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DEPARTMENT OF ECOLOGY AND RESOURCES MANAGEMENT.

ASSESSING THE CONTRIBUTION OF AGROFORESTRY TECHNOLOGIES TO POVERTY ALLEVIATION IN THULAMELA MUNICIPALITY, LIMPOPO PROVINCE, SOUTH AFRICA.

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Dissertation Release Form

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ABSTRACT

Agroforestry is the sequential and spatial integration of multipurpose trees and shrubs with crops/livestock on the same piece of land. While much research and development effort is being undertaken in many countries to promote agroforestry land use in order to improve livelihood and reduce poverty in rural areas, relatively little has been done in South Africa. In Vhembe District of South Africa there is poverty and degradation of land due to declining soil fertility and land productivity for food, fodder, fuelwood and biodiversity loss of native flora and fauna.

The main aim of this research is to assess the role of existing agroforestry technologies as one of the tools for poverty alleviation among smallholder farmers in Thulamela Municipality of Vhembe District in South Africa. Thulamela is located approximately between 22 15’ and 25 45’ South latitudes and 29 50’ and 30 05’ East longitudes. The climate is characterized by lowveld (arid and semi-arid) region with an annual rainfall within the range of 300-1000mm. The area is composed of basalt rocks and various sedimentary lithologies. Soils in the research area vary from loamy clay to clay, sandy loam and sandy clay. Vegetation is characterized by Savanna forests with congested tall trees and grasses. Similar ecological conditions have supported agroforestry systems in Malawi, Tanzania, Zimbabwe and Mozambique.

Interviews using semi-structured questionnaire were administered to farmers practising or not practising agroforestry technologies. SPSS was the tool used to analyze the data. Major areas of investigation were on socioeconomic factors influencing use of agroforestry technologies, adoption of agroforestry technologies and its influence on household food security and poverty alleviation. The results indicated that agroforestry is practised in Thulamela municipality but on a relative small scale. Various agroforestry technologies are known among the farmers but few of the technologies like fruit orchards are practised extensively. Farmers practising agroforestry produce a lot of maize and other cereals thus improving food security and livelihood. Adoption of agroforestry is likely to increase with education, household size, and ownership of land and labour as the key effective variables. Furthermore about 65% of the smallholders are aware that

agroforestry can alleviate poverty and about 35% do not know that despite the fact that some of them are practising agroforestry. Also the community is experiencing poverty which they alleviate through selling of fruits, firewood and manure from agroforestry trees. The results of this research will contribute to making well informed decisions in planning for agroforestry development and poverty alleviation in Thulamela Municipality and elsewhere.

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DEDICATION

This thesis is dedicated to Tawananyasha Nokutenda Chimbalu. I left you when you were so young and tender (12 months old). This was the time you needed me most. Thank you so much for understanding that mummy wanted to study and for being a good girl whilst staying with grandmother. To my lovely mother I say thank you for taking good care of my daughter. Without you my life could have been incomplete. *I WILL ALWAYS CHERISH YOUR LOVE.*

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LIST OF ACRONYMS

AIDS: ACQUIRED IMMUNE DEFICIENCY SYNDROME
AFTP: AGROFORESTRY TREE PRODUCT
BTU: BRITISH THERMAL UNITS
CFP: COMMUNITY FORESTRY PROGRAMME
DWAF: DEPARTMENT OF WATER AND FORESTRY (Previously)
DEAT: DEPARTMENT OF ENVIRONMENT AND TOURISM (Previously)
FAO: FOOD AND AGRICULTURE ORGANISATION
GFSI: GROSS FOOD SECURITY INDEX
GM: GROSS MARGIN
HIV: HUMAN IMMUNE VIRUS
ICRAF: INTERNATIONAL CENTER FOR RESEARCH IN AGROFORESTRY
LPDA LIMPOPO PROVINCE DEPARTMENT OF AGRICULTURE
LDA: LIMPOPO DEPARTMENT OF AGRICULTURE
MDG: MILLENIUM DEVELOPMENT GOALS
NFSI: NET FOOD SECURITY INDEX
NGO: NON GOVENRMENTAL ORGANISATION
NPV: NET PRESENT VALUE
RSA: REPUBLIC OF SOUTH AFRICA
SADC: SOUTHERN AFRICAN DEVELOPMENT COMMUNITY
SAP: STRUCTURAL ADJUSTMENT PROGRAMS
SPSS: STATISTICAL PACKAGE FOR SOCIAL SCIENCIES
UNIVEN: UNIVERSITY OF VENDA
WAC: WORLD AGROFORESTRY CENTER

GLOSSARY

Agroforestry: is a collective name of land use systems and technologies used in the same land management units as agricultural crops and / animals in same farm of spatial arrangement or temporal sequence (Nair, 1993).

Agroforestry Technologies: A land-use system in which woody perennials (trees, shrubs, palms, bamboos) are deliberately used on the same land management unit as agricultural crops (woody or not), animals or both, either in some form of spatial arrangement or temporal sequence. These can also be refered to agroforestry practices. (http://www.bugwood.org/glossary/html/glossary-.html).

Community Forestry: Community forestry is a village-level forestry activity, decided on collectively and implemented on communal land, where local populations participate in the planning, establishing, managing and harvesting of forest crops, and so receive a major proportion of the socio-economic and ecological benefits from the forest (Martel & Whyte, 1992).

Exotic: This is something which is of foreign origin or character (dictionary.reference.com/browse/exotic).

Fodder: Plants or plant parts eaten by browsing or grazing animals. Fodder trees include species of Acacia, Leucaena and many others. Normally, fodder refers to the green parts of the tree, for example, leaves or sometimes flowers and pods. Often fodder is collected and stored for future consumption.

Food Security: thus the reliable availability of a sufficient quantity and quality food for a population (www-personal.umich.edu/alander/glossary/html).

Gross Margin: is the amount of contribution to the enterprise after paying for direct fixed and direct variable unit costs required to cover overheads and provide buffer for unknown items (http:en.wikipedia.org/wiki/Gross_margin).

Indigenous: it is originating in and characteristic of a particular region or country, native (dictionary.reference.com/browse/indigenous).

Multipurpose: it is having more than one purpose or use. (http://www.yourdictionary.com/multipurpose).

Poverty Alleviation: It is a concept aimed at combating and reducing the effect and problems of poverty, through the use of strategies such as agroforestry technologies (Wikipedia, 2007).

Poverty: According to May (1999), poverty is the inability of individuals, households or entire communities to command sufficient resources to satisfy a socially acceptable minimum standard of living.

Smallholders: a person owning or renting a small farm. wordnetweb.princeton.edu/perl/webwn

Smallholding: A smallholding is a farm of small size. Often too small to be efficient, the utility of smallholdings varies from place to place. en.wikipedia.org/wiki/Smallholder

1 CHAPTER ONE: INTRODUCTION

1.1 Background to the study

This study investigates ways in which agroforestry technologies can contribute to poverty alleviation thus improving livelihoods of smallholder farmers in Thulamela Municipality of Limpopo Province in South Africa. The research focuses on socio-economic aspects of poverty with regard to improving food security, fodder; live fencing and soil fertility in rural areas of Thulamela Municipality. Currently fruit orchards and woodlots are the main agroforestry practices in the province (DWAF, 1995). Through the Community Forestry Programme (CFP), woodlots, fruit orchards and other agroforestry practices are being promoted by the government throughout South Africa (DWAF, 1995).

Agroforestry is a dynamic, ecologically based natural resource management system that through the integration of multipurpose trees on farms and in the agricultural landscape diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels (ICRAF, 2006). Agroforestry in southern Africa started in 1987, through collaborative efforts between International Centre for Research in Agroforestry (ICRAF) now called the World Agroforestry Centre and national agricultural and forestry institutions in Malawi, Zambia, Kenya and Tanzania (Odual, 2006). The program extended to Zimbabwe in 1989 and Mozambique in 2001. Major land use problems of declining soil fertility, shortage of fodder, livestock fencing materials fuelwood and environmental degradation were identified as justifying the need for planting and integrating multipurpose trees with crops on farms.

Farmers have developed and managed agroforestry systems for decades by nurturing trees on their farms, pasture lands and homesteads. Traditionally agroforestry systems produced a wide variety of products such as timber, fuelwood, fruits, vegetables, spices, resins, and medicines to meet household needs and to generate some income through sales in local markets. Appropriate agroforestry technologies and conducive environment is required in the context of integrated rural development.

Agroforestry can therefore be regarded as an important strategy for rural poverty alleviation. According to May (1999), poverty is the inability of individuals, households or entire communities to command sufficient resources to satisfy a socially acceptable minimum standard of living. In this study, the aim is to assess the prospects of alleviating poverty through various inputs associated with agroforestry among rural communities. Limpopo Province is struggling to promote agroforestry for poverty alleviation and food security (LPDA, 2004).

Agroforestry is believed to be a socio-economically and ecologically sound system of land management. The World Agroforestry Centre has had many activities to promote agroforestry within small holder communities in southern Africa (Akinnifes, 2006) but South Africa has not been participating vigorously in agroforestry research due to past political barriers. It is possible that a wide diversity of agroforestry practices developed in neighbouring SADC countries with similar climate and socio-economic conditions as South Africa can be extended to parts of South Africa. It is also possible that some agroforestry technologies which exist in South Africa have not been adequately noticed by researchers. Further research is therefore needed to assess the potential of agroforestry in South Africa.

Scientific knowledge on agroforestry has been gathered in the last two decades in southern Africa (Sanchez, 1995), resulting in options with proven potential to mitigate rural poverty if timely and correctly implemented. Little is still known about the relationship between poverty alleviation and agroforestry in South Africa and there is therefore need to undertake research on this perspective in South Africa (DWAF, 1995). Socio-economic studies conducted elsewhere revealed that such tree-based technologies have positive impacts like increased soil fertility and fodder on rural livelihoods (Ajayi and Kwesiga, 2003).

Poverty is mainly associated with low income, poor material possessions, poor nutrition, low food intake and health conditions (Omara-Ojungu, 1992). Food security is when adequate amount of food is acquired to meet biological requirements. Under the community forestry program and industrial forest plantations, farmers in South Africa are encouraged to adopt agroforestry practices that increase farmer dependence on tree intercropping on their farmlands and minimize pressure in the few remaining natural forests and woodlands (DWAF, 1995). Home orchards with fruit trees and woodlots of woody trees for sale to commercial wood industries are promoted agroforestry practices in South Africa (DWAF, 1995).

The use of traditional crop management systems with low food production potential is high among rural farmers resulting into food insecurity. Farmers who once relied upon subsidized agricultural inputs, especially fertilizers no longer do so after many governments in the region embraced Structural Adjustment Programs (SAPs) during the 1980s that removed agricultural subsidies. This in turn increased the cost and unavailability of chemical fertilizers to resource poor farmers resulting in widespread food shortages. However, agroforestry with a range of low cost, low input sustainable land use options presents great potential for minimizing the agricultural and environmental problems prevailing in the country and the entire region (Mendonsa and Stott 2003).

1.2 Research Problem Statement

The general perception that agroforestry technologies provide a wide diversity of products and functions which can significantly contribute to poverty alleviation has not been substantiated with robust research in many countries (Hegde, 2005). South Africa is one of the most unexplored countries with regards to the potentials, realities and limitations of agroforestry development. In Vhembe District of Limpopo Province some agroforestry practices are noted and used by a number of farmers, but relatively little is known and documented about their contribution to poverty reduction and rural development. Unless such conditions are clearly understood, it will not be possible to implement the ambitious participatory forest management principles which are meant to redress past inequalities, engage forest and trees in poverty reduction and involve smallholder farmers in sustainable conservation of natural resources around them.

1.3 Research Questions

This research will be guided by the following questions:

- What are the agroforestry species and technologies used by farmers or communities in the Thulamela Municipality?
- What is the level of impact of agroforestry on household food security in local communities?
- What are the factors which affect the adoption of agroforestry systems within Thulamela Municipality?
- In what ways would agroforestry contribute to poverty alleviation in Thulamela Municipality?

1.4 Objectives of the study

1.4.1 Aim

- To assess the role of agroforestry technologies in poverty alleviation among smallholder farmers in Thulamela Municipality of Limpopo Province.

1.4.2 Specific objectives

- To identify the agroforestry species and technologies used in the Thulamela Municipality community.
- To determine the impact of agroforestry on household food security and income in rural community of Thulamela Municipality.
- To determine the factors which affect adoption of agroforestry within Thulamela Municipality.
- To recommend a strategies for using agroforestry as a vehicle for poverty alleviation.

1.5 Hypotheses

- Thulamela Municipality has unique socio-economic and environmental conditions which can support specific agroforestry species and technologies

- Existing agroforestry technologies contribute significantly to household food security.

- Different factors contribute to the adoption of agroforestry technologies in Thulamela Municipality.

- A strategy can be developed for poverty alleviation through agroforestry technologies.

1.6 Justification

Many agroforestry projects in Africa and elsewhere have failed for a number of different reasons. Inadequate characterization of the socio-economic factors such as production of socio-economic benefits to farmers have major influence on development potential of agroforestry systems and projects (Current *et al,* 1995). There is inadequate information in Thulamela Municipality, and the rest of Limpopo Province and South Africa on the potential roles of agroforestry on soil fertility, increased food production, cash income generation, management and conservation of natural resources. Information generated from this research will contribute to reduce this gap in knowledge which has a crucial impact and relevance to programs of community development and environmental protection in the Thulamela Municipality. The results will also assist local and international authorities in Southern Africa to make informed and collective decisions in respect to planning community based agroforestry development projects and poverty alleviation activities.

2 CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

A substantial body of scientific literature has been documented in southern Africa and other areas where agroforestry is practised. This chapter will explore the relevant and pertinent literature on agroforestry technologies and its contribution to poverty alleviation. The economic and social analyses of agroforestry captured in the literature are important for gauging how these technologies contribute to household welfare, food security and poverty alleviation.

2.2 Agroforestry definition and Scope

As indicated earlier, agroforestry is a dynamic, ecologically based natural resource management system that through the integration of trees and crops on farms and in the agricultural landscape diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels (ICRAF, 2006). Agroforestry, the integration of trees in agricultural landscapes, offers robust options to improve productivity and achieve environmental sustainability (World Agroforestry Centre, 2009). Agroforestry is a set of practices that intentionally retains or plants multipurpose trees that can co-exist on land with crop production or grazing (Nair, 1983). Such systems combine elements of forestry, either at the same time or in sequence, building on the unique productive and protective value of trees (Gliessman, 2007). Agroforestry has been recognized for its potential as a stable and sustainable production system and for its potential contribution to the management of agricultural systems and environment. Agroforestry can extend the amount of time that a given area can be productive, improve livelihoods, and contribute to forest and biodiversity conservation through constant renewal of soil nutrients.

