farmers.**

Agriculture is the mainstay of the economy with the majority of households engage in diversified farming activities such as livestock production as well as crop production. The climatic and environmental conditions suits well for agriculture production. Agriculture in this area has been also promoted by the abundance of water bodies thus irrigation has been enhanced to supplement rainfall. Murara area is one of the leading banana producing area in Mutasa District of Manicaland province of Zimbabwe. To this extent irrigation schemes have been established capitalizing on the presents of water perennial water bodies. Crops grown in the area include beans, tea, maize, pine apples as well as bananas. However, most small scale farmers have capitalized on banana production due to its commercial value. Small scale farmers have since in past relied on conventional varieties in banana production and this resulted in spread of pests and diseases. Common pests include banana weevils and diseases include Banana Brunch Top Viruses (BBTV), Cucumber Mosaic Viruses, (CMV) and Banana Streak Viruses (BSV) and nematodes.

From the turn of new millennium, banana production declined sharply as a result of a complex of factors which include resource shortage as well as lack of extension services in the area. to this extend, most small scale banana producers had abandoned their banana plantations. The youths had also resorted to migrating to nearby countries such as

South Africa, Mozambique and Botswana as farming was no longer lucrative as a livelihood strategy. To this end, several NGOs which include Practical Action, SNV, International Rescue Committee, intervened through capacity building projects which were earmarked on revitalizing agriculture activities in Mutasa district in general as well Murara are in particular.

Various factors have been revealed by different research participants to explain the introduction and hence adoption of agro-biotechnology in the form of TC in Zimbabwe's banana producing areas such as Murara area of Honde Valley in Manicaland Province in 2011. TC was however initially introduced at a very low experimental scale in 2008 and was then expanded as part of outsourced extension services funded by USAID from 2011. To this end, headed by USAID, private companies such as Fintrak contracted the Fruit and Vegetable Company (FAVCO), now Brandfresh and also Zim AIED to deliver extension services and facilitate the adoption of TC among small scale farmers. It is against this background that the use of tissue cultured plantlets for banana production started in Honde Valley in 2011.

Between 2000 and 2011, banana production was assessed as being at a very low ebb in Manicaland Province and in Honde Valley where Murara village is situated. In these years, many small scale farmers in Murara grappled with various diseases that seriously affected banana production levels. In this decade, the area produced as little as 500 tons for the market, translating to below 4tonnes per hectare (USAID, 2011). Things did not change much as the first decade of the new millennium progressed. The highest yields recorded in this decade was 2000 tons, which is not much in a market driven economy (AGRITEX, 2011). In this period, many youths as well as single women and widows opted to travel to either Mozambique or South Africa to work and trade as a way to make a living (Local leader, 16 July, 2018). In this first decade of the new millennium, the agrarian sector mainly catered for subsistence needs even as some opted for agrarian activities such as coffee production and dairy farming at very meager levels.

In Murara, subsistence farmers who produced haphazardly on very limited pieces of land utilized the conventional ways of banana farming whereby they relied on banana suckers from their fields to replant the very same fields. Indeed, one informant from AGRITEX (2018) explained

that, up to 2012, planters in Murara and other parts of banana producing Manicaland faced the scourge of various banana diseases, among the most prominent and devastating ones being Cordana Musae and *Xanthomonas* Wilt of Banana (BXW).

The AGRITEX Official (2018) explained that Cordana Musae is a fungal disease or pathogen that affects plants. On bananas, it produces cordana leaf spot. Murara Area, like most parts of Manicaland that produce bananas also encountered what the AGRITEX field workers identified as black rot or the *Xanthomonas* Wilt of banana (BXW). Agro experts from both AGRITEX and USAID concurred that BXM is among the most destructive diseases, infecting all cultivated varieties of bananas worldwide.

These among many other disease strains identified affected banana production and quality in Manicaland Province and in Murara specifically, crippling the agro activity through the first decade of the new millennium and even much earlier. This saw many disheartened growers abandoning their fields to go to neighboring countries to seek work while those who remained behind, mainly women, produced for subsistence. Many of the consulted informants recounted how they could not obtain chemicals to treat their crops and also that those who could found that the diseases would not respond readily to chemical treatment. Mr. Sanhanga (2018), a male informant who reduced production to less than a quarter of a hectare from a whole hectare and a half in 2000 stated that,

> *The diseases infected my banana plants right in the pith and others just caused wilting of leaves the outer parts of the banana palm itself. This then got to the fruits which split open and browned as soon as they split like that. How could you market such bananas? The yields were so poor that I felt that it was useless, so I left only a small proportion for my family and a few buyers who passed through our village.*

With visible trepidation, several female producers concurred with Mrs. Mungofa's testimony that,

> *One morning, you found that several crops had wilting leaves and outer parts of the palm itself. The next two days many plants were like that and the very fruits were splitting or drying up at the tip…. It was too quick and before you thought what to do, everything was lost…*

This tallies with the Agritex officials' expert exposition that,

> *These are among the most detrimental diseases to banana production because of their rapid spread and the ease with which they imbed themselves in the plant. They quickly cause the inevitable death of infected plants in the absence of inoculated tissue cultured varieties.*

In this crippling scenario, many farmers cut down production, while others abandoned it altogether, especially between 2000 and 2011 as such diseases seemed to worsen with climate change. The struggle of villagers with such big problems and the resultant impoverishment caught the attention of players such as USAID whose aim was to assist communities in rural Zimbabwe to be self-sustaining by promoting their already existing economic activities. FAO also came in to aid such farmers given the organization's focus on food security and its conviction that throughout the tropics, banana production was a sure source of food security (2015). With USAID, SNV, FAO and other players putting their hands together to promote banana production as a strategy to promote rural development and food self-sufficiency, agro-biotechnology entered the scene in Manicaland and in Murara specifically.

While inroads were already being made, albeit experimentally as early as 2008 by USAID in Honde Valley where Murara is located, much work commenced in 2011with the outsourcing of extension services to private players such as Fintrac Inc, FAVCO (now BrandFresh) as well as Zim IED who operated in consultation with AGRITEX, EMA and local authorities to promote banana production in the banana zone of the Eastern Highlands. The most fundamental intervention was the introduction and training of farmers to use tissue cultured plantlets to address the devastating disease strains that crippled banana production in the first place.

Several informants interviewed concurred with the following statement given by Mr Madewekunze;

This tissue culture technique was introduced to reduce the problem of pests and diseases which were affecting our work here. We always got our seedlings from banana suckers from the mother plant for new fields or to replant. That has always been our way. But this began to cause problems and we learnt that just like with animals, diseases from the mother plant were transferred to the suckers too causing the continued cycle of disease which left us poorer and poorer. We had serious problems there until most of us abandoned our fields. We only regained hope when these outsiders brought the new way of growing bananas (Madewekunze, 2018).

Therefore, USAID, SNV, FAO and the players whom they contracted to regenerate banana production in Manicaland Province stressed the importance of dealing with the diseases affecting banana production as the central issue. In this context, one crucial factor leading to the introduction of TC and its adoption by small scale banana farmers in Murara area was the dismal failure of conventional ways of banana farming to address the vulnerability of the crop to pests and diseases. Indeed, one AGRITEX Officer (2018) reiterated that,

> *Conventional banana farming is associated with unhygienic farming methods thus making banana plants vulnerable to fungal and other diseases. Xanthomonas* Wilt of Banana (BXW), Cordana Musae and *Cigar end rot - and this one causes a dry rot of flower ends that produces an ash grey wrinkled lesion on banana fingers - have long become common in Murara and in the rest of Honde Valley . Now this is why the first step to promote banana production here was to introduce the TC technique which ensured the production of very healthy plantlets under sterile conditions* (Chapinduka, 2019)

All key informants including the traditional authorities in the area, as well as male and female farmers consulted in the course of this study emphasized that, it was imperative to adopt TC given the need to shift from conventional ways of banana farming which tremendously affected banana quality and quantity in Murara.

Notwithstanding, some informants stressed that their adoption of the TC approach was a result of the success of banana production that they witnessed from the few participants who entered the USAID funded initial or pilot TC program in Murara area launched in 2008. By 2011 when the TC spread in the valley, it was due to the great success in banana production enjoyed by those initial adopters. As many farmers agreed, they shifted from old methods of using suckers having experienced perpetually poor yields of poor quality which they failed to market.

Indeed, according to Fintrac (2011), yields ranged between 2 and 4 tonnes per hectare. This was very meager given that in a field with r between 1 800 to 2 123 plants per hectare, a farmer could enjoy a harvest of between 15 to 45 tonnes per hectare for most varieties and even more especially higher yielding varieties. To make matters worse, because of the very poor quality, price evaluations placed the bananas at as little as $0,10 per kilogram (kg). It was due to such challenges of conventional banana farming that most households confined banana farming to family subsistence. But with evident success of the few households who were making it based on TC, households rose to the occasion when USAID-supported private and NGO players disseminated the new agro-biotechnology in the form of tissue cultured banana plantlets in Murara. In 2014, Fintrac in its report (2014) observed that,

> *Farmers are now fully convinced of the superiority of the tissue culture technique of banana propagation given the following: (a) the availability of large quantities of clean superior planting material enabling them to reclaim their old orchards (b) increased productivity due to the curbing of common diseases (c) a shorter maturing period and (d) uniformity of bunch sizes which denotes high quality and results in easy coordination of marketing.*

As for stakeholders such as USAID and SNV among the others, while they did not lose sight of the other prerequisites for the success of banana production in the area, such as labor, water, chemical inputs and finance capital, they shared the view that the lynchpin here was TC. As was the case with USAID, the organizations realized that the poor banana producers needed all these and yet, to obtain such necessities, they had to have finance capital. However, as explained by a USAID Project Officer (2018),

We as USAID, in planning the intervention agreed to say yes we could offer such capital for famers to purchase inputs and irrigation technologies appropriate for their needs. However, we also reasoned that giving out such capital would be a waste of resources unless we eliminated the crucial problem which made all other efforts useless. So, based on our base line surveys, we noticed that the disease factor is what destroyed the banana sector that was relatively okay before the 2000-2011 period. So we also said if we addressed this fundamental aspect then these people can earn sustained income and hence the needed capital or they may even be able to attract big trading companies to finance them through contracts. In this way, banana farmers could get all necessities from their bananas through the very use of TC…

Even representatives of the main trading companies such as FAVCO, now Brandfresh and Fintrac, among others who market bananas nationally and in the export market, had not felt secure enough to finance banana production until they were contracted to promote the TC way of banana propagation. A Fintrac official who operated in Manicaland Province since 2011 and in Murara specifically stressed that,

"we wanted certainty of continued high yields of international quality and the best way was disease elimination through agro-technology which most producers in Kenya and other banana producing countries were using with noted success."

NGOs and foreign state organizations such as USAID, with their concern for human well-being and rural development, earmarked banana production among other exportable crops in Manicaland as their springboard. To them, banana production represented a way to attack poverty and promote self-sufficiency. Here, introducing TC to resuscitate banana production was the crucial step in the right direction. That banana production, if purged of the major diseases affecting productivity and quality, provide nutritious food for communities in developing countries has been a common perspective among aid providers targeting banana production in the Third World. Also, in Zimbabwe, with companies such as FAVCO and Fintrac (now BrandFresh) facilitating both national and international trade in bananas, the crop also became an

excellent income source for the communities who have a ready market; for the nation which needs forex and for the companies in the trade. The indigenes of Murara, could even supplement their food through purchase since they could earn income towards this. Different stakeholders ranging from USAID and SNV, AGRITEX officers and traditional leaders all came to the same central point. Their responses showed that the introduction of TC was thus propelled by the conviction that the elimination of the disease vectors through TC was the quickest route to socioeconomic well-being in impoverished rural zones where most households depended on small scale banana production among other agrarian activities.

Additionally, provision of extension services was one of the outstanding factors which influence the use and introduction of Tissue Cultured banana plantlets in Murara area. To this end local firm known as FAVCO now Brandfresh was contracted by Fintrack to provide extension services in Murara area. Some of key extension services delivered included training and advice on good agricultural practices, provisional for seasonal farm inputs, help in accessing markets as well as the introduction of planting varieties such as tissue cultured banana plantlets. The farmers were organized basing on geographical location.

Given the terrain of Mutasa District of undulating slopes, geographical proximity was the only criteria used on oragnising farmers into groups. These groups comprise males and females. Small scale banana farming capacity building techniques included demonstration plots, workshops, agricultural shows and farmer field schools. Demonstration plots were created by extension officers officers from FAVCO and comprise 10- 20 farmers basing on the geographical locations. Good agricultural Practices (GAP) formed the bases of the learning process. Key informants (KI) interviewed mentioned that demonstration plots were the most capacity building techniques used by Zim AIED.

Key informant interviewed mentioned that in 2011, nine demonstration plots were introduce by FAVCO. That is in 2011, demonstration plots were only four and the following years five were introduced. These were set in different areas of Mutasa district especially in

Honde valley. Complementarity between the public and donor-funded extension services is unlikely except in the sense that AGRITEX staff may improve their skills by taking advantage of training sessions hosted by private service providers. Complementarity is situation whereby public and donor extension services work together towards the provision of extension services. Hence provision of extensions services enhanced the use of tissue cultured banana plantlets. These findings resonates well with the findings of Upoff (2002) who explained that household required practical training through demonstration and extension services to improve productivity and adoption of Tc banana plantlets.

True FAVCO introduced demonstration plots as a platform to cascade information on cultivation of TC banana plantlets among other issues. Opening up more TC bananas multiplication and demonstration and widening the technology transfers scope among small scale farmers through investment by government and development partners in farmer training and extension, education excursion or tour to contemporary areas on TC banana production would enhance the impact of this and other technologies in the target countries (Robinson, 2014).

This also resonates with findings of Wanyama etal (2013) who explained that farmers' exposure to more extension services leads to increased adoption since farmers are able to gain knowledge on TC banana farming. Wanyama further noted that provivion of agricultural extension services is critical in banana farming as a way to modern technology transfer between researcher and farmers (Wanyama, etal 2013).

Findings from this study revealed that small scale farmers with large pieces of land could utilize more capital and had demand of Tissue cultured plantlets. Through the transact walks carried out by researcher, it was observed that the area under Tc banana plantlets improved significantly since the introduction of TC plantlets in 2011 Murara area, henceforth the researcher came to the conclusion that the use of TC among small scale banana farmers was also influence by land owned by small scale farmers. Findings from this study have also revealed that idle land was also brought under banana farming, hence TC banana plantlets have proved to be productive that conventional banana

plantlets. This was noted specifically in Mukupe Village in Murara area whereby TC banana farming had proved to be productive. Findings from this study resonates well with the views of Thorp etal (2007) who noted that intensive land use increase with land size due to better application of technologies such as Tissue Cultured banana plantlets and vice versa. Land is also important resource in farming activity in arid and semi-arid regions as noted by Manda etal (2013)

In the context of environmental factors, the study has also revealed that presents of good soils, climatic conditions, and water bodies for irrigation also influenced the introduction and use of Tissue cultured banana plantlets among small scale farmers in Murara area. Mathange explained that ecological factors are key determinant to the growth of any crop (Mathenge etal 2015). Honde valley in general and Murara area in particular has a conducive environment for banana production. The agro-ecological region is suitable for banana production therefore given the marketability of bananas in the country banana farming has been conceived and perceived as a livelihood strategy.

From key informant interviewed by the researcher, it was revealed that bananas matured in eight to nine months in the study area due to conducive environment favorable for the growth of the crop. Bananas also respond to growth factors such as soil fertility and moisture. This means that Murara area is favorable for the growth of bananas hence one of leading banana producing area in Mutasa District. The terrain of Mutasa district is mountainous and this promotes free gravitational flow of water for farmers doing irrigation. Practicing irrigation is critical in tissue cultured banana plantlets due the fact that the plants have high affinity for water. To this end, small scale banana producers have capitalized on the presence of water bodies to practice irrigation as a way to maximize banana production.

From the transact walks carried out by researcher, in villages such as Mukupe small scale banana producers have invested much in irrigation equipment. Hence the researcher

came to the conclusion that environmental factors have also played a critical role in the introduction and use of Tissue cultured plantlets by small scale banana farmers.

The researcher thus concluded that multiple factors explain the adoption of TC as an agro-biotechnological approach directed at not only resuscitating but increasing banana production in banana producing areas of Zimbabwe and in Murara area of Honde Valley, specifically. While these include the concerns with improving food security, poverty alleviation and socio-economic development, the most immediate need or the means to all ends was attacking the core problem of vulnerability to diseases emanating from conventional ways of banana propagation.