Multipurpose tree is a term common to agroforestry, especially when speaking of tropical agroforestry where the tree owner is a subsistence farmer. Multipurpose trees are trees such as *Sesbania sesban* that are deliberately grown and managed for more than one output. These trees are called agroforestry tree species because they co-exist well with crops without competing for nutrients with the crops. They also can sprout easily if cut and may supply food in the form of fruit, nuts or leaves that can be used as a vegetable while at the same time supplying firewood, timber, building materials, nitrogen to the soil, or supply some other combination of multiple outputs (Rocheleau *et al*,1988). Examples of agroforestry tree species include *(Moringa oleifera), Gliricidia sepium, Sesbania sesban, Cajanus cajan, Trefosia vogeli, Acacia angustissima, Leucaena pallida, Calliandra spp, Gravelia robusta.*

Agroforestry technologies are practices which involve the use of multipurpose trees outside of forests and provide a wide array of forestry related benefits as well as complementing agricultural production (Ruark, Schoeneberger and Nair, 2003). In agricultural production, agroforestry technologies are associated with use of multipurpose tree species, benefits and are complementary to the existing agricultural system. This therefore differentiates agroforestry systems from other forestry activities whose natural existence and regeneration has no direct human influence.

The term agroforestry as is suggested by Long and Nair (1999) traditionally refers to the production of crops which are mainly subsistence in nature under the discontinuous cover of trees. Modern agroforestry technologies contribute to the sustenance of hundreds of thousands of rural people through their role as a major source both in numbers and volumes of timber and non-timber products which contribute immensely to household food security and cash incomes (ICRAF, 1996). The current trends of growing pressure on limited natural resources coupled with rising demand for forestry products suggests that reliance on farm forests is going to increase and so their conservation within agricultural systems is vital (Long and Nair, 1999).

The concept of communal agroforestry has been evolving and implemented during the past decades as a particularly promising approach to integrated planning and management of rural tree resources. Agroforestry can be mainstreamed into global and national efforts to reduce poverty, improve food security and sustain newly emerging environmental management agenda (World Agroforestry Centre, 2005).

2.3 Examples outside South Africa of perspectives of Agroforestry Technologies

Today over 417,503 farmers in Malawi, Tanzania, Zambia, Zimbabwe and Mozambique (189,854 farmers in western Tanzania) are enjoying benefits from agroforestry focusing on trees grown on farms and rural landscapes (Odual *et al*, 2006) .These include fertilizer trees for land regeneration, soil health and food security, fruit trees for nutrition; fodder trees that improve small holder livestock production, timber and fuelwood trees for shelter and energy and trees that produce various products and medicinal trees that combat diseases. Due to a mix of agro-ecological factors (drought, low soil fertility, environmental degradation) and other man-made problems (illiteracy, poor land use techniques, unfavourable development policies), southern Africa region faces several challenges including worsening poverty, food insecurity, low income base and more recently the HIV/AIDS pandemic (Ajayi *et al*, 2006).

In Zimbabwe smallholder farmers have adopted agroforestry technologies well and are benefiting from them. Many farmers have many advantages coming out through the use of agroforestry trees in their farms. *Sesbania sesban*, *Tephrosia vogelli*, *Cajanus cajan*, *Leucaena* species, *Gliricidia sepium*, *Jatropha carcus*, *Uapaka kirkiana*, *Moringa oleifera* and *Acacia anguistissima* were grown for soil improvement, livestock feed, fruit, grain, herbs, poles, fuel wood, live fencing, and in some instances for oil and soap making in Manicaland Province of Zimbabwe (World Agroforestry Centre, 2009). Some farmers who established and maintained the use of agroforestry technologies have realised the benefits particularly in soil improvement. Testing and adoption of agroforestry in Zimbabwe is promising, considering the variations in climate in relation to improved farmers' yields (ICRAF, 2003). Results in some farmers' fields in Zimbabwe have proven that the technology can alleviate the impact of reduced fertilizer application and length of fallow periods.

According to the World Bank Report 2002, ''Agroforestry technologies in Indonesia currently harbor 50 percent of the plants, 60 percent of the birds, and 100 percent of the large animals that would normally be found in a natural forest. Cocoa agroforestry in Cameroon conserves 62 percent of the carbon found in a natural forest, and contains a plant biomass of 304 tons/hectare (compared to 85 tons/hectare in crop fields). In southern Africa, improved fallow agroforestry technology (including species such as Sesbania) add soil nutrients equivalent to approximately US$240 worth of chemical fertilizers per hectare. This helps in increasing the yield due to increased soil fertility. In Burkina Faso, the planting of live fences (including *Acacia nilotica, Acacia senegal, and Ziziphus mauritiana*) has increased farm incomes by US$40 per year.''

2.4 *Existing agroforestry technologies in smallholder farmlands in South Africa*

Farmers in South Africa practise planting of woodlots, biomass transfer, intercropping and domestication of indigenous fruit trees like *Adansonia digitata, Sclerocarya berea* as part of agroforestry technologies but these are not done extensively. Domestication of fruit trees (both indigenous and exotic) is one of the main agroforestry practices of farmers in South Africa. Currently fruit orchards and woodlots are the main agroforestry practices in the Limpopo Province (DWAF, 1995). Through the Community Forestry Programme, woodlots, fruit orchards and other agroforestry technologies are being promoted in many parts of South Africa (DWAF, 1995).

Many farmers have domesticated fruit trees like *Sclerocarya berea* in their fields (LPDA, 2004). *Sclerocarya berea* has been domesticated at a national level and many farmers have adopted domestication of such indigenous fruit trees because it has been proved to be income generating (can produce wine and it can also be used in medicine production). Evidence from South Africa indicates that the yield of *Sclerocarya berea* in South Africa has increased folds from cultivation in homestead plots and fields (Shackleton *et al*, 2003). Indigenous fruit trees can vary in their seasonality and this will supplement income opportunities across the year through selling of the fruits. In South Africa the use of tree species for nutrient recycling is being practised but on a small scale (LPDA, 2004).

2.5 Promising agroforestry practices for poverty alleviation in southern Africa.

Different types of agroforestry technologies address specific human, socio economic and environmental needs in southern Africa. These include *fertilizer tree systems* for replenishing soil fertility, *rotational woodlots* for solving fuel wood problems, *fodder banks* to supplement feed for livestock and *indigenous fruit trees* for improving nutrition and enhance the preservation of indigenous plant genetic materials (Ajayi *et al*, 2006). In southern Africa, smallholder rural farmers face critical problems of declining soil fertility, fodder, fuelwood, forest resource depletion and environmental degradation all of which contribute to rampant poverty. Agroforestry has the potential to reduce rural poverty and food insecurity if it's practised extensively. According to Nhau and Mano (2006), in Zimbabwe agroforestry had been found very beneficial, many farmers are practising domestication of indigenous fruit trees and intercropping with multipurpose trees is done at full force and this has helped farmers in increasing soil fertility without using a lot of money to buy fertilizers.

Most of the inhabited land in South Africa like in other countries in southern Africa has been subjected to extensive deforestation primarily due to shifting agriculture and overexploitation of forest products leading to soil erosion and consequent loss of soil fertility (McDonald *et al,* 2003). Decreased soil fertility is one of the major problems facing agricultural production in the region. Fertilizer tree species are notable for soil fertility regeneration among the portfolio of new agroforestry technologies in southern Africa. Research in southern Africa has promoted the domestication of indigenous fruits of the miombo woodlands, fodder and timber improvement (World Agroforestry Centre, 2006). According to Odual *et al* (2006), the following are the agroforestry technologies being promoted in southern African countries like Zimbabwe, Malawi and Zambia;

- **Rotational woodlot and boundary planting** using leguminous trees species such as *Acacia crassicarpa, Acacia leptocarpa, Acacia julifera, Acacia polyacantha, Acacia nilotica, Leucaena* spp, and non-leguminous trees such as *Azadirachta indica* for rehabilitation of ecosystem and improving soil fertility and income.
- **Improved fallows** using *Gliricidia sepium, Sesbania sesban, Tephrosia vogeli, Tephrosia candida* for improving soil fertility so as to increase food production
- **Fodder banks** using *Gliricidia sepium, Acacia angustissima, Leucaena pallida, Calliandra spp* for improvement of livestock nutrition
- **Processing and domestication of indigenous fruits** for adding value, improving nutrition and income generation.
- **Domestication of medicinal trees** for conservation of valuable indigenous medicinal trees and improvement of health.
- **Nutritional gardens** for food security and improved nutrition and income generation.

In Thulamela Municipality various agroforestry technologies have a potential for poverty alleviation but there is need for promoting better use of the technologies. Smithson and Giller (2002) reviewed different agroforestry systems and pointed out that the system of gliricidia-maize mixed (Gliricidia *sepium* (Jacq)-Zea may L) intercropping (also known as gliricidia sepium-maize simultaneous intercropping) developed at Makoka, Zomba in Malawi was more successful. In Malawi alley cropping was unsuccessful because of low tree biomass production and competition for resources between trees and crops (Itimu, 1997); while gliricidia-maize mixed intercropping has been successful (Ikerra *et al*, 1999). Many of these agroforestry trees have multiple uses, each providing a range of benefits that can be used for alleviating poverty.

2.5.1 Fertilizer tree technology

Fertilizer tree technology is one of the first agroforestry technologies in southern Africa. Its development began in Zambia and it includes improved tree fallows (common in Zambia) and mixed inter-cropping technologies (popular in Malawi) (Akinnifesi *et al*, 2006). Improved soil fertility in fertilizer tree systems are explained by the capacity of certain leguminous trees to fix large amounts of nitrogen(N) from the air through rhizobia contained in their root nodules and accumulate fixed N together with the native soil nutrients they draw from different soil horizons in their roots, stems, branches and leaves as they grow. The nutrients accumulate in tree biomass during growth. The tree biomass is cut and incorporated into the soil during land preparation. When the tree biomass decomposes, it releases nutrients to crops grown in the subsequent two to three years without adding external or artificial fertilizer but relying simply on the residual effect of the increased soil fertility.

Plant species used in fertilizer tree species to overcome soil fertility problems in southern Africa include *Sesbania sesban, Tephrosia spp, Gliricidia sepium* and *Cajanus Cajan.* The practice involve alley fallow cropping with short rotation shrub and tree species (Ajayi *et al*, 2006). Two-year fallows with *Sesbania* can yield nitrogen biomass in the range of 70-100 kg/ha and is generally accumulated and can be applied as green manure (Ajayi *et al*, 2006).In Malawi, continuous cultivation of maize with *Gliricidia sepium* yielded more than 5 tonnes per hectare in good years and using *Sesbania sesban* and *Teprosia vogeli* provided 100-250kgs of nitrogen/ha (Pye-Smith, 2008). According to Banzi *et al* (2004), in Tanzania there is high inorganic N content of soils under fallow and increased maize yields was recorded after fallowing.

2.5.2 Biomass Transfer

Biomass transfer uses the nutrient-rich leaves of agroforestry species (e.g. *Tithonia diversifolia)* as fertilizer for the production of high value vegetable crops (World Agroforestry Centre, 2009). Biomass transfer offers smallholder farmers the opportunity to supplement their incomes by growing cash crops that fetch high prices in urban markets (Policy Brief, 2009). Here nitrogen fixing trees or shrubs are planted on a separate plot and the leaves are regularly cut and used to fertilize neighbouring field plots in a cut-and-carry way, especially in the dambos or wetlands. It simply involves transferring of leaves and twigs of fertilizer trees from one part of the farm to another. In Eastern Zambia, *Gliricidia sepium* leaf mulches were used in combination with nitrogen fertilizers (Ajayi *et al*, 2006). It was estimated that yield of 3 t/ha of maize could be achieved either through application of 52 kg N or incorporation of 3.4 t/ha (dry weight) or 15 t/ha fresh weight of *Gliricidia* green manure (Ajayi *et al*, 2006). Biomass transfer increases food production and income for farmers thus contributing to poverty alleviation by;

- Helping farmers to produce diverse and high value crops (e.g cabbages and onions).
- Improving farm household income.
- Allowing production during the off season when farm produce attracts prices.
- Increasing production to 2-3 crops per season.
- Potentially being combined with fish farming.

2.5.3 Indigenous fruit tree crop system

A number of miombo indigenous fruit trees are important for food and nutritional security as well as being a source of income for rural communities in the southern Africa (Akinnifesi *et al*, 2004). Developing indigenous fruit and nut trees into tree crop system continue to be an important strategy to reduce poverty and hunger and to create employment opportunities in rural areas (Akinnifesi *et al*, 2006). According to ICRAF (1997), domestication is when tree species accelerated and human-induced practices are brought into wider cultivation through a farmer-driven and market-led process. The tree domestication aims at building on the desire of rural communities to cultivate indigenous fruits and nuts so as to meet their livelihood needs especially food and nutritional security, increase household income, tree conservation and diversify farming systems and the rural economy (Akinnifesi *et al*, 2006). Based on household surveys to identify the important traits for improvement, the four species of indigenous fruit tree that were identified in southern Africa are *Uapaca kirkiana, Strychnos cocculoides, Parinari curatellifolia* and *Sclerocarya birrea* (Ajayi *et al,* 2006).

Domesticating indigenous fruit trees will increase their quality and productivity and can also create opportunities for marketing the products thus empowering smallholder farming communities to conserve and cultivate them.

2.5.4 Rotational woodlots

This is whereby trees are grown in a field for a certain period of time and are removed and new trees are planted. Rotational woodlot technology is cheap and a good source of timber for construction, fuelwood for domestic use and tobacco curing and also for soil fertility improvement by the planted trees. It also provides fodder for the livestock. Rotational woodlots are meant primarily to provide high quality wood biomass. Some of the woodlot species also helps to fertilize the soil and are therefore grown in rotation with food crops (Kwesiga *et al,* 2003). The main woodlot species that have been promoted in the sub-region are Acacias especially *Acacia crassicarpa* and *Acacia polyacantha* and *Acacia auriculiformis*

2.5.5 Fodder banks

This is the growing, harvesting and storage of nutritious protein rich leguminous tree leaves during the wet season and using them as protein supplement for ruminant animals during the dry season (Kwesiga *et al*, 2003). The agroforestry technology helps to reduce the cost of animal concentrate feeds for smallholder farmers (Ikera *et al*, 1999). The research and development of this agroforestry technology has been much more emphasized in Zimbabwe where livestock production is more predominant.

2.6 *Environmental effects of agroforestry*

Agroforestry is associated with positive environmental outcomes because of the role trees play in larger ecosystem functions. Trees can improve soil quality in various ways. Root systems prevent soil erosion, leguminous species fix nitrogen, improve nutrient recycling, and detritus from trees increases the organic content of soil. Well-developed agroforestry systems provide habitat for wild animals and contribute to biodiversity. Agroforestry affects climate change by storing carbon, and offsets deforestation by providing an alternate source of wood products and habitats for fauna. Agroforestry can act as a buffer between protected forests and surrounding agricultural land and minimize edge effects in natural forests. Plants help remove pollutants from the air in three ways: absorption by the leaves or the soil surface; deposition of particulates and aerosols on leaf surfaces; and fallout of particulates on the leeward (downwind) side of the vegetation because of the slowing of air movement velocity (Kuchelmeister and Braatz, 2003).

Fertilizer trees provide alternative sources of wood for tobacco curing and help reduce deforestation of miombo woodlands. Also they provide up to 10 tonnes of wood biomass per hectare thus providing wood for energy (Nyadzi, 2004 an FAO, 2007d). Agroforestry tree species also suppress weeds and reduce soil compaction (Policy Brief, 2009). Again multipurpose trees help in mitigating the effects of climate change (Nyadzi, 2004).

In Zambia, farmers noted that wood produced in improved fallows would substitute for wood from forests and would thus help conserve the forest and biodiversity (Kristjanson *et al*, 2002). Research on the removal of airborne pollutants by vegetation shows that plants are effective sinks for pollution. Trees absorb sulphur dioxide very efficiently. Soil effectively absorbs gaseous pollutants, including carbon monoxide, sulphur dioxide, nitrogen oxides, ozone and hydrocarbons. Trees also often mask fumes and offensive odours by replacing them with more pleasing scents or by actually absorbing them and also help to increase the relative humidity of air through evapotranspiration (Gliessman, 2007). Agroforestry performs carbon sequestering role at zero cost. It cleans the air and water and promotes biodiversity.

Trees, shrubs and other vegetation help to control temperature extremes in rural environments by modifying solar radiation. Trees can help both by absorbing and refracting or dissipating noise such as that produced by the heavy vehicle traffics that characterizes urban areas.

Water use, reuse and conservation forests can help in the protection of water supply, wastewater treatment systems and storm water management (Gliessman, 2007). Trees and forests are a means of soil conservation, preventing landslides in fragile ecosystems with steep terrain, little vegetation and harsh seasonal rains, and thus protecting people's lives and homes (Gliessman, 2007). Green areas have a vital role in biodiversity. Wetlands can be some of the most productive natural ecosystems and can provide important habitats for fauna.

2.7 Benefits of agroforestry technologies to poor communities.

Agroforestry technologies can reduce poverty directly by providing cheaper sources of fuelwood, fruit and nuts, and livestock fodder all of which can be sold to generate income or fulfil basic family needs (www.worldagroforestrycentre.org). The sale of timber is particularly important to poverty reduction, as returns are long term. Indirectly agroforestry can increase crop production and incomes through conservation of soils and soil moisture. Smallholder farmers could benefit from including agroforestry technologies ready for application in limited spaces as well as open areas.

In Northern Nigeria, women buy higher quality cotton cloth, cement bricks, tin roofs and more small ruminants from the extra income earned from sales of fodder from tree species (Kristjanson *et al*, 2002). Since small ruminants are typically sold on an emergency needs basis, monitoring both the number of small ruminants owned by a household and the frequency of sales may be good poverty indicators, as more regular sales will indicate an increase in the wealth and security of the household (Hegde, 2005). Basic products including gum trees, oils, proteins, fruits and to some extent fruit juices are among the main and most frequently consumed items in their respective food categories by a majority of people even in the rural communities (Kwesiga *et al*, 2003). In addition food and non-food products from diverse trees and shrubs can improve the nutrition and incomes of poor rural farming households. This could be realized by better integrating diverse fast-growing tree species and shrubs in the farming areas. Already tested and proven tree species that provide fruit, medicinal products, timber and fuel wood could be popularized to enrich existing farming practices.

Agroforestry can improve crop and livestock production by providing relatively less costly, more affordable and locally available inputs for fodder and soil amendments to the smallholder farmer (Kwesiga *et al,* 2003). Society can derive maximal benefits from agroforestry goods and services and augment traditional forestry by gleaning some portion of these benefits from agricultural lands where agroforestry can or is being practised. Trees and green spaces help keep rural areas cool, act as natural filters and noise absorbers, improve microclimates and protect and improve the quality of natural resources, including soil, water, vegetation and wildlife. Trees contribute significantly to the aesthetic appeal of cities and rural landscapes thereby helping to maintain the psychological health of nearby communities. Beyond ecological and aesthetic benefits, forestry has a role in helping resource-poor populations meet basic needs, particularly but not exclusively in developing countries (Kuchelmester and Braatz, 2003). In Zimbabwe, Zambia, Malawi and Tanzania it is evident that agroforestry has a positive impact on the livelihoods of the farmers and their families, in the following areas (ICRAF, 2006).

- Improved soil fertility and yields
- Increased income and savings
- Increased knowledge and experience related to agroforestry and role of plants
- Improved food security and nutritional status
- Improved health status and increased health expenses
- Increased educational expenses
- Increased firewood supply
- Mitigation of the impacts of HIV/AIDS
- Improved family relations

2.8 Ways to improve adoption efficiency of agroforestry for poverty alleviation

About 1,2 billion rural people currently practise agroforestry on their farms and in their communities and depend upon its products (World Bank, 2004). Their tree based enterprises help ensure food and nutritional security, increase their income and assets and help solve their land management problems. During the past 30 years, agroforestry has progressed from being a traditional practice with great potential for the point where development experts agree that it provides an important science-based pathway for achieving important objectives in natural resources management and poverty alleviation (Garrity, 2004). Despite its ubiquitous use by smallholder farm families, there is inadequate awareness about the potential of agroforestry to poverty alleviation among millions of households trapped in poverty.

A global agroforestry promotion is needed to mobilize science and resources to remove the socio-economic, ecological and political constraints to widespread application of agroforestry innovations and thereby help attain the Millennium Development Goals (MDGs) (World Agroforestry Centre, 2006). The target is a future in which millions of poor farming households have access to a wide variety of adapted and productive tree enterprises that improve livelihoods in a holistic way (World Agroforestry Centre, 2005).There is need to introduce various policies in South Africa so as to increase the adoption rate of agroforestry. It seems the Limpopo Province is still behind when it comes to the use of agroforestry technologies because there are few stakeholders who are involved in agroforestry.

Research comparing different approaches and strategies for increasing the adoption of agroforestry is needed to ensure effective and efficient extension programs (Garrity, 2004). Non-Governmental Organizations (NGOs) provide valuable support in business development services for agroforestry, but privatizing such services and promoting a private market for business development services is a key element of developing the sustainable marketing of agroforestry products for small enterprises (World Agroforestry Centre, 2005).

2.9 Research techniques and findings from previous research

A profitability analysis that was carried out in other southern African countries like Zimbabwe shows that the various agroforestry technologies are profitable relative to conventional production practices where trees are not grown (Franzel *et al*, 2004; Ajayi *et al*, 2006a; Place *et al*; 2002). The results of a recent study in Zambia to assess the financial profitability of five soil fertility management technologies like *Sesbania sesban, Gliricidia sepium, Tephrosia vogelii,* continuous maize production with fertilizer and continuous maize production without fertilizer show that over a five-year period, agroforestry-based soil fertility management technology ("fertilizer tree fallows") are more profitable than farmers' practices of continuous maize production without external inputs but, it is less profitable than full fertilizer application (Ajayi *et al*, 2006a). The financial analysis carried out in Tanzania regarding rotational woodlots shows that despite higher costs and longer payoff, rotational woodlots generate a net present value 16 (NPV) of US$388 per hectare, which is six times higher than the net benefit obtained in conventional maize fallow systems (Franzel *et al*, 2004).

Qualitative (e.g. in depth case studies) and quantitative techniques (e.g. econometric analysis) distinguish impacts of single interventions, but because they are intensive, they require clear guidance on relationships in order to be accomplished with a reasonable budget (Kristjanson *et al*, 2002). Farmer-participatory impact assessments are only one component in a comprehensive research assessment of impacts. While impacts at plot, farm/household and (to a lesser extent) village/community levels can be evaluated using this approach, it does not establish quantitatively or qualitatively the relationship between the adoption of a certain technology and the particular impact (such as household income) in question. This requires more in-depth case studies (qualitative) or rigorous data collection and econometric analysis (quantitative) (Kristjanson *et al*, 2002). The household econometric approach and other broader-scale approach are essentially complementary. To be effective, a broad-scale approach has to be done via linkages between the household level (approaches based on participatory rapid appraisals and more formal household models) and the broader scale, attempting to identify variables that are relatively easy to measure that can be used as proxies for poverty indicators.

Detailed household surveys and econometric analyses provide large amounts of information concerning impacts on household well-being and even address the attribution issues but the effort and resources required to collect and analyze such data are substantial (Nicholson *et al,* 1999). The econometric techniques allowing an extrapolation of poverty measures to the fifth or sixth level administrative level of a country (encompassing roughly several thousand households) where as the poverty surveys only allow reporting at the second or third administrative level are now well developed and have been applied by researchers in South Africa (Statistics South Africa, 2000). Regression models are used to explain the factors that influence the adoption of agroforestry technologies (Mercer, 2004). The analysis of the results of the formal survey used a logit regression model to assess various farm and household characteristics as influencing adoption of agricultural technologies (Place *et al*, 2005a). In this study econometric analyses which involve the use of the logit regression model will be used to meet some of the objectives.

Given the key issues raised, the major findings and agroforestry benefits cited in the literature, there is good cause to assess the potential and promote agroforestry amongst small holder farmers in Thulamela Municipality.

2.10 Conceptual framework for the assessment of the contribution of agroforestry technologies to poverty alleviation

Agroforestry which is the co-existence of trees, crops and livestock on the same piece of land can produce a variety of benefits to smallholder farmers. The study problem is hereby conceptualized as the one balancing sustainable use of multipurpose trees in the existing cropping activities against household decisions to adopt or not adopt agroforestry technologies. Farmers need to practise agroforestry technologies within their farms effectively so as to produce the benefits. Many farmers have cleared the land available thereby exposing the less fertile land to extreme conditions of erosion and also reducing fodder and fruits for livestock and human consumption.

Agroforestry multipurpose tree species like Sesbania *sesban* has to be incorporated together with crops and livestock. There are famers who are practising agroforestry in their fields by incorporating soil fertility enhancing trees, fodder species, fruit trees (both indigenous and exotic) and woodlots. These agroforestry technologies will realize multiple benefits from the small piece of land whilst on the other hand those not practising agroforestry may not realize these benefits directly. The benefits of agroforestry include improved yields, soil fertility enhancement, fruits, minimized erosion, firewood, improved scenery and conservation of the environment. The smallholder farming environment is influenced by a number of climatic/bio-physical factors such as topographical characteristics, soils and rainfall patterns.

Also tree services (of fertilizing the soil leading to high yield) can lead to marketing of the yields and milk from livestock tree services and marketing of tree products will lead to sustainable environment thus reducing pressure on the wild trees. When all these benefits are obtained, there will be reduced poverty within the community thus leading to poverty alleviation. By this the Millennium Development Goals (MDGs) would in part met. This is represented by the figure 2.1 below. The flow diagram has been developed specifically for this study to illustrate how MDGs would partly be met.

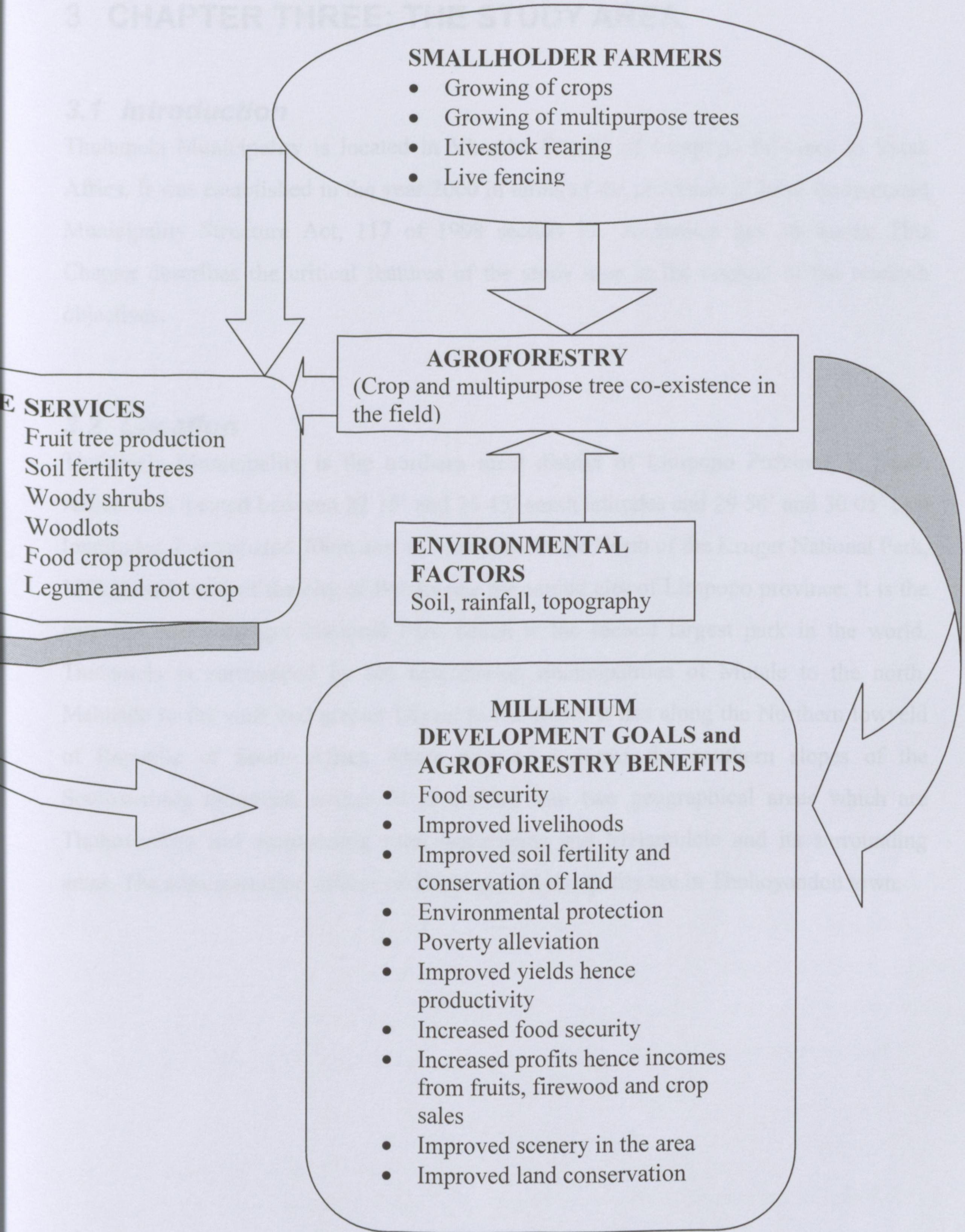


Figure 2:1: Conceptual framework for the assessment of the contribution of agroforestry technology to poverty alleviation.

3 CHAPTER THREE: THE STUDY AREA

3.1 Introduction

Thulamela Municipality is located in Vhembe District of Limpopo Province in South Africa. It was established in the year 2000 in terms of the provision of local Government Municipality Structure Act, 117 of 1998 section 12. Thulamela has 36 wards. This Chapter describes the critical features of the study area in the context of the research objectives.

3.2 Location

Thulamela Municipality is the northern most district of Limpopo Province in South Africa. It is located between 22 15' and 25 45' south latitudes and 29 50' and 30 05' east longitudes. It is situated 70km east of Makhado, in the North of the Kruger National Park, 180km north east of the city of Polokwane the capital city of Limpopo province. It is the gateway to the Kruger National Park which is the second largest park in the world. Thulamela is surrounded by the neighboring municipalities of Mutale to the north, Makhado to the west and greater Giyani to the south. It lies along the Northern lowveld of Republic of South Africa where part of it forms the southern slopes of the Soutpansberg mountain ranges. It is divided into two geographical areas which are Thohoyandou and surrounding rural settlements and Malamulele and its surrounding areas. The administration offices of Thulamela Municipality are in Thohoyandou town.