4.2 Impact of TC on Banana Productivity and Quality.

From the data collected during the field work beginning in July 2018, the researcher found that impact of TC on productivity must be measured from two angles. Firstly, shifts in the hectares under banana cultivation and secondly the yields per hectare or shifts in yields in general.

Using these two indications, the researcher found that the adoption of TC indisputably boosted banana production in Murara area as in the whole of Honde Valley. While the era between 2000 and 2011 was marked as one of poor performance even by local standards, the post 2011 era is presented as a boom era. While all households of Murara had reduced hectares under cultivation because they failed to curb the impact of diseases prior to 2011, in the current boom years they have reclaimed old farms and started to open up virgin territory to expand their fields. Mr. Mungofa recalled that he had abandoned bananas to concentrate only on maize, beans and sweet potatoes but returned to bananas in 2011 with the advent of TC. As he stated,

"I have always used only one hectare and a half to produce bananas and had left only a quarter as I shifted to other food crops. But we got training on how to produce TC plantlets that were disease free and with that I first regained the one and a half hectares that I once worked on, that is by 2012. In 2013, I was using 2 and a half hectares."

Others such as Ms Manhungo, a single mother of four testified that, from just a small filed with 20 plants since 2000, she now boasted 2 000 plants one hectare and is opening up another hectare since her two eldest children were grown and now have land of their own which they brought under family land. According to Simon Manhungo (2018), a 23 year old youth and the eldest son of Ms. Manhungo;

> *We have been trained along with our mother and we have opted for the best variety, the kavhenda (sic) (i.e. Cavendish), for greater yields. We had one hectare in 2011 but are opening new land now with one hectare is now ready, making them two. One additional hectare will also be opened soon and all three will be under the Cavendish variety because with this you get an average yield per hectare ranging between 40 and 50 tons, especially when you use TC for it. Mother produced this variety since we were kids but never before did well with it because like most people here, she could not deal with the diseases because it is very vulnerable to diseases.*

While some are not keen on commercializing banana production and are thus non adopters, most households including female headed ones are using family labor and hiring youths in the area to open new land. While this has raised concerns for the Environmental Management Agency (EMA) which now oversees such clearance of virgin territory by liaising with local authorities and small scale farmers, the process has continued. Evidence from the transaction walks carried out by the researcher showed the most rapid clearing in banana producing sections where farmers have embarked on TC. Land for undertaking tissue culturing of plantlets is also expanding alongside the actual fields for final production. The same cannot be said among the few households who have not bothered to adopt TC. These non-adopting households have continued with small subsistence production and are focusing on either dairy, maize, beans and sweet potatoes for the local market. According to the District's EMA official who works in Honde;

We are concerned with the cutting down of trees for banana production which coincided with the adoption of TC. We do not experience this rate of clearing with those who are not tissue culturing and who farm other crops. Even coffee farmers are not like the adopters of TC. We

however, work with even USAID trainers to educate the people as far as Murara, against biodiversity destruction because it can't be a healthy environment with bananas only.

Additionally, through interviews, a focus group discussion with adopters and non-adopters, and evidence from transect walks, it is undisputable that banana farmers who have adopted TC are enjoying higher yields than the very few banana producers still using conventional varieties. The yield range of between 25 and 50 tons per hectare is being witnessed only among adopters and as such, the researcher sought to understand why non adopters were not adopting. At most, the non-adopters, whose yields have not gone above the 4 to 10 tons per hectare are conservative and feel that TC is not healthy and is not their tradition. It appears that, the few non adopters in Murara are more concerned with other economic activities as well.

Expansion is also seen by the increasing numbers of TC nurslings. One small scale banana producer mentioned that :

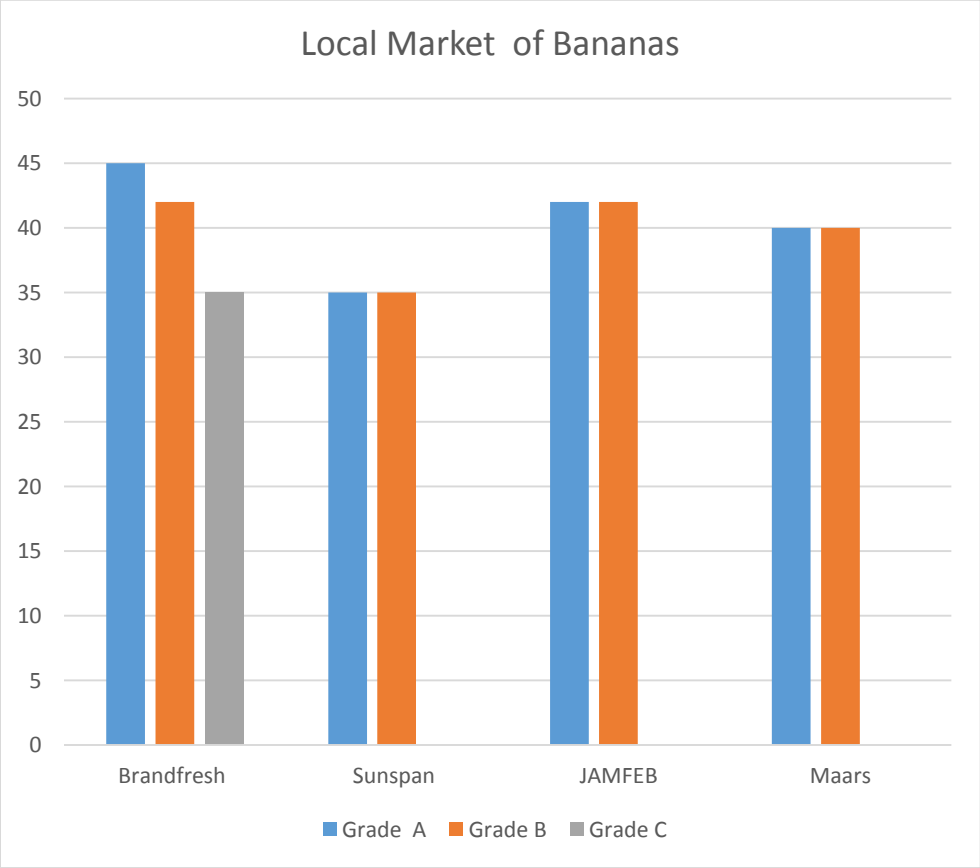
I first started with 200 Tc plantlets in 2011 and now I have a nursery with a capacity to carry 4000 TC plantlets which will cover 2 hectares of my plot. So from less than a hectare. I now produce on 2 hectares based on TC (Mukupe, 2018).

A small scale farmer, Mr. Wadesango (2018) testified that before TC, most of them harvested a meager 30 to 50 kilograms of bananas per month, that is, very far below one ton. As Wadesango stressed, "but now, monthly yields of over 1,000 kilograms are common. Today, even if you produce a ton of bananas, you feel it's not enough." This is true given that on average, leading farmers are producing 4 to 6 tons per month and earning a monthly income of $2520.Generally, banana production in Murara area has gone from roughly 2,000 tons in 2011 to more than 27,000 tons in 2017 (Fintrac, 2017).

As noted in the opening to this section, in measuring impacts of TC, quality also matters. Due to the curbing of disease on crops through tissue culturing, the quality has markedly improved as can be seen through bunch weights. Prior to 2011, the average bunch weight was far below 20kgs (USAID, 2012). This is because the crops, through their growth period, struggled with a multiplicity of diseases which affected growth and hence quality. Today, TC has ensured that a bunch could range from 25 to 50 kgs in weight upon harvest. In its 2017 report, Fintrac, a banana

buying establishment whose buyers religiously weighs bananas per bunch during purchasing expeditions in the area, recorded that the majority of farmers had average bunch weights between 30 and 40 kilograms, with the leading ones getting to the 50 kgs mark. This was opposed to the bunch weight of between 15 and 20 kgs among non-adopters of TC in Murara. That the people of Murara still enjoy the commercial advantage of working with such leading banana export companies as Fintrc Inc and FAVCO or Brands Fresh, as it is now known, testifies to the internationally acclaimed quality of their banana. Additionally, quality high qulity of bananas produced by small scale farmers who have adopted TC has lured companies offering competitive banana pricing as compared to 0,10cents per kilogram which was the average banana pricing system before the introduction of Tc.