3.3 Location of the study area.

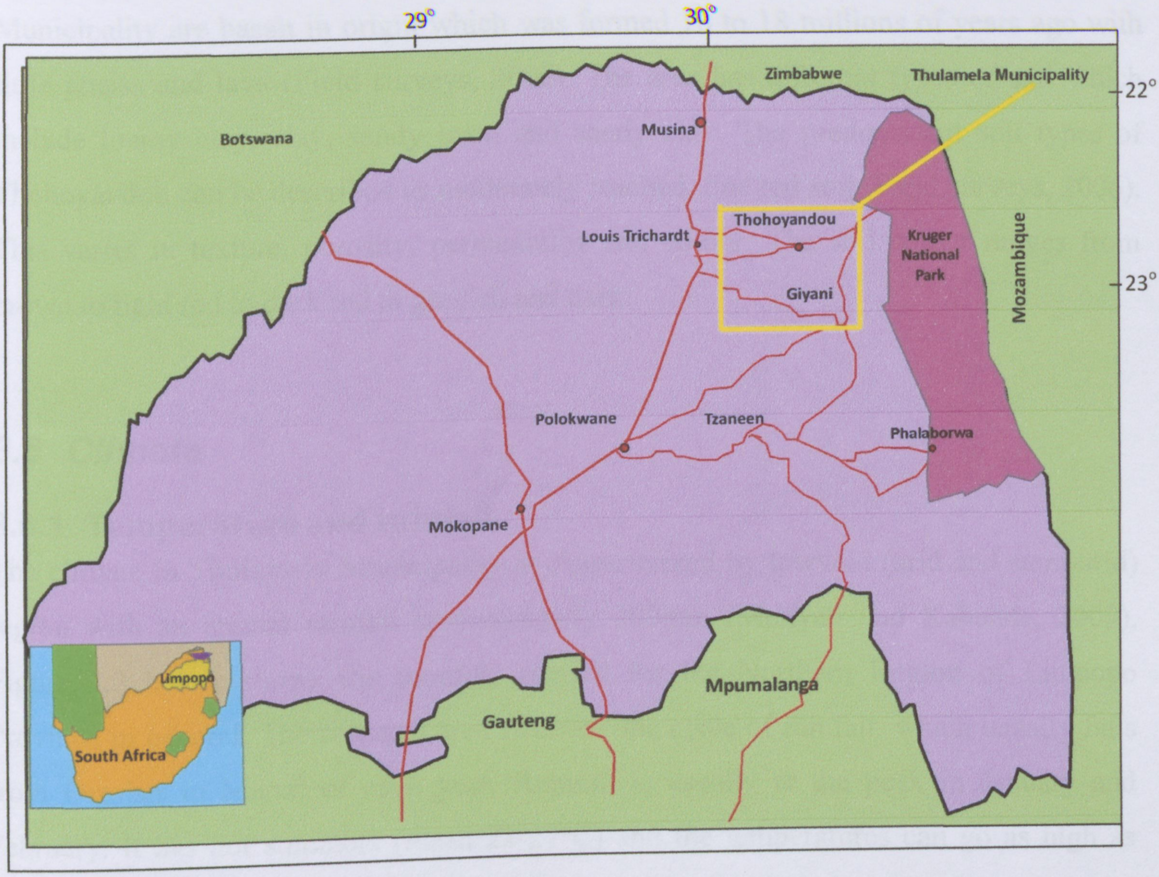


Figure 3:1: Map of the study area.

3.4 Topography

Thulamela Municipality has steep relatively flat plains and gentle slopes with isolated hills and mountains. It lies along the Northern low veld of South Africa. The rest of it forms the Southern slopes of Soutpansberg mountain ranges. The slopes vary from 1; 4 to 1:100. The town of Thulamela is Thohoyandou which can be divided into two very distinct areas; the south of the town is characterized by very gentle sloping topography.

3.5 Geology and soils

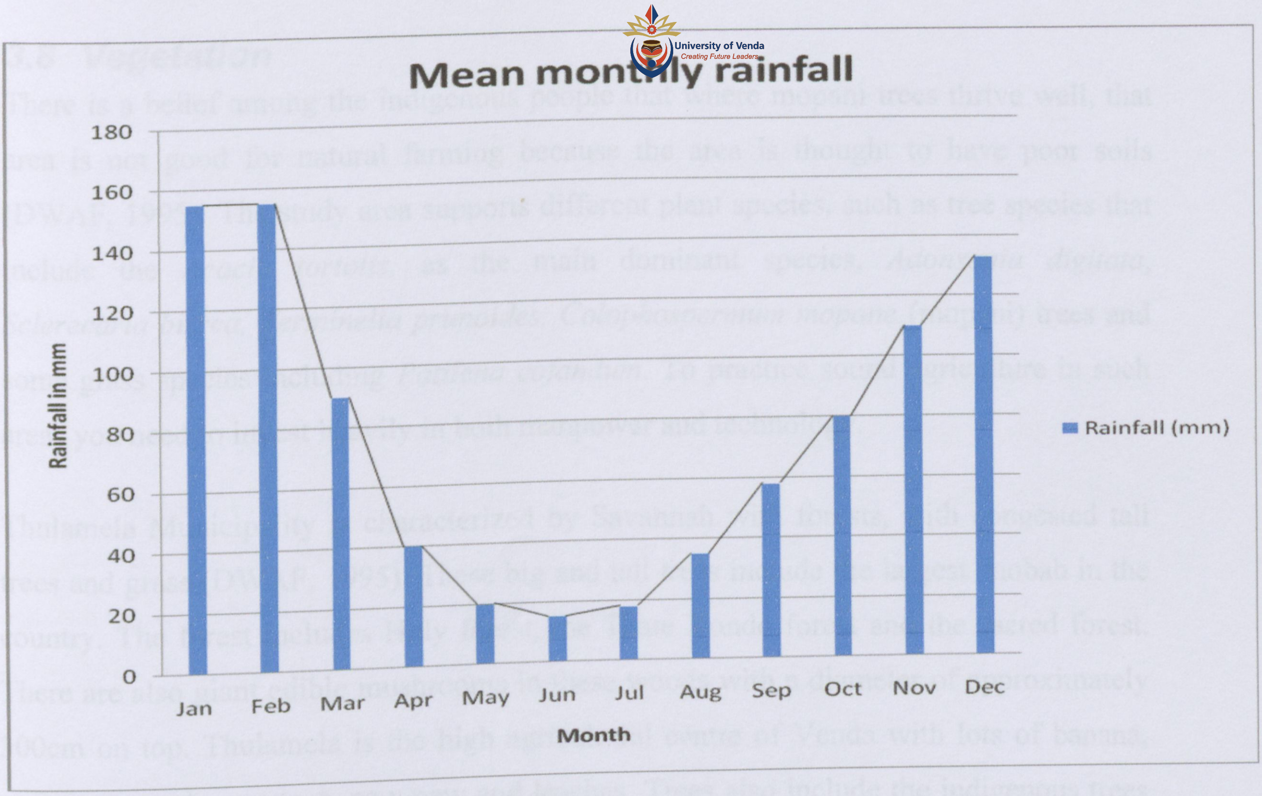
The southern part of the study area which lies south of Punda Maria road is underlain by basement gneisses (granite rock) intruded by certain diabase types. The northern section of the study area is underlain by basalt of the Sibasa formation which forms part of the

Soutpansburg group (Munyati and Kabanda, 2009). This group comprises of basalt and various sedimentary lithologies. The dominating underlying rock strata of the Thulamela Municipality are basalt in origin which was formed 16 to 18 millions of years ago with little gneiss and lava (Field surveys, 2006). The area has different types of soil which include loamy clay, clay, sandy loam and sandy clay. The predominant soil types of Thohoyandou can be described as moderately leached, fine red soil (Field surveys, 2006). This varies in texture, porosity, permeability and colour. The soil colour ranges from brown to light red to dark red to greyish and dark.

3.6 Climate

3.6.1 Temperature and rainfall

The climate in Thulamela Municipality is characterized by lowveld (arid and semi-arid) region with an annual rainfall approximately 300mm (Munyati and Kabanda, 2009). Figure 3.2 below shows the monthly rainfall for the Northern Region of Limpopo Province in general. The research area receives one cycle of rainfall, which usually falls from October to March of each year. Rainfall is usually at the peak in January and February. It has hot summers (mean 23-27°C) and the temperatures can go as high as 40°C (Munyati and Kabanda, 2009). The Vhembe district experiences mild to moderate winters (mean 8-15°C) which is often cool and dry (Meteorological Data Sibasa, 2007). It is frost-free and winter comes between May and August. Thulamela municipality usually experiences wind erosion in August when the land will be dry.



Source: Meteorological Data Sibasa, 2007

Figure 3:2 Northern Region of Limpopo Province, long term monthly mean rainfall.

3.7 Drainage

The major rivers in the study area are Luvuvhu, Mutshindudi, Thate Vondo and Mutale. These rivers drain in a northeasterly direction. In the north part of the study area the mountainous terrain divides the study area into catchment areas. The rivers on the northern side of the mountain drain into Mutale River which forms the northern boundary of the study area. The rivers of the south drain into Mutshindudi and Luvuvhu rivers. The approximately 80% of the ground water found in the study area occurs in secondary aquifers (weathered and fractured) which lie directly beneath the surface of the depth of less than 50m (White paper on Agriculture, 1995). Currently Thulamela Municipality obtains water from Thate Vondo dam. Water is used for agriculture (irrigation), industrial, domestic consumption and for recreation. Almost 89% of households in the municipality areas are provided with acceptable levels of water services (Field surveys, 2006).

3.8 Vegetation

There is a belief among the indigenous people that where mopani trees thrive well, that area is not good for natural farming because the area is thought to have poor soils (DWAF, 1995). The study area supports different plant species, such as tree species that include the *Acacia tortolis,* as the main dominant species, *Adonsonia digitata*, *Sclerecaria birrea, Terminelia prunoides, Colophospermum mopane* (mopani) trees and some grass species including *Patilena cofandum*. To practice sound agriculture in such areas you need to invest heavily in both manpower and technology.

Thulamela Municipality is characterized by Savannah with forests, with congested tall trees and grass (DWAF, 1995). These big and tall trees include the largest baobab in the country. The forest includes Holy forest, the Thate Vondo forest and the sacred forest. There are also giant edible mushrooms in these woods with a diameter of approximately 300cm on top. Thulamela is the high agricultural centre of Venda with lots of banana, mango, avocado, oranges, paw-paw and leaches. Trees also include the indigenous trees such as *Combretum*, *Apiculatum*, *Pterocarpus*, *Rotundifoluis*, *Terminalia* and *Adansonia digitata* (Baobab). This area is also invaded by alien trees and shrubs which includes *Psydium guajava* (guava), *Lantana camara* (Lantana), *Casalpinia decapetala* (Mauritius thorn) and *Azolla filiculoides* (Water ferns). Thulamela has some of the shrubs such as the *Bauhinia galpini* (Pride of the kaap), *Annona selegalensis* (wild custard apple) and *Transvaal quar* (elliptica).

Table 3:1: Some of the agroforestry species found in Thulamela Municipality.

Scientific Name	**Common Name**
Acacia caffra	*Common hock thorn*
Acacia karoo	*Sweet thorn*
Acacia totolis	*Umbrella thorn*
Acacia sibberiana	*Paper bark thorn*
Acacia mellifera	*Hook thorn*
Acacia galpini	*Monkey thorn*
Ficus sycamores	*Common cluster fig*

Erythrina lysisteman	*Common coral tree*
Parinari curatellifolia	*Velvet bush*
Peltophorum africanum	*Weeping battle*

3.9 Land use

The population of Vhembe District can be classified as rural and agriculture plays a major role in the economic growth and development of the District. The land is mainly used for agricultural development and subsistence farming, pastoralist and horticulture supplement seasonal crop production. Modes of production and their economic base operate within various forms of tribal chiefdom apart from little commercial farming and a few large state-owned timber productions.

Livestock in the area includes cattle, donkeys, goats, sheep and chickens. Livestock especially cattle, they feed on the grasses and the surrounding trees within the woodlands. There are quite a lot of indigenous and exotic trees in the area. The smallholder farms are located mostly in the former homeland areas. Farming under small holder system is characterized by low level of production being primarily for subsistence and little marketable surplus (White Paper on Agriculture, 1995). Maize is the dominant cereal grain despite the dry and drought prone ecology of much of the district. The smallholder farmers also grow leguminous crops like groundnuts, bambara nuts, cowpea and vegetable crops which include spinach, cabbage, tomatoes and onions (Nesamvuni *et al*, 2003).

The other activities include shopping activities, settlement and industries. Thulamela Municipality is characterized by rural settlement patterns, enormous backlog in basic household infrastructure and services. Discontinuous land use concentration of taxable economic resources in the formerly R293 town on its periphery are scattered concentration of extreme rural and urban poverty (Statistics S.A, 1991). There are also four inactive gold mines.

3.10 Settlement and population

The population of Thulamela Municipality consists of few ethnic groups distinguished by culture, language and race. Vha-Venda makes up the largest group, approximately 85% in the greater Thohoyandou. The Tsonga (Shangani) comprises nearly 12.4% and Indians making nearly 2.6%. The population of Thulamela Municipality is approximately 584275 with 261304 males and 322953 females (Statistics S.A, 1991). One part of the Thulamela Municipality is historically rural composed of approximately 200 villages and the other part is urban composed of about 30 thousand residential sites. There are numerous rural and urban villages namely: Dumasi, Mphego, Mangodi, Tshikonelo Xithelani, Madansi, Saselemani, Xigulo, Ngudza, Tshivhulami, Mtatshe, Vhufuli, Ngovhela, Maungani, Miluwani, Mbaleni, Sibasa, Shayandima.

4 CHAPTER FOUR: METHODOLOGY

4.1 Introduction

This chapter presents the research methodology and the various techniques used in data analyses. It shows the linkage between the research questions, hypotheses and type of data and analyses to be used. There are two types of data namely primary and secondary. Primary data is collected at first hand from the field. Three basic means of obtaining primary data are observation, surveys and experiments. Secondary data is data from published materials such as government reports, annual company reports or published statistics. Primary data collection is also known as direct method whereas secondary data collection is also known as indirect method. In this research project, both the direct and indirect methods of collecting data were used.

4.2 Data required and Analytical tool.

The major variables used in this research include household basic needs, food security level, agricultural activities practised in the study area, agroforestry tree species within the area, agroforestry technologies practised, contribution and potential of agroforestry technologies in poverty alleviation within the study area and the smallholder farmer's perception of the use of agroforestry technologies to alleviate poverty in Thulamela Municipality, Vhembe District.

The research required data on such socio-economic profiles as the household income, gender, age, level of education, household size and type of ownership of land. This data was required so as to obtain information about the personal and socio-economic conditions of the population group which may affect the adoption of agroforestry technologies in the study area. The data also helped in understanding its implications to poverty.

Data on the small scale farming and food security was required so as to see its implications on the need for agroforestry technologies in the alleviation of poverty in the communities in the study area. It helped to develop poverty indicators and assess the level of poverty in the study area as well as the level of food security in the study area. Data on agroforestry activities helped to identify the type of agroforestry species and assess the use of agroforestry tree species within the area and also if the agroforestry technologies are being practised effectively. The data also helped to gauge the knowledge level on the use of agroforestry technologies within the farming areas. Again it helped in assessing the sustainability of resource use and the role of multipurpose tree species in poverty alleviation in order to provide recommendations to the relevant stakeholders on the use of agroforestry technologies.

All this data were captured and analysed using the Statistical Package for Social Sciences version 14.0 (SPSS, 2004).

Table 4.1 summarizes the data required, research questions, hypotheses and analytical tools used.

Table 4:1: Summary of data requirements, research questions and analytical tools.

Research Question	Hypothesis	Analytical tool	Data requirements
What are the agroforestry species and technologies used in Thulamela Municipality?	Thulamela Municipality has unique socio-economic conditions which need specific agroforestry species and technologies.	Cross tabulation and descriptive statistics (pie chart, histograms) and contingency tables will be used.	Agroforestry tree use (fodder, fertility, fruits etc), household size, labour, farm size, level of education, knowledge level of agroforestry.
What is the level of impact of agroforestry on	Existing agroforestry technologies	Chi-squared test will be used on categorical data such as crops,	Main crops/livestock produced, tree uses on the land, types of trees

household food security in local communities?	contribute significantly to household food security.	livestock, agroforestry practices, ownership of household and other socio economic characteristics. Descriptive statistics like pie charts will also be used.	on the field, variable input costs and purchased input level, benefits of agroforestry, total arable area, and monthly income.
What are the factors which affect the adoption of agroforestry technologies within Thulamela Municipality?	Different factors contribute to the use of agroforestry technologies in Thulamela Municipality.	Logistic regression will be used to address the hypothesis.	Levels of education, marital status, household size, landownership, gender and land use type.
In what ways would agroforestry contribute to poverty alleviation in Thulamela Municipality.	A strategy can be developed for poverty alleviation through agroforestry practices.	SPSS will be used to analyze data and cross tabulations and descriptive statistics like pie charts will be used to address the relationship between agroforestry and poverty alleviation.	Socio-economic and environmental benefits of agroforestry in Thulamela.

4.3 Sampling methods and sample size

The main criterion used in selecting the study site was its agroforestry potential measured by existing agroforestry practices and the need for modification of the existing agroforestry technologies. Performance and current agricultural activities in the study area was also considered in site selection so that farmers belonging to different cooperatives and performing at different levels (poor or rich) are included in the sample. Random sampling ensures that every individual in the sampling frame has an equal chance of being selected (Goddard and Melville, 2001). Random sampling was used because it ensures representation of the overall population of the study area and also it reduces bias. Thulamela Municipality has approximately 500 small holder farmers and the basis of random sampling is to find at least 10% of the population from the communities to represent the entire district population (Melville, 1996). A total of 64 farmers were selected randomly within the Thulamela municipality. Random numbers table was used in the selection of farmers.

4.4 Data collection

A pre-testing of the questionnaire before going for proper field work was done. This was done within the surrounding community and within the University so as to test if the questions were well structured and easily understandable and to identify critical variables. A field survey and interviews were conducted by the researcher by administering a questionnaire to selected (64) farmers in Thulamela Municipality. The target population was from the 500 smallholder farmers. The primary data obtained from the survey was supplemented by using surveys and focus group discussion for those who had a cooperative farm. A structured standard questionnaire was used to assess the contribution of agroforestry technologies in Thulamela Municipality (e.g. what agroforestry technologies do you use and their benefits?). Cohen and Manion (2005) maintain that one of the advantages of the questionnaire is that it is anonymous and more reliable therefore encourages greater honesty.

Prominent or influential people like chiefs, local leaders and business people were interviewed during the focus group discussion so as to obtain their views on agroforestry technologies. Also transect walks by the researcher were undertaken to make participatory observations within the area so as to capture some of the information which the interviewee may not have provided efficiently. According to Leedy (1989), direct observation is one of the ways of making a correct description of an object. Secondary data like use of information which was once collected from the farmers by other researcher was also used to enrich and improve quality of information gathered for detailed analyses.

4.5 Data Analysis

The data collected was entered in the computer and analyzed using the Statistical Package for Social Scientist version 14.0 (SPSS, 2004). The logit regression analysis was done using the SPSS. Also descriptive statistics were produced by SPSS. Chi-squared test was done using SPSS as well.

4.6 Data analysis framework

This section interprets the hypothesis and describes the technique for analyzing the data relevant to the hypothesis.

4.6.1 Hypotheses 1: Thulamela Municipality has unique socio-economic conditions which need specific agroforestry species and technologies.

Socio-economic and agronomic factors which were likely to influence the household decisions to accept and use certain agroforestry tree species were analyzed and differentiated using descriptive statistics through SPSS. Figures were used to help in the pie charts and histograms to be produced.

4.6.2 Hypotheses 2: Existing agroforestry technologies contribute significantly to household food security.

Contingency tables were used to ascertain the contribution of existing agroforestry technologies to food security. Various correlations such as between fruit trees and adoption of the technology were performed so as to ascertain the household food security. To assess the contribution of agroforestry to food security, an advanced analysis of the Gross Food Security Index (GFSI) and Net Food Security Index (NFSI) were used (Nhau and Mano, 2006). These were applied as follows (Jari and Mano, 2006):

$$\text{GFSI} = \frac{\text{Total Food Obtained}}{\text{Total Food Required}} \times 100$$

$$\text{NFSI} = \frac{\text{Retained Food after Sale}}{\text{Total Food Requirement}} \times 100$$

4.6.3 Hypotheses 3: Different factors contribute to the adoption of agroforestry technologies in Thulamela Municipality.

To address this hypothesis, SPSS was used to analyse data obtained and the results were represented in tabular form. Logistic regression was used to ascertain the factors that may have an influence on adoption of agroforestry. Also descriptive statistics such as pie charts were used. Details of the independent and dependent variables used in logistic regression are provided in chapter 5, section 5.6.

4.6.4 Hypothesis 4: A strategy can be developed for poverty alleviation through agroforestry practices.

To address this hypothesis, SPSS package was used to analyse data and results were presented in tabular forms and charts. Descriptive statistic such as histograms and pie charts were used to present data. Benefits of agroforestry technologies in the community were presented in tabular form.

5 CHAPTER FIVE: RESULTS AND DISCUSSION

5.1 Introduction

This chapter presents the results of the study in the context of the research objectives. These results are classified into the socio-economic set-up of the community with regards to views on poverty indicators, knowledge and adoption of agroforestry, identified agroforestry technologies and tree species with major contribution to food security and poverty reduction at household level.

5.2 Socio-economic and household characteristics influencing agroforestry species and technology to be used.

This section presents information on age, gender, family size, educational status, income, employment status of the respondents in the Thulamela municipality. This study maintains that these variables influence the adoption and application of agroforestry technologies in the study area.

5.2.1 Age status of the community

Age is a significant aspect of the household that affects basic needs such as education level, food production, quality of family labour and use of certain tree species and adoption of agroforestry technologies. This variable interacts and influences the community in maintaining household basic needs and has been examined within the context of how the community copes with the problem of poverty.

The research shows that 33% of the respondents are above 65 years in age thus the highest group while 23% of the respondents were between the ages of 51-65 (Figure 5.1). This implies that most of the people within these two age groups would be retired and out of formal employment thus giving them enough time to work in their fields and attend the extension workshops which will be taking place within the communities. By attending extension workshops and being full time on ground they will have increased knowledge and time to introduce certain tree species in their field and practising projects that will be underway like agroforestry. The young generation between 20-35 years is 14%. This age group is mainly in towns looking for employment such that it's not very effective in rural areas.

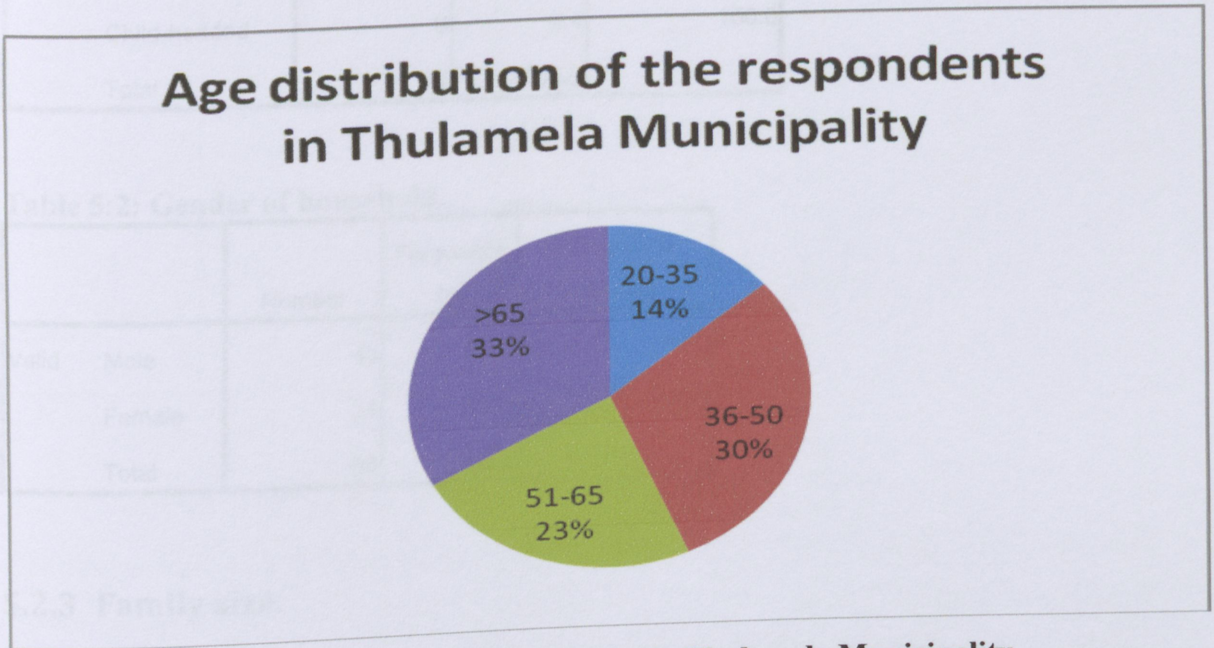


Figure 5:1 Age distribution of the respondents in Thulamela Municipality

5.2.2 Gender status of the community

Of the total respondents in the survey, 32.8% were female headed families with mother being the household head, 57.8% are male headed families with father being the household head and 9.4% are child headed families (Table 5.1). Table 5.2 also indicates the frequency of gender giving attention to the gender of the child headed families. There are 67.2 % of male headed families within the Thulamela community and 32.8% female headed families (Table 5.2). Females are the ones who usually work in the field and in those families which are headed by male; the females usually do not make decision on how to utilize the fields. Those families which are headed by female, they make their own decision on how to utilize the field. These also greatly affect the taking part of females in the agroforestry projects.

Table 5:1: Household head status.

		Number	Frequency (%)	Cumulative Percent
Valid	Male	37	57.8	57.8
	Female	21	32.8	90.6
	Child-headed	6	9.4	100.0
	Total	64	100.0	

Table 5:2: Gender of household.

		Number	Frequency (%	Cumulative Percent
Valid	Male	43	67.2	67.2
	Female	21	32.8	100.0
	Total	64	100.0	

5.2.3 Family size.

The size of family has important bearing or linkage to the situation and effect of poverty and food security. Food security is about food availability, accessibility, stability of supply and consumption by all members of the household and how it might influence poverty situation within the community.

The family size varied between 2 and +7 members and the mean family size being 7. The majority of the family members is found within the range greater than 7 and has the percentage of 59.4%. This is shown in Table 5.3.3. The larger the number of the family members the more labour is available since the family will help in the field. Again the larger the family the more food is required within the family and this will lead to lot of ploughing so as to try and provide enough food for the family. Smaller family is less expensive to maintain unlike the larger families. According to Maxwell (2001) it is not easy to ensure basic needs to households with more than 3 members. As the size of the family increases, more food is required and the more expensive it becomes to maintain the family. This justifies the need for the multipurpose agroforestry trees for poverty alleviation.

Table 5:3: Family size

		Number	Frequency (%	Cumulative Percent
Valid	1-2	2	3.1	3.1
	3-4	7	10.9	14.1
	5-6	17	26.6	40.6
	7+	38	59.4	100.0
	Total	64	100.0	

5.2.4 Educational Status

The educational background of the respondents was assessed in order to identify if there is any correlation to respondents' knowledge and adoption of multipurpose tree species and agroforestry technologies as a poverty alleviation tool. About 40% of the respondents have primary school level of education and 30% of the respondents had never attended school at all. Those with tertiary education level are about 17% and these usually tend to have high knowledge of multipurpose trees. This can be linked to the possibility that they learnt about agroforestry and role of trees in agriculture at school and at college. Those who went up to secondary level were about 16% of the total respondents.

The highest percentage of the respondents is those who never attended school and those who went up to primary level. This shows that the highest percentage of the respondents is not adequately educated. This will lead to a small percentage of farmers adopting agroforestry within the community. Also Level of education helps in understanding the policy and technical inputs on agroforestry thus improving the rate and level of adoption of agroforestry technology. Figure 5.2 below clearly indicates the educational status of the respondents in Thulamela Municipality.

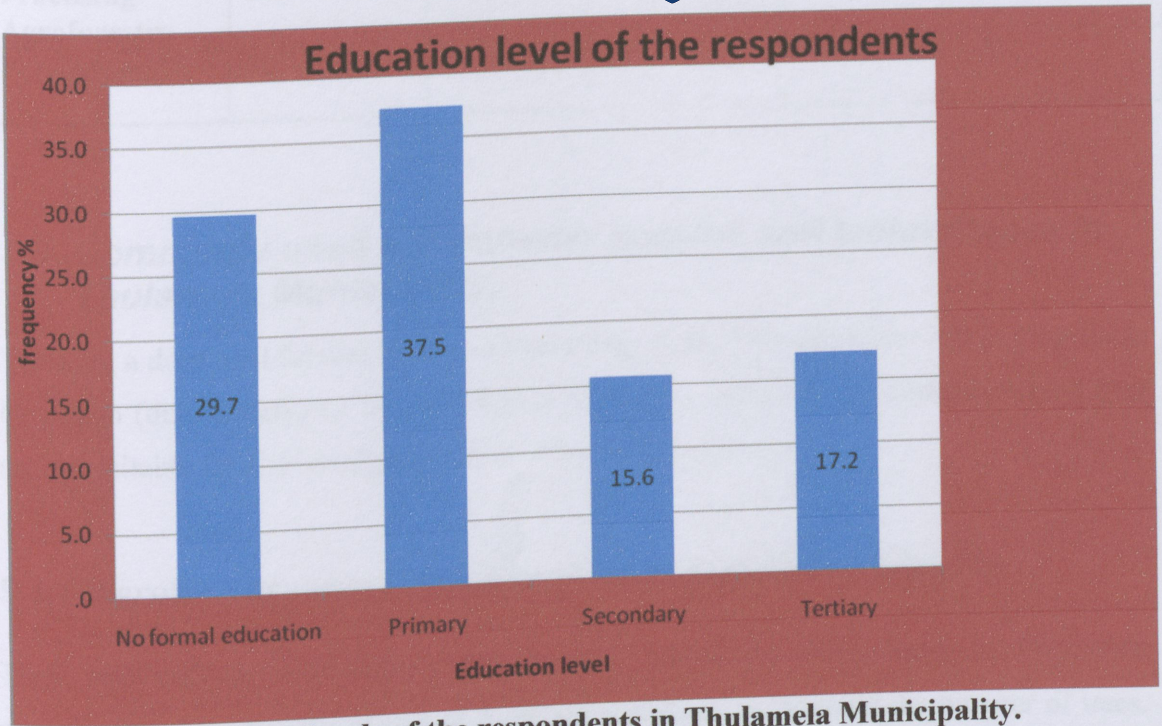


Figure 5:2 Education levels of the respondents in Thulamela Municipality.