Fig 4: banana pricing by private companies operating in the Murara Area



That such companies, under the direction of USAID as well as FAO and SNV have participated in training farmers on best practices such as TC was not devoid of self-interest. They wanted to ensure sustainable quantities of high quality bananas for both local and international trade and their continued operation in the area long after the TC program ended in 2016 proves the success of TC in ensuring quality and quantity. Indeed, even the continued application of TC after the official end of the program, not only proves the success of the program where sustainability is concerned but the utility of TC as witnessed by the farmers in their productivity, quality of crop as well as socio-economic conditions as the next section will show.

Table 8**: Comparison of Yield Levels of TCV and T V from the Sampled Farmers**

Yield Range (t/ha)	TC (No. of farmers)	Traditional Varieties (No. farmers)
0-5	2	21
6-10	5	13
11-15	4	3
15-20	9	1
20-25	6	0
25+	14	0
Total	**38**	**38**

On a comparable note farmers who were supported by tissue cultured banana plantlets had outstanding yields as compared to non-beneficial farmers who used traditional way of propagating bananas. Biotechnology improves yield and quality of bananas (Ozowa 2007).They also produce bunches earlier than traditional banana varieties. On average farmers were getting 25t/ha from tissue culture bananas and used to get about 5t/ha from traditional varieties.

4.3 Socio-Economic Impact of the Adoption TC IN Murara

Research findings have proven that the boosting of banana production through the introduction of TC has led to improved socio-economic conditions for small scale farmers in villages such as Murara of Honde Valley. As shown in the above section, TC resulted in high yields of high quality bananas and hence increased income for rural farmers in the village.

In Murara, those farmers who managed to produce an average of between 4 and 6 tons a month earned a monthly income of $2520. The least of the farmers would get not below $1000 a month given that TC ensured high grade bananas which weighed adequate kilograms to warrant high prices from leading companies such as FAVCO or Brands Fresh and even Fintrac Inc. With a general rise from about 2000 tons in the formative year of TC, that is, 2011, to more than 27,000 tons in 2017, Honde Valley and Murara area within it contributed more than $7.5 million to the rural economy every year (Fintrac, 2017). Research proved that even the lowest among producers, primarily the elderly, earned an average of $7000 yearly. For instance,

Mrs Saungweme, a widow of 64 testified that,

"I used to specialize in maize growing and other things such as knitting jerseys, but I am now growing bananas on a full time basis because we were taught to use mbeu yakaombekwa (inoculated seedlings) and we have been taught to do it ourselves ….. I now get income of $7 000 sometimes and $8 000 during my good years. I have bought this residential stand (near the Hauna Business Center) and I have built this house with three–bedrooms, and you see, I am adding two more bedrooms there… Yes I now live here with my grandchildren".

The house is a beautiful structure with tiled floors. A neat kitchen stands apart also with tiled a tiled floor. USAID has also reiterated this finding in its reports of farmers, both from male and female headed households who have built beautiful homes while others were renovating as proven through the transect walks undertaken by the researcher. The researcher also observed

highly satisfactory sanitary conditions in the area with most homesteads boasting of well-constructed Blair Ventilated Pit Latrine (BVIP). This is a markers of rural development not just infrastructural but in terms of the insurance of human health.

Through targeted transect walks where researche used an observation checklist to measure impacts of TC boosted banana production in Murara, it became apparent that the homes of those who had adopted TC for banana farming were doing much better than of those who had not due to income gaps. Monthly earnings of non-adopters as proved through focused discussions were mostly below half of the earnings of adopters and this explains differences in life styles.

One female respondent, Mrs Chandiamba, aged 55 further articulated that "*I am a widow," she explained.*

"My husband died in 1980 leaving me to take care of my three children. Before I became involved with USAID, I was farming beans, maize and only a few bananas. I also had several goats and was knitting jerseys, but I didn't make enough money to take care of my family. I joined the men and women who were being trained here to adopt the new banana planting system by USAID in 2011. I had to compromise a lot since I now concentrated on this training. But when I look back today, I do not regret at all. In fact, joining the project was the best decision of my life. I didn't have a chance to go to school, but look, I am doing very well here.

Mrs Chandiamba has built a beautiful homestead despite widowhood, she has invested earnings from bananas into livestock purchases and has 21 cattle, many goats and chickens. Salient to note here is the fact that trainers did not sideline women and hence women are the leading adopters of TC. They are competing directly with men in tissue cultured banana production. Resultantly women have been empowered not only in terms of financial security but their livelihoods capabilities. A cursory look through the Fintrac and USAID reports of 2011 to 2015 reveal that many of the prominent farmers who have turned their fortunes around are females, especially single and widowed women who head their own homes.

Concurring with the USAID report's observation of how the TC induced banana boom improved women's status in Manicaland, Evans Muranganwa, a News of the South reporter covering Murara area noted how banana farming has bailed out women since 2011 (27 , Feb 2015)

Women, who would otherwise not have been able to afford to educate their children since most are widowed, divorced or have never been married, have however earned enough to give their offspring their right to education. Parents, including those in male headed households, are channeling banana proceeds into education. Sme have even been able to send children to boarding schools such as Bonda Girls High School and Saint Columbus High, some of the upmarket schools in Mutasa District. Private colleges such as Hauna Christian College have considered it lucrative enough to decentralize services into Murara as banana funds have raised the income levels and hence the socio-economic standards in the area. There is a high demand for education such that even players such as USAID (2017), Zim IED (2015) have noted this phenomenon in their separate reports.

One respondent interviewed testified that:

> *I saw how that banana farming style (TC) made it possible for people to earn highly and do very well. So I gave everything up to train and focus on the new banana system. Because I made that decision and took the new ideas of banana production seriously, my daughter is now enrolled at a boarding school called Saint David Girls High. I can afford to pay, yes its high because I pay $600 per term and also buy supplementary food and other school need for her. I am also paying for my son who is at Harare Poly college. Another one of my daughters has recently graduated from Seke Teachers college. You know these days government no longer pays for you in these colleges. So, I paid all of it and bought all her needs. (Esteri Mwaera, 2018)*

Henceforth investment in education is one of the indicators of social development to the introduction of TC has contributed in Murara.

The TC induced banana economic boost has had forward linkages in that it spurred the growth of employment locally. Banana producers have had to supplement family labor by employing other youths from the location. One informant concurred with the above stating that;

I employ two workers not on a seasonal basis but permanently so we can work together to care for the TC plantlets, plough, plant the plot, bolster the fruit laden banana plants with poles so they don't fall and then harvest and grade. I pay $150 monthly. During harvesting I even hire additional laborers and at the end of the day each pockets $20 per day.

In addition, the trainings for TC have also been another source of employment. Especially with the end of USAID's and Zim IED's programmes between 2015 and 2017, the youths who had grasped how to use TC to propagate inoculated seedlings for healthy banana plantations began to train new adopters for a fee. Three male youth who attended Zim-AIED trainings on tissue cultured banana production – Mukupe (26); Kambanje (32); and Mukupe (32) – are now making a living from their sound knowledge and expertise in banana production by providing training services to other farmers. Such young men gathered fees which when aggregated amounted to between $200 and $350 monthly (USAID Report 18 December 2017.

These youths provided such consultant services even beyond Murara area in Honde Valley. Others have also worked with banana buying companies such as Brand Fresh, assessing, weighing and grading bananas for pricing and then loading them on a train of trucks to be ferried to different market destinations. Earnings for such assessors cum loaders ranged from $10 and $15 per day and thus $300 per month.

Most significantly, in an area that has been cited as contributing more than $7.5 million to the rural economy every year roughly between 2011 and 2017, Honde Valley and Murara area within it have attracted much business investment for a rural zone (Fintrac, 2017). A walk through the zone will show that businesses are opening and growing. Shop buildings, previously abandoned, have been given a new lease on life and are open for business. Mutare-based wholesaler, Major Family Savings (MFS) took over one of the large idle warehouses and set up a one-stop-shop for groceries, agrochemicals, electrical appliances, hardware, and building materials. The researcher have also noted that many other small- and medium-sized businesses, such as supermarkets, farming supply stores, butcheries and hair salons have opened. These businesses provide employment opportunities, especially for youths.

Henceforth, the introduction of tissue cultured technology has generated employment not only the youth in particular but the community in general. The study revealed that

before the introduction of TC technology, there was massive exodus of youth to nearby countries such as South Africa in search of employment. As a result of adoption of TC, youths have come back to venture into banana production. To this end the standard of living has been improved. Income diversification has been promoted as some of the community members have embarked on off-farming activities. Indirect employment has been also created as companies and micro-finance institution have decentralized their activities from the city of Mutare to Hauna Growth point after realizing the marketability of Bananas in Murara area and Honde Valley in general.

Key informants interviewed confirmed that people are returning from urban areas and abroad to establish banana plantations. One male respondent aged 35 respondent interviwed noted that " *I was in South Africa of late surviving from hand to mouth, I had to return back in Honde valley and Iam now earning $300 per month.*

Key informant iterviwed also mentioned that in 2015, casual labour was paid $5per day in contrast to $3, 50 per day which was being paid by Eastern Highlands Tea Plantation.

One key informant mentioned that prior to the intervention of Zim AIED, the district was characterised by massive exodus of the youth (15 – 45 years age group) in search of employment in South Africa and Mozambique and that most of the women who were involved in cross boarder trading have returned back to banana farming. Improvement of small-scale farming practices will not only raise farm income and average yields but also effectively absorb underutilized labour (Todaro 1979).

One male respondent aged 33 explained " *I returned back from South Africa in 2012 after relealising the viability of banana farming at home. During my period of work in South Africa, I worked as a casual labourer earning between 1500 Rnds and 2000 rands. To this end, I could not remit the money back since it could not sustain my livelihood. Today Iam earning an average of $280 after producing an average of two tonnes*"

Banana farming has boosted entrepreneurship amongst youth in Mutasa District. Aside from venturing in banana farming two youth aged 32 and another one aged 26 have teamed up assist and train other small scale farmers for a fee.

4.4 Challenges and prospects of using TC plantlets on production among small scale farmers.

The study has also revealed that like all other technologies , TC technology has its own challenges in banana farming among small scale banana farmers. Wambugu and Kiome (2001) indicated that although TC plantlets were free from pathogens, they were not entirely resistant to pests and diseases. True, while they have done far much better than suckers plucked from the mother plant, interviewees revealed that, to some extent, TC plantlets have proved to be vulnerable to nematodes and this has been a relative challenge to small scale banana producers which affect banana production. Sigatoka has also been mentioned as the diseases which has reduced production in some plantation areas. Key informant interviewed pointed out that.

Sigatoka is a pholia disease which is caused by humidity and hot and wet conditions. It is also necessitated by high plant density. Previously, conventional varieties were planted only in drains making it necessary to keep plants less dense and hence eliminating the preconditions for sigatoka (Madewekunze, 2018)

One small scale farmer also expressed her worry over nematodes thus, " *my tissue cultured plantlets are wilting unexpectedly despite implementing good agricultural practices (GAP)".* In this contextGAP include TC, crop rotation, mulching and application of manure.

Henceforth, while it is understandable that TC plantlets are free from pathogens as highlighted by Wambungu and Kiome (2001), they are still open to some pests and diseases. From the transect walks that the researcher carried out under the guidance of the AGRITEX Officer, they noted that some plants were affected by Sigatoka and Nematodes. During the field walks, the AGRITEX officer explained that despite TC, additional precautions, for example, virus indexing were still necessary to prevent the transmission of viruses to the plantlets or to the growing plants in the main fields. Virus indexing is a laboratory technique which involves growing plant cells under adverse conditions to select resistant cells before growing the full plant (Molina, 2002). Additionally , the study also noted that for TC to be

even more effective, agro-chemicals are indispensable for high yields to be realized by small scale farmers in Murara area.

By consulting non-adopters as part of the research participants, the researcher learnt that tone of the reasons for non-adoption was the labor intensity and costs of TC application. Those who never adopted and the youths who had initially adopted only to revert back to the convectional method of banana farming explained that TC was too laborious for them as compared to conventional methods of banana propagation.

These findings resonate with Qaim's (1999) contention that the cost of labor for the establishment of the banana orchard is higher for famers using TC-plantlets than for those using conventional suckers. For Murara TC adopters, the main labor intensive activities are land preparation, planting, manure application, weeding, watering, de-suckering, de-leafing, propping, harvesting and marketing. In Murara, area, respondents highlighted that implementing good agricultural practices in line with TC technology has proved too demanding and expensive, since they not only needed additional inputs but labor to care for plantlets and the orchard. In contrast, non-adopters do not need elaborate land preparation, irrigation among others but used ditches near water courses, wetlands and only needed to pluck off already growing suckers from the mother plants.

Conventionally, bananas are grown under rain-fed conditions. Respondents noted that planting Bananas was done in mid-November with the onset of the rains. But with TC, irrigation is the way forward. One key informant explained that, this is because TC plants do not have a rhizome that acts as a storage reserve for initial growth of roots and leaves, unlike conventional suckers. The growth of TC plants depends on its own roots and leaves, and as a result its leaves are more active than those of its counterpart. As such, farmers are therefore required to water their plants much more frequently than usual to receive better yields. One *respondent interviewed queried that;*

> *I relied on Chandanda River for irrigation of banana plantlets. However, the only challenge which I have is that the River is not perennial and this has been worsened by*

climate change. Had it not been for resource scarcity I would have harnessed water for irrigation purposes from the perennial River, Pungwe.

The high water demand has been mentioned as one of the major challenges of the use of TC plantlets. In light of climate change, water bodies are inevitably drying in Murara area and this is affecting yields. Without irrigation of crops banana yields using tissue cultured plantlets are likely to decrease since TC plantlets have high affinity for water.

The study has also revealed that market imperfection is one of the problem bedeviling small scale banana producers in Murara area, since it is not enough to simply adopt tissue culturing. Despite a number of private companies flocking into the area, market imperfections or exploitative markets have affected the farmers. At farm level, bananas are sold at giveaway prices of $1 for 20 bananas which is not sustainable given the fact that inputs are expensive. Hence, while farmers are happy to have a steady flow of income and make good use of such income as indicated in the proceeding section on socio-economic benefits, the pricing is highly exploitative. Infact, if trade relations had not been exploitative, farmers could make even more than they are currently making given that bananas are a popular export crop reaching markets as far as USA and China.

It is not surprising that most of the key informants expressed dissatisfaction with the pricing system of private companies. S one informant stressed, *the price of bananas fluctuate time and again making it difficult for us to plan in terms of income or profit. All the time, the big and medium buyers alike on top decide the price using criteria we don't really comprehend and the prices are skewed against us, the producers. Some people have thus been disheartened and dropped their production. With regards to Brand Fresh, the grading is pegged in Harare and at times I have to send my employee to see the grading system but to no avail since we don't have power over trade terms…. (Mukupe, 2018)*

As a corollary to the above, the Manicapost (26 December, 2017) noted that low banana prices are having a toll on farmers in Honde Valley. The post noted that, "farmers as they are being forced to part with their perishable produce for a song." Farmers used to sale their bananas for 35

cents per kilogramme, but prices have dropped to 25 cents despite the high production costs. It is not clear if this is due to the banana flooding the market, that is, supply overwhelming demand or simple exploitation. Additionally, inexplicable price fluctuations are said to be common. Currently Brand Fresh is buying banana using a three tier system, that is, Grade A-45c, Grade B-42c and Grade C-35c.

The Manicapost (2017) observed that these fluctuations are just a reflection market forces of supply versus demand with the TC induced banana boom causing the flooding the market and reducing prices to 35cents per kilogram and below. Therefore, due to market imperfections, it has proved difficult for small scale farmers to maximize TC induced advantages and has even the abstention of some households from TC as a strategy of banana production.

Respondents have also pointed out that inaccessibility has also proved be a challenge bedeviling small scale banana farmers. Due to poor macro-economic environment prices of inputs for banana farming have proved to be beyond the reach of many. Given that TC plantlets demands a lot of chemicals and fertilizers, some farmers have mixed TC plantlets and conventionally propagated ones due the inaccessibility of inputs needed for TC plantlets. Respondents interviewed noted that fertilizers such as Muriate of Potash (MoP) is not available at Hauna Business Center and many farmers have ended up using Ammonium Nitrate as top dressing.