According to table 5.4, those who went to school up to primary level are the ones who have adopted agroforestry at most despite the fact that they have less knowledge in general. This is because they would have learnt about the use of multipurpose trees in their field at school and hence they had acquired the knowledge. Also this group of people since it did not further its studies, most likely does not have formal employment and hence they spend most of their time working in the field and undertaking the projects which will be underway in the community. According to table 5.4, those who went to secondary school and tertiary level have adopted agroforestry at lower level (16% and 17% respectively). This is because most people with secondary level and tertiary level education have formal employment hence they don't have enough time to practice agroforestry in their fields. Also these people won't have time with the agricultural and environmental extension workers who teach some of the agroforestry practices to the community since they spent most of their time at work.

Table 5:4: Relationship between Education and adoption of agroforestry.

	Never attended school	Primary level	Secondary level	Tertiary level	Total Respondents

Practising Agroforestry	19	24	10	11	64
Percentage %	30	37	16	17	100

5.3 Commonly used agroforestry species and technologies in Thulamela Municipality.

Trees are a dominant feature in almost every crop field. They are either left in crop fields by design (deliberately) or by default (unknowingly) especially in instances where they are not suitable for firewood purposes or other household uses.

5.3.1 Agroforestry tree species used in Thulamela Municipality

There are various multipurpose tree species which are being used in Thulamela municipality though cultivation and firewood collection is reducing the number of trees. Fruit trees are mostly found in the fields and around homestead. Eucalyptus species are mainly used for poles and wind breaks. Again there are lots of indigenous trees e.g Sclerocarya Berea within the community some of which produce edible fruits whereas those which are not edible are mainly for fuelwood, livestock feed and medicinal purposes. Farmers in the Thulamela area have some basic knowledge of agroforestry practices through the various sources of information at their disposal.

Various soil fertility tree species are known within the Thulamela municipality though they do not exactly plant them. Figure 5.3 shows various tree species which the community believes can improve soil fertility. About 15% of the respondents know leucaena species for increasing the soil fertility. According to Kwesiga *et al* 2003, Sesbania *sesban* and leucaena species have been proved to significantly increase soil fertility. Mangifera *indica* has 9% of the respondents which believe that it increases soil fertility. Cajanus *cajan* and Combretum *microphyllum* are the least known to increase soil fertility and only about 1% of the respondents believe that they increase soil fertility.

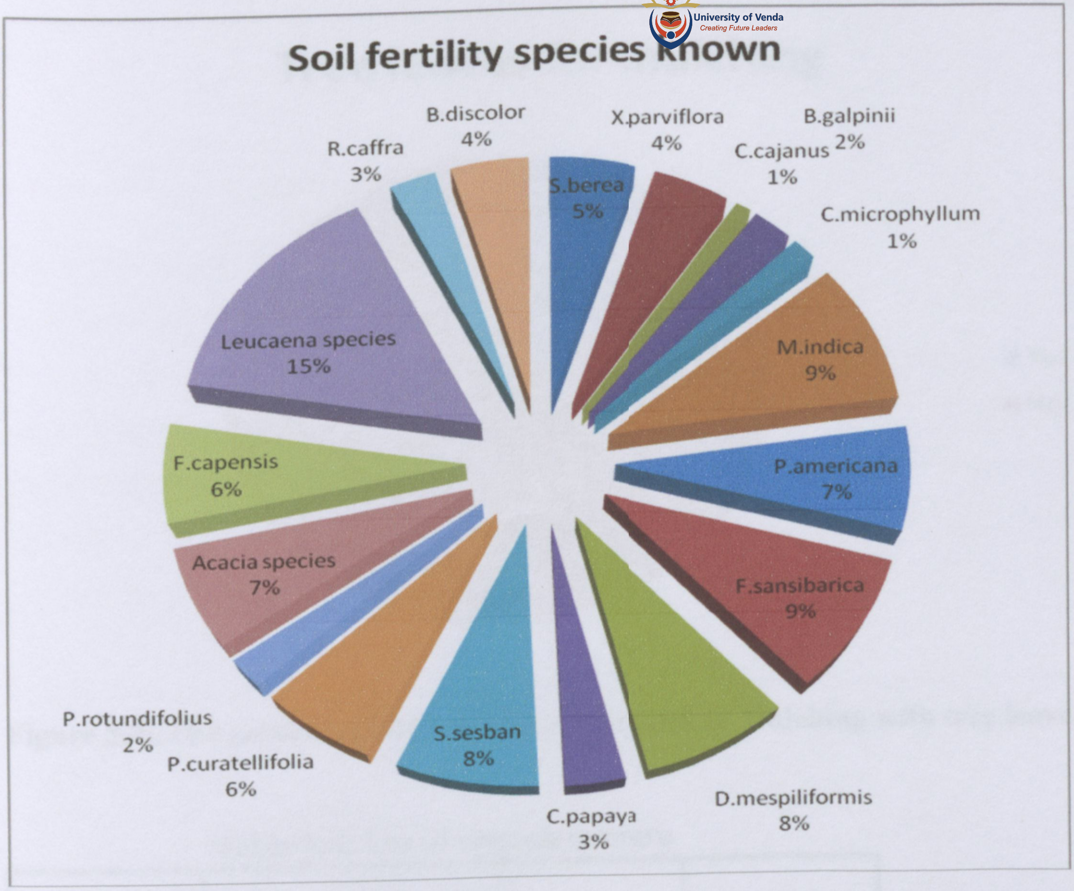


Figure 5:3: Respondents' views on tree species for soil fertility.

Small scale farmers in Thulamela municipality do not usually practise intercropping in their fields using tree species, instead they practise mulching through the use of tree leaves from various off-farm tree species. Figure 5.4 shows the percentages of respondents who are practising the use of tree leaves for mulching in their field. 84% of the respondents are not practising mulching whereas 16% practice mulching. This indicates that many people use chemical fertilizers and compost manure to increase soil fertility in the field as shown by the Table 5.5 and 5.6. Mulching is not a common practice within the Thulamela municipality as shown by figure 5.4 though it's the one being practised more than intercropping.

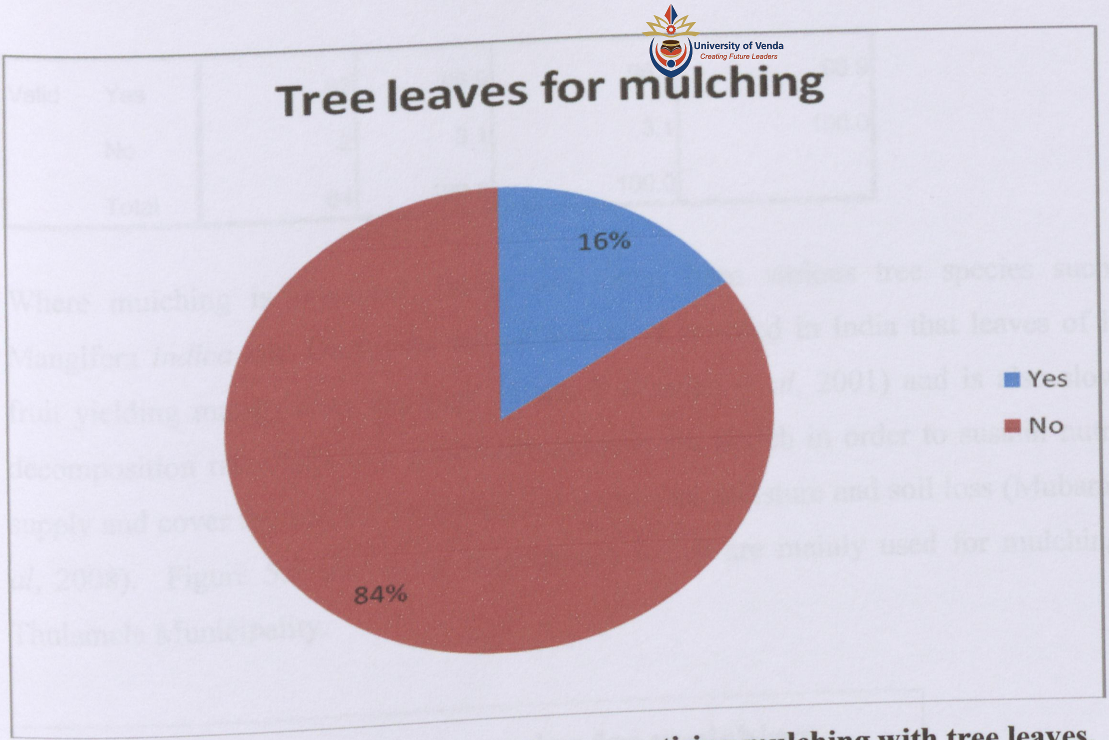


Figure 5:4: The percentage of respondents practising mulching with tree leaves.

Table 5:5: Use of organic manure

		Number	Frequency (%	Valid Percent	Cumulative Percent
Valid	Yes	48	75.0	75.0	75.0
	No	16	25.0	25.0	100.0
	Total	64	100.0	100.0	

Table 5:6: Use of compound fertilizer.

		Number	Frequency (%	Valid Percent	Cumulative Percent
Valid	Yes	63	98.4	98.4	98.4
	No	1	1.6	1.6	100.0
	Total	64	100.0	100.0	

Table 5:7: Use of AN fertilizer.

	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	Yes	62	96.9	96.9	96.9
	No	2	3.1	3.1	100.0
	Total	64	100.0	100.0	

Where mulching is practised, leaves are taken from various tree species such as Mangifera *indica* and Diospyros *mespiliformis.* It is noted in India that leaves of high fruit yielding mango trees has high N and P (Kurian *et al*, 2001) and is also slow in decomposition rate. This is a good characteristic for mulch in order to sustain nutrient supply and cover the soil for longer period to prevent moisture and soil loss (Mubarak *et al*, 2008). Figure 5.5 shows the tree species which are mainly used for mulching in Thulamela Municipality.

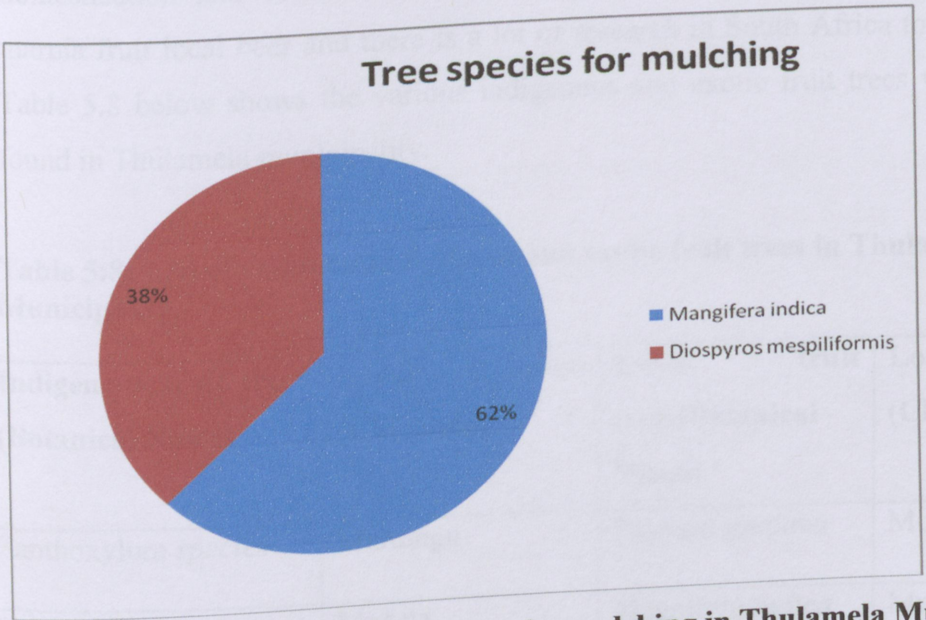


Figure 5:5: Tree species mainly used for mulching in Thulamela Municipality.

5.3.2 Tree species for indigenous and exotic fruits

There are various fruit trees found in Thulamela municipality. Some are exotic trees and others are indigenous.They both produce edible fruits. Most small scale farmers have exotic fruit trees in their homesteads and most of these exotic trees were planted by the farmers and only a few are naturally occuring. Farmers in Thulamela municipality get fruits from both exotic and indigenous trees for sale. Exotic fruits (refer to Table 5.8) are the most common in the municipality. Farmers prefer growing exotic fruits because the trees are easy to establish, grow fast and yield fruits earlier than indigenous fruit trees. Indigenous fruits are gathered from remnants of trees on farmlands or from neighbouring communal or protected natural woodlands. According to some study, yield from natural woodlands is lower than from trees on farmer's lands (Leakey, 2005). There is a need for more research on how to sustain indigenous fruit supplies on farmers lands.

Again a lot of research have been done on many exotic fruits thus leading to improved fruit quality unlike in most of the indigenous trees like Uapaka kirkiana and Adansonia digitata. In Zimbabwe and other Southern African countires, the World Agroforestry Centre (ICRAF) is doing a lot of research on many indigenous trees so as to promote domestication and commercialisation of the indigenous species. Many farmers sell marula fruit local beer and there is a lot of research in South Africa to improve marula. Table 5.8 below shows the various indigenous and exotic fruit trees which are mainly found in Thulamela municipality.

Table 5:8: List of common indigenous and exotic fruit trees in Thulamela Municipality.