However is imperative also to note that the prospects of tissue cultured plantlets over conventional ways of banana farming lies on the fact that, they are able to resist pests and diseases hence production is likely to increase. Key informant interviewed mentioned that before the introduction of TC banana plantlets production was very low as 4t/h and vast tracts of land was abandoned due to low production associated with conventional ways of banana farming.

Many farmers had abandoned their plantation due to the prevalence of pests and diseases such as weevils and fungus. Therefore TC proved to be superior as it has proved to resist pests and diseases, thus banana productivity is enhanced. Thus, the study concluded that the introduction of Tissue cultured banana plantlets among small scale banana producers

has the potential to increase banana production in Murara area of Mutasa District in Manicaland Province of Zimbabwe. Key informant interviewed by the researcher mentioned that:

I have faith in tissue cultured banana plantlets over traditional varieties which we relied on before the introduction of TC varieties that is from the turn of new millennium to 2011. To this end, yields were low since the my plants were affected by different diseases and pests. Tissue cultured plantlets have proved to be marketable, diseases resistant and quality yields have been enhanced (Nyakunhuwa, 2018)

This was confirmed by Fintrack report (2014) which noted that, the farmers who are in tissue culture banana were fully convinced of the superiority of the tissue culture banana in several ways including: (a) the availability of large quantities of clean superior planting material enabling them to reclaim their old orchards (a) increased productivity (c) a shorter maturing period and (d) uniformity of bunch sizes resulting in easy coordination of marketing. To this extent, tissue cultured plantlets resultantly produces high quality of bananas as well as high quantity is enhanced as noted large bunch size than of conventional variety. This lured companies offering a competitive price which include Brandresh, Sunspan and GermFeb.

Rapid multiplication of clean planting material is also enhanced through the use of tissue cultured plantlets. The study has also revealed that despite the fact that conventional varieties have reached commercial acceptability, Tissue cultured have been shown to have definite and indispensable advantage over conventional varieties. Hence an advantage on production of bananas among small scale farmers in Murara Area of Mutasa District.

Conclusion

The use of case study design for the study helped to produce a comprehensive information on the of agro- biotechnology in the form of Tissue cultured plantlets among small scale farmers in Murara area of Mutasa district in Manicaland Province of Zimbabwe. Qualitative case study research design provided a general analysis of the opinions, beliefs, feelings, attitudes and impressions of the farmers and other agricultural stakeholders, hence relevant for this study.

CHAPTER 5: CONCLUSION

1.0 Introduction

This section of the study provides brief summary of research findings. It is imperative to note that various factors have influenced the introduction and the use of tissue cultured banana plantlets among small scale farmers. To this banana production among small scale farmers increased phenomenally hence improvement of livelihoods of farmers. Conclusion and also recommendations are also made.

1.1 Summary of Research findings

The research findings revealed that the introduction of agro- biotechnology in form of tissue cultured plantlets has improved production among small scale farmers in Murara area of Mutasa District. The area under banana production specifically for TC banana farming improved phenomenally as well as yields which on average ranged on 25t/h.

Various factors have influenced the introduction and use of TC banana plantlets among small scale farmers. This included environmental factors, availability of land, as well as the need to hedge pests and diseases associated with conventional ways of banana farming. In this regard conventional ways of banana farming were associated with pests and diseases and this affected the quality and quantity of banana produced in Murara area. Shifts in hectares under banana cultivation and shifts in general yields were two indicators used by the researcher to measure the impact of TC on productivity and quality. Using these two indications, the noted that the use of TC banana plantlets indisputably boosted banana production in Murara area as in the whole of Honde Valley. While the era between 2000 and 2011 was marked as one of poor performance even by local standards, the post 2011 era presented as a boom era. The yields ranged between 25 and 50 tons per hectare was witnessed only among small scale farmers who have harnessed tissue cultured banana plantlets while the yields range of non-adopters ranged between 4 to 10 per hectare. Research findings have proven that boosting of banana production through the introduction of TC has led to improve to socio-economic conditions for small scale farmers in villages such as Mukupe in Murara area. TC resulted in in high yields of high quality of bananas and hence incomes for rural farmers in the village. The has also revealed that despite the advantages of TC on banana production, it has also its disadvantages. Some of disadvantages are earmarked on the fact that maintaining of TC banana plantlets demands labor and resources hence some farmers were resorting back to conventional ways of banana farming given the fact that management of Tc banana plantlets require more - resources than conventional ways of banana farming. Be that as it may, the pros of TC on banana production outweigh the cons associated with TC on banana production

1.2 Recommendations

There is need for small scale farmers to specialize on banana farming as revealed in research findings. There is the potential high income generation from specializing in banana farming using tissue cultured banana plantlets. The climate of Honde Valley in general and Murara area in particular is well suitable for banana farming. Therefore concentration on banana farming will result to rapid income generation.

There is also need for further intensive training on tissue cultured banana plantlets. The study revealed that some small scale farmers were reverting back to conventional ways on banana, hence training small banana farming on tissue cultured banana plantlets will go a long way in widening their understanding on the technology.

There is also need for establishment of sustainable market for agricultural produce. There is price monopoly by private companies operating in the research area. Price of market produce is being imposed on farmers without their consent. Without a well-established market, production increase would remain difficult to reach. The study revealed that the price of inputs is higher as compared to produce.

There is also need for the establishment of value addition cooperatives in Murara area as a strategy to increase the income of small scale banana producers in the area. Establishment of value addition cooperatives will then go a long way in sustaining incomes of small scale banana producers in Murara area.

1.3 Conclusion

Agro-biotechnology is indispensable for realizing maximum production. Empirical evidence have pointed out that during green revolution in Asia and Africa, agriculture production was enhanced. The introduction of Tc technology has successfully revolutionized small scale banana farming in Murara area of Mutasa District, Manicaland Province of Zimbabwe. Conventional methods of banana farming were characterized by low yields attributed to factors such as pests and diseases. The fact that the suckers are carrying pathogens like, nematodes and other pests, made them less attractive for use as planting material. In this regard, advances in biotechnology in the last few years especially in tissue culture production have made a great impact on the cultivation of banana. Adoption of Tc resulted to increase in yields, hence production of banana farming has increased as compared to the conventional way of banana propagation. The livelihood of small scale banana farming

has also improved as noted by improvement in housing qualities. Direct and indirect employment has been also realized thus the livelihood diversification strategies have improved as well. Critical note is also the fact that the introduction of Tc technology has not only empowered women financially but improved their livelihoods. However in adopting Tc technology like other technologies, challenges have its own disadvantages chief among them is the fact the use of Tc is labour and capital intensive against the background of poor resourced small scale farmers

Reference list

Adesina A, A. (2002). "Smallholder Technical Efficiency Controlling for Environmental Production Conditions." Journal of Development Economics 69 (1): 85–101. 2.

Adesina, A, A and Zinnah, M.M (1993). Technology Characteristics, Farmers' Perceptions and Adoption Decisions: A Tobit Model Application in Sierra Leone; Agricultural Economics 1993;9: 297-311 3.

Adesina, A. A. and Baidu, J.F (2011), Revised Edition). "Farmers' perception and adoption of new agricultural technology: Evidence from analysis in Burkina Faso and Guinea, west Africa." -Agricultural Economics 13(1995): 1-9 4.

Adesina, A.A and Forson. B, (1995). Farmers' Perception and Adoption of New Agricultural Technology: Evidence from Analysis in Burkina Faso and Guinea, West Africa. Agricultural economics. 1995; 13: 1-9.

Asian Development Bank, (2001). *Agricultural Biotechnology, Poverty Reduction and Food Security*. Working Paper May 2001. Manila, Philippines: Asian Development Bank.

Amalu, U. C.**,(** 2004). "Plant Biotechnology and Food Crop Development in Sub-Saharan Africa" *Technology in Society* 26: 537-550

Anyango, J.J., Wambugu, F.M., Nkanya, J. and Kyalo G., (2007). :Introduction of Tissue Culture Banana Technologies and Their Impact on Producer Well being (2007)., Journal Of Advanced Agricultural Technologies, Vol.12 6.

Awotide, B.A, Diagne A, Awoyemi, T.T. and Ojehomon, V.E.T, (2012). Impact of Seed Voucher System on Rice Yield, Income Inequality and Poverty Reduction in Rural Nigeria: A Randomized Control Trial Approach. Proceedings at the 26th International Conference of the Centre for the Studies of African Economies (CSAE), St. Catherine's College Oxford, U.K. 18th-20th March, 2012. 2012: 1-33. 7.

Churchill, L.R. Ethical Issues of a Profession in Transition. American Journal of Nursing, , 873-875, May, 1977

Creswell. J. (1998)Qualitative Enquiry and Research Design, Housing Among Five Traditions, Thousand Oaks, CA, SAGE,

Bandiera, O. and Rasul, I. (2002). Social networks and technology adoption in northern Mozambique. Technical Report 3341, CEPR Discussion Paper. 8. Bandiera, O. and Rasul, I. (2006). Social networks and technology adoption in northern Mozambique. The Economic Journal 116, 869–902. 9.

Barrett, C. B. (2003). "The Disappointing Adoption Dynamics of a Yield-Increasing, Low External-Input Technology: The Case of SRI in Madagascar." Agricultural Systems 76 (3): 1085–1100

Beshir, H, (2014). Factors Affecting the Adoption and Intensity of Use of Improved Forages in North East Highlands of Ethiopia. American Journal of Experimental Agriculture. 2014; 4(1): 12-27. Biological factors affecting seed production in East African Highland bananas. J Crop Imp 16: 67.

Birner R & Resnick D (undated) Policy and Politics for Smallholder Agriculture, A paper on the Success of Smallholder Strategy presented for the International Food policy Research Institute (IFPRI), IFPRI, USA

Brink, J. A., Woodward, B. R., and Dasilva, E.J, (1998). "Plant Biotechnology: A tool for Development in Africa." *Journal of Biotechnology* 1 (3): 1-10

Chandler, S. (1995). The nutritional value of bananas. P.468–480. In: S. Gowen (ed.), Bananas and Plantains. Chapman and Hall, London. International world Journal,Vol.12 –77

Couros, A. and Kesten C, (2003). Innovation, Change Theory and the Acceptance of New Technologies: A Literature Review. 2003: 1-42

Dekkers, J.C.M, and Hospital, F (2002). The use of molecular genetics in the improvement of agricultural populations. Nat Rev Genet 3: 22–32.

Dubois, T. (2011). Towards a healthy tissue culture banana industry in East Africa. R4D Review, 6. www.r4dreview.org

Falconi C (1999). Agricultural Biotechnology Research Indicators: Zimbabwe. Discussion Paper. International Service for National Agricultural Research (ISNAR), the Netherlands

FAOSTAT(2011). Food and Agriculture Organization of the United Nations (faostat.fao.org)

Feder, G., Just, R.E., and D. Zilberman. (1985). "Adoption of Agricultural Innovation Developing Countries: A Survey." Economic Development and Cultural Change 33(2): 255-298

Forson, B, (1994). Adoption of soil and water conservation practices in the Sudano-Sahelian Zone: constraints and incentives. In: Napier, T.L., Camboni, S.M., EI-Swaify, S.A. (Eds.), Adopting Conservation on the Farm: An International Perspective on the Socioeconomics of Soil and Water Conservation, 13. Soil and Water Conservation Society (U.S.), Ankeny, IA, pp. 157-169

Hahlani,C.D. (2010). Peasantry Transformation and Policy Planning in Zimbabwe. Journal of History and Development Volume 1 Number 1 September 2010

Harrison, G (2001). Peasants, the Agrarian question and lenses of development progress in Development studies

Karembu, M., Otunge, D., Wafula, D., (2010). Developing a Bio-safety law: Lessons from the Kenyan experience, ISAAA Africenter, Nairobi, Kenya.

Holzmann, P. & Boudreau, T. (2008). The Practitioners' Guide to Household Economy Approach. [Electronic]. Available: www.feg-consulting.com. [2015, December 14]. Heems and Visers(1999)

Kabunga, J., Nassul, S., Thomas, D. and Qaim, M (2012). Yield Effects of Tissue Culture Bananas in Kenya: Accounting for Selection Bias and the Role of Complementary Inputs. Journal of Agricultural Economics 63(2): 444–464. DOI: 10.1111/j.1477-9552.2012.00337

Kabunga, N.S., Dubois, T., and Qaim, M. (2012). Heterogeneous Information Exposure and Technology Adoption: The Case of Tissue Culture Bananas in Kenya. Journal of Agricultural Economics; 43: 473–86. DOI: 10.1111/j.1574-0862.2012.00597.x

Kuhnen, F., (1987): Causes of underdevelopment and concepts for development: An introduction to development theories. The Journal of Development Studies (Peshawar); Vol. VIII, pp. 1125.

Langat, B.K, Ngeno, V.K, Nyangweso, P.M, Mutwol M. J, Kipsat, M.J, Gohole, L and Yaninek S (2013). Drivers of Technology Adoption in a Subsistence Economy: The case of Tissue Culture Bananas in Western Kenya. Invited Paper Presented at The 4th International Conference of the African Association of Agricultural Economists, September 22-25, 2013, Hammamet, Tunisia. 2013: 1-17, Journal Of Agricultural Economics, Vol.6,

Lidia, D. J., Aliou, D., Gauthier B, Simon N.C., and Kifouly, S.M, (2012). Determinants of diffusion and adoption of improved technology for rice parboiling in Benin. - Review of agricultural and environmental studies, INRA Editions, 93 (2), pp.171–191

Manda, J., A.D., Alene, C., Gardebroek, Kassie, M., and G. Tembo (2015). Adoption and Impacts of Sustainable Agricultural Practices on Maize Yields and Incomes: Evidence from Rural Zambia. Journal of Agricultural Economics, 67(1), pp. 130–153. DOI: 10.1111/14779552.

Matuschke, I. and Qaim, M. (2009). The Impact of Social Networks on Hybrid Seed Adoption in India. Journal of Agricultural Economics; 40 (5): 493–5012.

Mbaka, J.N. M. Mwangi and M.N. Mwangi, (2008). "Banana Farming as a Business: The Role of Tissue Cultured Planting Materials in Kenya" *Journal of Applied Biosciences* 9(1): 354 – 361

Mbogoh, S. G., Wambugu, F. M. and Wakhusama, S., (2003). Socio-economic impact of biotechnology Applications: some lessons from the pilot tissue culture (Tc) banana production promotion project in Kenya, 1997-2002. Proceedings of the 25th International Conference of Agricultural Economists (IAAE), Durban, South Africa, Document Transformation Technologies

Molina, Jr., Agustin B., (2002). "Tissue Culture in the Banana Industry. " Paper submitted at the International Training Course on Biotechnology for Seed and Seedling Production, 2-6 December 2002 at PCARRD Headquarters,Los Baños, Laguna, Philippines

Netherlands Development Organization (SNV),(2007),Livelihoods Case Studies in Honde Valley , Zimbabwe.

Nguthi, Faith N., (2007). "Adoption of Agricultural Innovations by Smallholder Farmers in the Context of HIV/AIDS: The Case of Tissue-cultured Banana in Kenya." PhD Thesis,Wageningen University, Germany

Nguthi, F. N. (2007). Adoption of agricultural innovations by smallholder farmers in the context of HIV/AIDS: The case of tissue-cultured banana in Kenya. PhD Thesis: University Of Nairobi, Pp 1-226.

Nyang, M.N, Webo, C. and R.L Roothaert, (2010). The Power of Farmers Organisations in Smallholder Agriculture in East Africa Working Papers. A review of 5 project initiatives of the Maendeleo Agricultural Technology Fund. In FARM-Africa Working Paper, London, UK, FARM-Africa.

Ogoro, O. Kennedy, (2007). *Biotechnology Innovation in Kenya: Where are the Small holders Farmers?* IDS Working Paper No. 547. Nairobi: University of Nairobi, Institute for Development Studies

Pinstrup-Anderson, P. and Cohen, M. (2000) 'Modern Biotechnology for Food and Agriculture: Risks and Opportunities for the Poor', in G.J. Persley and M.M. Lantin (Eds.), Agricultural Biotechnology and the Poor. An International Conference on Biotechnology, CGIAR, Washington DC, pp. 159-169.