Indigenous fruit trees (Botanical Name)	Local Name (Chivenda)	Exotic fruit trees(Botanical Name)	Local Name (Chivenda)
Zanthoxylum *species*	Munungu	Psidium *guajava*	Mugwavha
Sclerocarya *berea*	Mufula	Mangifera *indica*	Munngo
Hexalobus *monopetalus*	Muhuhuma	Citrus *sinensis*	Maswiri
Adansonia *digitata*	Muvhuyu	Carica *papaya*	Mupapawe
Azanza *garckeana*		Persea *americana*	Magadhaperi
Mimusops *zeyheri*	Mumbubulu	Citrus *reticulata*	Munaratshisi

Ficus *capensis*	Muhuyu	Litchi *chinensis*	Nombelo
Ziziphus *mucronata*	Mutshetshete	Morus *nigra*	Muima-vanda
Bequaertiodendron *magalismontanum*	Munombelo		
Gardenia *amoena*	Murombe		
Annona *senegalensis*	Muembe		
Grewia *microthyrsa*	Mupfuka		
Vangueria *infausta*	Muzwilu/Mavelo		
Diospyros *mespiliformis*	Muthala		

5.3.3 Tree species for fodder

Various tree species like Mangifera *indica* are used for feeding livestock in Thulamela municipality. Mainly cattle and goats are sometimes fed with fodder tree leaves though mostly they give them grass and other supplements. Figure 5.6 shows the livestock ownership of farmers in Thulamela municipality. About 53% of the respondents do not own livestock whereas 47% own livestock. However the difference between the two percentages is not so high, indicating the relative importance of livestock to people's livelihood. The introduction of high fodder value multipurpose trees is needed for smallholder farmers especially with goats and sheep. Trees and shrubs have proved to be a useful fodder bank resources in dry lands and if properly managed can significantly contribute to improved food security, income generation and livelihood of smallholder farmers in southern Africa e.g. Zimbabwe (Chakaredza *et al*, 2007). Such experiences need to be extended to other farmers and countries like in South Africa where smallholder farmers have considerable indigenous knowledge as depicted from figure 5.6 but still unaware of the full diversity of species (Table 5.8) and potential of using trees and shrubs as fodder banks. Use of fodder from various tree species would minimize dependence on concentrates which are expensive for smallholder farmers. The main livestock found in the municipality include chicken, goats, pigs, cattle and sheep.

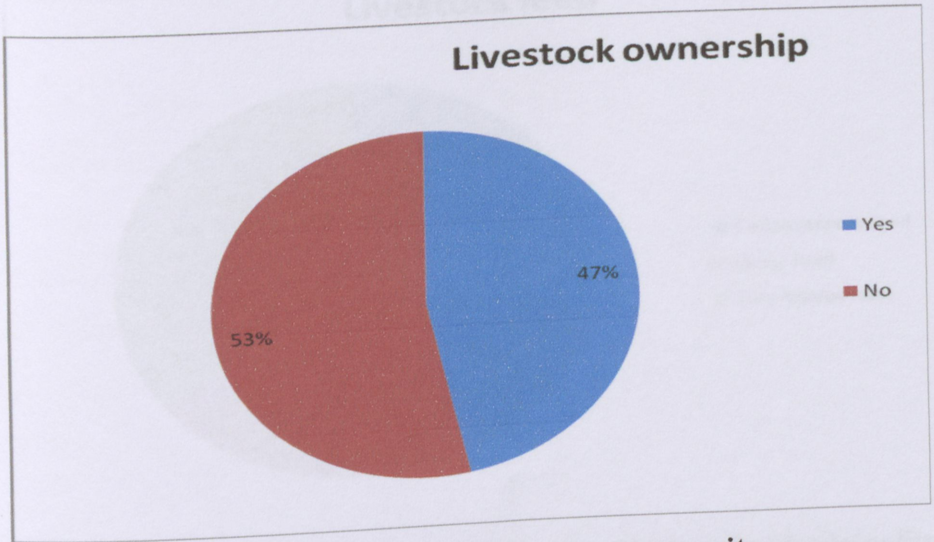


Figure 5:6: Livestock ownership within the community.

Leaves are pruned from the trees and taken into the grazing areas for livestock. Also some livestock can be brought to the areas where there are various tree species and they feed on the fallen leaves. Some of the tree species like Sesbania *sesban* have nutritious tree leaves which can increase the milk production for the dairy cattle. Also these nutritious leaves can keep the livestock strong and healthy. Figure 5.7 shows the livestock feed which is mainly used in Thulamela municipality.

Mainly livestock in the community feed on grass and tree leaves. According to the research findings, about 36% feed on both tree leaves and grass and 28% feed on concentrates. Use of concentrates is not very common because of poverty within the area. Small-scale farmers cannot afford buying the concentrate feed because they are expensive and instead they end up feeding the livestock with tree leaves and grass.

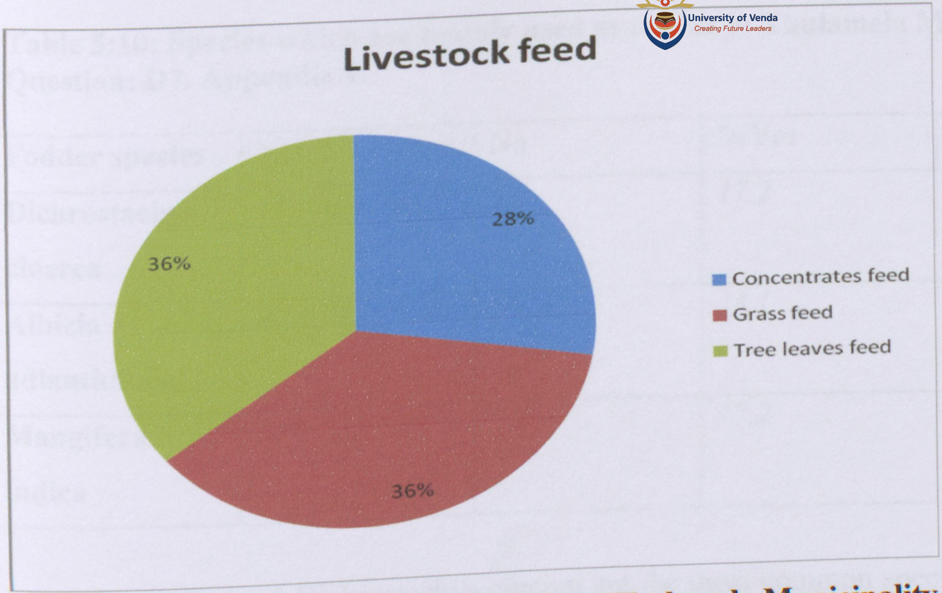


Figure 5:7: The type of feed for livestock in Thulamela Municipality.

In Thulamela municipality use of nutritious fodder species is very low. Livestock just feed from indigenous trees mainly. Again the knowledge of use of leguminous tree species as fodder is inadequate in the municipality. There is poverty within the municipality and the number of people with livestock is low. Some people can't afford buying the livestock. Table 5.9 shows common species known for livestock feed within the municipality.

Table 5:9: Species which are mainly known for fodder within the Thulamela community.

Botanical Name	**Botanical Name**
Dichrostachys cinerea	*Cajan cajanus*
Parinari curatellifolia	*Jatropha curcas*
Albizia adianthifolia	*Grewia microthyrsa*
Sesbania sesban	

The trees which are mainly known for fodder are indigenous trees and Sesbania *sesban* and Cajan *cajanus* are the exotic and leguminous plants which are as well being used as fodder. Table 5.10 shows the respondents who are practising use of tree leaves as fodder.

Table 5:10: Species which are mainly used as fodder in Thulamela Municipality. Question: D7. Appendix 1.

Fodder species	Yes	No	%Yes	%No
Dichrostachys cinerea	*11*	*53*	*17.2*	*82.8*
Albizia adianthifolia	*9*	*55*	*14.1*	*85.9*
Mangifera indica	*11*	*53*	*17.2*	*82.8*

Mangifera *indica* and Dichrostachys *cinerea* are the most common species being used to feed cattle and goats. 17.2% of the respondents are using the two species to feed livestock. These tree species are found in numbers that is why farmers favour them for feeding livestock.

5.3.4 Tree species for live fencing.

Many farmers protect their homesteads and fields from livestock and thieves by using different tree species for fencing and some use barbed wire and grass. In Thulamela municipality, farmers know various species which can be used for fencing the homestead and certain species are used to fence the homesteads. Various species are known for live fencing but practical use of trees as live fencing is not prevalent in the study area. There is little knowledge about the effectiveness of trees as live fencing. Also people in the community have been used to barbed wire as a way of protecting the field. Members of the community find it difficult to find seedlings for tree species which are mainly suitable for live fencing. Table 5.11 shows the tree species known by farmers for live fencing.

Table 5:11: Live fencing species known in the Thulamela community. Question D7: Appendix 1.

Live fencing species (Botanical Name)	% frequency (knowing the species)
Jatropha curcas	*47%*
Dichrostachys cenerea	*31%*
Caesalpinia decapetala	*19%*
Dombeya burgessiae	*12%*
Pine species	*26%*

Those who are practicing use of live fencing are few.

5.3.5 Tree species for windbreaks

Various species are used for windbreak in Thulamela municipality. Mangifera *indica*, Carica *papaya* and pine species has been proved to be the most common species used for windbreak. Mangifera *indica* has been used as a windbreak species because it adds value to the community by providing fruits. This is also the same with Carica *papaya*.

5.4 Agroforestry technologies within theThulamela community.

Agroforestry is the traditional way of growing multi-purpose trees on farms for the benefit of the farm family. Growing trees along with crops and livestock was postulated to enhance crop yields, conserve soil and recycle and conserve nutrients while producing fuelwood, fodder, fruits and timber. Agroforestry technology is used when the tree and crop and/or animal components interact with each other in a mutually beneficial way and have discrete boundaries separating the technology from other practices on a farm.

The agroforestry project was initiated by the South Africa government e.g. Department of Water Affairs and Forestry, Department of Agriculture and Department of Environment. These departments initiated the project because they wanted to reduce pressure on the savanna woodland because farmers were mainly cutting firewood from these. Again people were also competing with the wild animals on the wild fruits so by introducing agroforestry, they were also getting fruits from their homesteads. Again agroforestry was helping in improving soil fertility. Farmers in Thulamela Municipality area have some basic knowledge of agroforestry technologies through the various sources of information. These sources are shown in the figure 5.8.

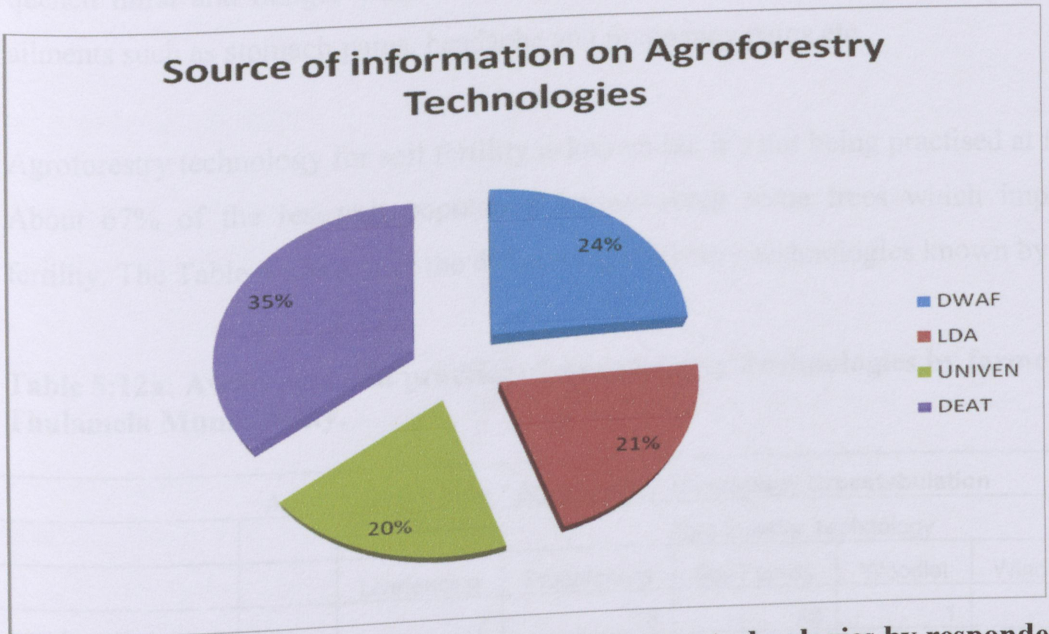


Figure 5:8: Sources of information on agroforestry technologies by respondents in Thulamela Municipality.

According to the research findings, farmers who are aware of agroforestry technologies are mainly getting the information from DEA and DWAF (Figure 5.8). Extension officers of these departments helped to create awareness campaign about agroforestry technologies among farmers. Also University of Venda students and LDA are helping in disseminating the technologies to the community. Farmers were subsequently trained in various agroforestry technologies through meetings, focus group discussions and farm visits. The major agroforestry technology extended to farmers is fruit orchards and woodlots around the homestead and around the fields. These are agroforestry practices used by many farmers within the study area. Woodlots are mainly used for getting poles and firewood and these products are sometimes sold to get income.

According to the research findings, some farmers already had some agroforestry trees deliberately left in their outside homestead plots during land clearing and these mainly included high value indigenous fruit trees such as Parinari *curatellifolia*, Adansonia *digitata*, Sclerocarya *berea*, Ficus species, and other common wild fruit tree species and some trees, shrubs and herbs for medicinal uses. These trees would therefore provide shade in the summer when most agricultural activities are at their peak, edible fruits to quench thirst and hunger while in the fields, teeth cleaning sticks and cure for simple ailments such as stomach pains, headache and pregnancy pains etc.

Agroforestry technology for soil fertility is known but it's not being practised at full force. About 67% of the research population knows about some trees which improve soil fertility. The Table 5.12a shows the different agroforestry technologies known by farmers.

Table 5:12a: Awareness and practice of Agroforestry Technologies by farmers in Thulamela Municipality.

Agroforestry farmer * Agroforestry Technology Crosstabulation								
		Agro forestry Technology						
		Livefencing	Fruitorchard	Soil Fertility	Woodlot	Windbreak	Fodder
Agro forestry farmer	Yes	7	58	43	1	51	50
	No	57	6	21	40	13	14
Total		64	64	64	41	64	64

When asked about awareness and use of agroforestry technologies, the answer showed differences between the farmers who use (Yes) and those who are not aware and do not use (No) agroforestry technologies. As indicated in Table 5.12a differences also occur in the range and the specific type of agroforestry technologies adopted by farmers. It was therefore necessary to establish whether these differences are statistically significant by using the chi-square test.

Table 5.12b: The chi-square test of significant difference between the farmers.

Chi-Square Tests			
	Value	df	Sig. level (p-value)
Pearson Chi-Square	163.510[a]	5	.000
Likelihood Ratio	184.506	5	.000
Linear-by-Linear Association	25.158	1	.000
N of Valid Cases	64		

Note: Null hypotheses: There is no significance difference between farmers who practice and those who do not practice agroforestry technologies in Thulamela Municipality.

The chi-square test was performed at 5 degree of freedom (df), 0.05 critical value and at 0.000 confidence/significant level. The results presented in Table 5.12b shows that the level of significance ($p<0.05$) is less than 0.05. This means the null hypothesis that there is no significance difference between farmers who practice and those who do not practice agroforestry technologies is rejected. The converse hypothesis that there is a significance difference between farmers who practice and those who do not practice agroforestry technologies is therefore accepted.