Ponelis, S. R. (2015). Using interpretive qualitative case studies for exploratory research in doctoral studies: A case of Information Systems research in small and medium enterprises. International Journal of Doctoral Studies, 10,535-550. Retrieved from http://ijds.org/Volume10/IJDSv10p535-550Ponelis0624.pd

Perret, S.R, Stevens, Y. and Joseph B. (2006). "Socio-economic Reasons for the Low Adoption of Water Conservation Technologies by Smallholder Farmers in Southern Africa: A Review of the Literature." Development Southern Africa, 23 461–76.10: 1-44

Qaim, M, (1999). “Assessing the Impact of Banana Biotechnology in Kenya.” Briefing B-10 Ithaca, NY: International Service for Acquisition of Agri- biotech Applications (ISAAA)

Qaim, M (2010). Agricultural Economist Center for Development Research (ZEF): Assessing the Impact of Banana Biotechnology in Kenya, Journal of Agricultural Economics, Vol.12

Robinson, J.C. (1996). Bananas and Plantains. Crop Production Science in Horticulture Series No. 5, CAB International,Wallingford, UK.

Rine, D.L, (1994). Kenya Country Gender Profile. Royal Netherlands Embassy (RNE), Directorate-General for International Cooperation (DGIS), Nairobi. International Journal Of Advanced Technologies, Vol.6., 1994

Robinson, J.C. (1996). Bananas and Plantains. Crop Production Science in Horticulture Series No. 5, CAB International, Wallingford, UK, American Journal of Agricultural Economics, 65 (3): 212–8

Rogers, E.M. (1995). Diffusion of Innovations (4th Ed.). New York: The Free Press. 1995.

Saunders, M., Lewis, P. and Thornhill, A. (2000) Research methods for business students. 2nd edition. Harlow: Pearson Education

Singh H P, Uma S, Selvarajan R and Karihaloo J L (2011) Micropropagation for Production of Quality Banana Planting Material in Asia-Pacific. Asia-Pacific Consortium on Agricultural Biotechnology (APCoAB), New Delhi, India. 92.

Thorpe, T. (2007), History of plant tissue culture. J. Mol. Microbial Biotechnology. 37: 169180. Journal of Agricultural technologies, vol.13.2007

Tracy SJ,(2013), Qualitative Research Methods, Blackwell Publishing, Sussex, United Kingdom

Uaiene, R. (2011). Determinants of agricultural technology adoption in Mozambique. In African Crop Science Conference Proceedings, Vol. 10, 375–380.

Todaro. M.P (1982) (2nd edition).Economics for Developing World: Introduction to principles problems and policies for development. Longman: Singapore.

United States Agency for International Development (**USAID**) (2017). **The Humble Banana Transforms an Entire Community in Eastern Zimbabwe report available on https://medium.com/usaid-frontlines/the-humble-banana-transforms-an-entire-community-in-eastern-zimbabwe-3dd5768e6fcf**

Uttam, K.D. and Mahabub, H. (2006); effect of education on technology adoption and aggregate crop output in Bangladesh, Asian Journal of Agricultural Extension, Economics and Sociology 2014; 3(4): 258-279

Wambugu, F. M, (2004). Food, Nutrition and Economic Empowerment: The Case for Scaling up the Tissue Culture Banana Project to the Rest of Africa. Proceedings of the NEPAD/IGAD Regional Conference held in Nairobi, Kenya on November 22nd - 25th, 2004.

Wambugu, F and Kiome, R. (2001). The Benefits of Biotechnology for small-scale farmers in Kenya. ISAAA Briefs No. 22. ISAAA: NY

Wambugu, F.M, Mbogoh, S.G. and Wakhusama, S (2015). Socio-Economic Impact of Biotechnology Applications: Some Lessons from the Pilot Tissue Culture (TC) Banana Production Promotion Project in Kenya, 1997-2002. Document Transformation Technologies. Proceedings of the 25th International Conference of Agricultural Economists (IAAE). Durban, South Africa, 16--22 August 2003. Journal Of Scientific Research, Vol.1

Wanyama, J., Masinde, G. and Obare A. 2013. Factors Influencing Adoption of Tissue Culture ; proceedings of the 4th International Conference of AAAE held at Diar Lemdina Hotel – Yasmine Hammamet, Tunisia on 22nd – 25th September , 2013

Yin, R.K., 2014, Case study research: Design and methods, 5th edn., Sage, Los Angeles, CA.

Yin, R.K., 2015, Qualitative research from start to finish, 2nd edn., Guilford, New York

Zikhali P (2008) Fast Track Land Reform and Agricultural Productivity in Zimbabwe , Working Papers in Economics, No 322, School of Business Economics and Law, Goteborg University

Internet sources

https://www.fintrac.com/sites/default/files/2017-11/Zimbabwe_HondeValleyUpdate.pdf accessed on 27 December 2018

http://manicapost.co.zw/poor-banana-prices-rile-honde-valley-farmers/ accessed on 26 December 2018

https://medium.com/usaid-frontlines/the-humble-banana-transforms-an-entire-community-in-eastern-zimbabwe-3dd5768e6fcf accessed on 26 December 2018

https://www.newsday.co.zw/2014/06/manicaland-farmers-banana-passport-prosperity/

Accessed on 26 December 2018

APPENDIX 1: INTERVIEW GUIDE.

Introduction

My name Cephas Mandirahwe and I am a student at Midlands State University Master's degree in Development studies. I am doing a research on the IMPACT **OF TISSUE CULTURED PLANTLETS ON BANANA PRODUCTION BY SMALL SCALE**

FARMERS. The information obtained is only for academic purposes and our responses will remain confidential. Please note that there is no any material benefits accrued as a result participating in this research now or in future. Should you wish to decline to be interviewed, you are at liberty of doing so without hesitation.

Shall I go ahead with the interview? Yes/ No

1. Who introduced TC banana plantlets and why was it introduced?
2. Were small scale farmers consulted on Tissue Cultured plantlets?
3. How small scale farmers were chosen to participate in TC project.
4. Do you receive extension services on TC technology. If yes Who provided the services and the frequency?
5. How many households have benefited from tissue cultured projects?
6. Differences in yield and return between TC and conventional varieties

- Average income…….us$
- Average yield…….t/ha

7. Name of assets purchased from TC revenue and the asset value…..

Tissue cultured banana expansion

1. What was the average area per farmer at the inception of project……H
2. What is the current average area per farmer……?
3. What are the pros and cons of TC over conventional varieties?

4. what is the impact of TC had on the following?

	Level of impact
Family food security	
Family's Health	
Family's Access to support networks	

Family's capacity to coup with social issues such as un employment.	
Children education.	
Family Savings	
Housing qualities	
Quality of family diet	
Gender empowerment	

1= improved 2 = deteriorated 3=No effect

APPENDIX 2: OBSERVATION GUIDE

The following are aspects that the researcher observed in the research.

1. Presence and type of other income generating project at homesteads that are funded by revenue from TC

2. Development at homesteads.
3. Irrigation at homesteads.
4. Hygiene Enabling Facilities.

    - BVIP Toilet…….yes/no
    - Refuse Pit……....Yes/no
    - Fence……...Yes/No
    - Source Water……Protected or Unprotected
    - Potrick……Yes/No

5. Livelihood Assets……
    - Vehicles.
    - Scotch Catts.
    - Wheelbarrows

Appendix 3 **Document Analysis guide**.

Does the farmer has and make use of the following.

1. Banana input Records…….Yes/No

2. Output/input Records……Yes/No
3. Market Sales Records……Yes/NO
4. Rainfall and Irrigation Scheduling Records…..Yes/No
5. Hired labor and Payment schedule……..Yes/no

Appendix 4: Stages involved in tissue culturing of Bananas

APPENDIX 5. PHOLIA DISEASES NOTED CONVENTIONAL VARIETIES.

APPENDIX 6: COMPARISON OF TC AND NON TC BANANA PLANTLET

TC PLANT **NON TC PLANT**

APPENDIX 7: HOUSE BUILT USING REVENUE FROM TC.

Widow who build house at Hauna Growth Point using proceeds from TC farming

The above picture shows a house in Murara area which built using TC banana proceeds

Appendix 8: Newly Established TC banana plantation

Appendix 9: well managed Tc banana plantation

Appendix 10: **Small Scale farmers at Demonstration plots**

Appendix 11: Woman fixing irrigation for TC plants

Appendix 12: nursey of Tissue cultured Plantlets.

Appendix 13: Harvested banana from TC

Appendix 14: plants affected by sigatoka.