Indeed table 5.12b shows that live fencing, fruit orchards, soil fertility, woodlots, windbreak and fodder are the agroforestry technologies practised by the farmers. The Table also shows that fruit orchard is the most widely practised (90%), followed by windbreak (80%), fodder (78%), soil fertility (67%) and live fencing (11%). The live fencing is the least known and used hence about 90% indicated No to its use.

As indicated, a chi-square value of 0.05 and below indicates significance difference at a degree of freedom 5. The Table 5.12b indicates a p value of 0.05 and significance level of 0.000. This means there is significance difference between farmers who practice (Yes) and those who do not practice (No) agroforestry technologies cited. The results of this test further mean a farmer can be an agroforestry farmer without practising all the six agroforestry technologies. This finding also leads to a conclusion that Thulamela farmer can be regarded as agroforester and in return Thulamela Municipality can also be regarded as a potential agroforestry area.

5.5 Impact of agroforestry technologies on household food security.

The problem of household food security is not only due to short-term factors such as seasonal drought effects on crops but also due to vicious cycle and long-term impacts of poor deforestation, food supply, availability of fodder and other trees for fruits and other uses for people's livelihood. In many rural areas forests and farm trees play an important role in household food security. Table 5.13 shows the household food security among small scale farmers practising agroforestry.

Agriculture is the cornerstone of the economy in rural areas of Limpopo Province (Nesamvumi *et al*, 2003). The sustainable production of food is the first priority of food production. Sustainable food production through the use of regenerative technologies can lead to poverty alleviation since the technologies will be cheap for production. Also the use of nature conservation based agriculture or farming approaches and technologies can build and enhance the health and diversity of available natural resources without depleting them. Trees can be profitable sources through their use for food, fodder and other useful material; they can help households cope with fluctuations of socio economic and climatic conditions such as periods of long drought spells.

Table 5:13: Household food security between farmers practicing agroforestry and those not practising agroforestry.

Items	Practising Agroforestry	Not Practising Agroforestry
Average maize Income	*R18 000.00/yr/household*	*R2650.00/yr/household*
Average maize sales	*7.043478tonnes/yr/household*	*1.950000tonnes/yr/household*
Average maize yield	*7.48462 tonnes/yr*	*2.19792 tonnes/yr*
Mean household size	*7*	*7*
Cereal	*720kgs*	*720kgs*

requirement/individual/yr (UNICEF)		
Average food requirement per household	*5.040tonnes/household*	*5.040tonnes/household*
Surplus for sale	*2.4406tonnes/household*	*-2.8506*

According to this research findings, the average income made by households practising agroforestry technologies is R18 000 per household size and for those not practising agroforestry is R2650 per household size. This shows that those farmers practicing agroforestry are producing a lot of maize and other crops in their field. Farmers are using tree leaves for fertilizing the soil and also they are getting lot of money from sale of fruits and this will help them to buy fertilizers and other chemicals which are needed to increase crop production thus improving food security and their livelihood. The average tonnes of yield obtained per household practising agroforestry are 7.048. The average cereal requirement of an individual is 0.750kg/yr. Those practising agroforestry have surplus sale of 2.4406tonnes /household of cereals per year. This is because of extra income from various activities which involved selling of poles, fruits and vegetables. This income helps them to pay hired labour for extensive operations. Majority of the families practising agroforestry are having surplus crops for sale and do not depend on food aid thus indicating that majority of the household are meeting their annual food requirement.

Those farmers not practising agroforestry at full scale have mean sales of 1.95t per household and the majority of the household do not meet their annual food requirements by 2.8506 although they generally do not depend on food aid. These farmers obtain their food from relatives in addition to buying from others and from retail shops using money from their children and also money from social grants and other sources of income. Also some of them work in the towns to meet their food requirements.

5.6 *Factors affecting the adoption of agroforestry systems*

This section explores the socio-economic factors that have a potential impact on the adoption of agroforestry. The logistic regression model is used to ascertain the different factors that contribute to the decision to accept or not to accept agroforestry technologies within the community (Nhau and Mano, 2006). The logistic regression has a high prediction and explanatory power (Nhau and Mano, 2006). Table 5.14 shows the likelihood based on the explanatory variables for interviewed farmers to accept and try out the technology.

5.6.1 Practising agroforestry versus non practising agroforestry

Farmers who are participating actively in agroforestry have integrated multi-purpose trees in their fields. They have partly adopted the technology and are considered agroforestry practitioners. Sesbania *sesban*, leuacaena species and Jatropha *carcus* are some of the common agroforestry tree species in Thulamela municipality. Technology adoption is the decision made by farmers to use agroforestry technologies. Some researchers have defined adoption as the degree of use of a technology in the long run when the farmers have all the information about the technology and its potential (ICRAF, 1997).

5.6.2 Dependent variable defined

The dependent variable is participation or non participation in agroforestry and is in this research treated as a dichotomous variable. Farmers who have planted the agroforestry species in their fields are considered as participants and those who have not as non-participants.

5.6.3 Independent variables defined

Independent variable has impact on the dependent variables or it is variables that are likely to influence dependent variables. The specified model below shows all the independent variables statistically selected to be included in the model. This section explores the justification of including such variables and their anticipated relationship to the dependent variable. The odds ratio (exp B) is used to determine the adoption of agroforestry within the community.

5.6.4 The logistic regression model for practising agroforestry

A farmer's decision to participate in agroforestry is influenced by a number of factors all of which contribute both positively and negatively to the final outcome of the decision making process. These factors are the socio-economic characteristics such as educational level, age, household size, land ownership, gender, marital status, hectares of the field, livestock ownership, labour, food requirement, agricultural and environmental training among other factors. The identified binary model will be employed both to ascertain the relevance of inclusion of the identified explanatory variables and to precisely show their effects on participation or non participation in the agroforestry practices. Table 5.13 shows the results of the regression model.

The logistic model is specified as $\log\ participtn = a + \sum_{i=1}^{11} bxi$

Where;

participtn = *practising agroforestry or non practising agroforestry in the field*

α = *constant*

x_1 = *marital status of household head*

x_2 = *education level*

x_3 = *food requirement of the family*

x_4 = *ownership of livestock*

x_5 = *agriculture/environmental training*

x_6 = *household size (family labour)*

x_7 = *ownership of land*

x_8 = *plot size in hectares*

x_9 = *gender of household head*

x_{10} = *age of household head*

x_{11} = *labour*

Table 5:14: The logistic regression model for factors contributing to the adoption of agroforestry systems.

Variable	B	S.E	Sig	Exp (B)
Constant	*-0.1453*	*1.1745*	*0.9016*	
Gender	*-0.3049*	*0.4433*	*0.2142*	*0.7372*
Marital Status	*-0.7890*	*1.3048*	*0.5454*	*0.4543*
Age	*-0.5575*	*0.4433*	*0.2086*	*0.5726*
Education	*3.1738**	*0.9640*	*0.001*	*23.8985*
Household size	*0.2721***	*0.1527*	*0.045*	*3.444*
Ownership of land	*0.1707***	*0.0849*	*0.0444*	*1.1862*
Hectares of field	*2.576**	*14162*	*0.000*	*0.076*
Ownership of livestock	*-0.1322*	*0.1283*	*0.303*	*0.8762*
Labour	*0.1821***	*0.0758*	*0.0164*	*1.1997*
Food requirements	*-43.889*	*0.000*	*0.997*	*0.000*
Agriculture/Environmental training	*-1.7402***	*0.7526*	*0.0208*	*0.1755*
Log likelihood *59.328* Goodness of fit *64.6*				

*** indicates Significant at 5% probability and * indicates the significant at 1% probability.*

The Table 5.14 summarizes the logistic regression results for the survey data with the explanatory variable that have impact on adoption of agroforestry. From the above table it can be seen that adoption of agroforestry is likely to increase with education, household size (family size), and ownership of land, labour and land size of the field being the effective variables. These variables are the most significant variables which are differentiating between the adoption of agroforestry and non adoption of agroforestry. Educated small holder farmers have significant difference in adopting the agroforestry technologies since knowledgeable farmers are well informed and as such their participation in the agroforestry project is based on its perceived merits. Smallholder farmers with the appreciation of the benefits of agroforestry technology are the ones who are adopting the technologies of agroforestry.

The larger the family sizes the better the availability of labour for agricultural activities. There will be no need for hiring in of labour thereby reducing variable costs and overall returns will be higher. A 1% increase in labour and 3% in household size will increase the odds (Exp B) likelihood of participating in agroforestry and likewise a percentage increase will increase the likelihood that the given household will participate in any agroforestry technology.

Ownership of land is significant in affecting the adoption of the agroforestry technologies in Thulamela municipality. From the odds given by exp (B), ownership of land is 1.18% times more likely to be effective in influencing adoption of agroforestry technology. Smallholder famers who own the land are more likely to be involved in different agroforestry projects and they can grow trees and invest a lot on their land because they will be having certainty that they will be on the same piece of land in years to come hence they can grow long term trees.

Household size and labour are also significant in influencing the adoption of agroforestry technology and this is also shown by the table 5.14. Where there are many people in the family, there will be increased labour. This can lead to the adoption of the technology since many hands will be helping in the field and also different ideas will be brought into the family plans. According to the research findings, Agriculture/Environment training is significant at 5% but with a negative influence on the adoption of agroforestry. This indicates that the likelihood of adoption of agroforestry decreases with an increase in agriculture/environment training. This is expected because as households acquire more agriculture/environment training they tend to go and work in organisations which utilize agriculture or environment training thus leaving the farms. Also since they will be educated they will be having other options or advanced systems which might not include use of trees. According to the research findings in table 5.14 gender, marital status, age, and ownership of livestock and food requirements were not significant in affecting the adoption of agroforestry technology and also were negatively related in affecting the adoption.

The use of maximum likelihood estimation requires interpretation and use of a number of measures of goodness of fit since each of the measure has its own shortcomings. As shown in the table 5.14, Log likelihood shows that 59.3% of the variation adopting or non adopting agroforestry technologies are explained by the included explanatory variables and showing that the test is fit. According to the research findings, the Goodness of fit of 64.6 implies that the model was effective at predicting factors affecting adoption and non adoption of agroforestry technologies.

This shows that for farmers to fully appreciate and adopt a technology they should at least be well versed with the technology in terms of its advantages and disadvantages among other factors. Therefore there are different factors that contribute to the adoption of agroforestry technologies in Thulamela. Level of education, land ownership, household size, labour and agricultural or environmental training were all significant in explaining the observed participation or non participation in practising agroforestry.

5.7 Agroforestry technologies for poverty alleviation.

Agroforestry technologies can reduce poverty directly by providing fuelwood, fruit and nuts and livestock fodder all of which can be sold to generate income or fulfils basic family needs (Kwesiga *et al*, 2003). Farmers in Thulamela municipality are aware of various benefits which are produced by practising agroforestry. The benefits mainly known by farmers in Thulamela municipality are shown in the table 5:15.

Table 5:15: Agroforestry benefits known by Thulamela smallholder farmers.

Benefits
Provide fuel wood
Provide fruits
Bring income through selling of fruits and

vegetables
Provide fodder for livestock
Improve livelihood through providing food supplements like fruits
Provide timber
Provide shade
Increase soil fertility

Agroforestry has the potential to reduce rural poverty and food insecurity if it's extensively practised (Kwesiga *et al*, 2003). Many agroforestry tree species have multiple uses, each providing a range of benefits that can be used for alleviating poverty. Sustainable reduction of global poverty is among the critical global challenges of the 21st century. The sustainable production of food is the first pillar of food production. The sustainable production through the use of regenerative technologies can lead to poverty alleviation (World Bank, 2004). In many countries like Zimbabwe, forests and farm trees play an important role in household food security. In Zimbabwe farmers practising agroforestry produce a lot of maize and other cereals unlike those not practising and they are food secure (Chakaredza *et al*, 2007). Figure 5.9 shows the percentage of farmers who are aware that agroforestry can alleviate poverty.

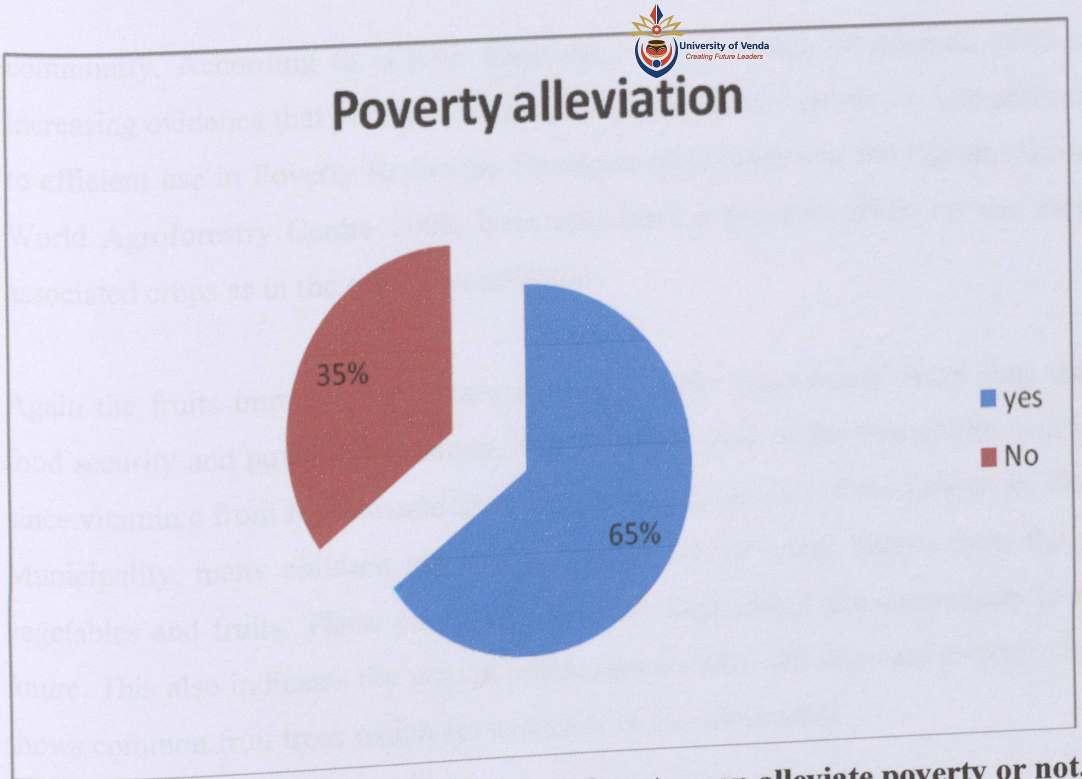


Figure 5:9: Farmers who know that agroforestry can alleviate poverty or not.

About 65% of the farmers are aware that agroforestry can alleviate poverty and about 35% don't know that agroforestry can alleviate poverty. Some of the smallholder farmers are practising the agroforestry technologies but they don't have a full idea that it can alleviate poverty. Many extension farmers are needed within the municipality and these need to educate the famers on the full importance of agroforestry.

5.7.1 Fruit trees for poverty alleviation.

Trees on farms and in landscapes can make significant contribution to the interlinked problems of poverty, low agricultural activity and deterioration of the environment (ICRAF East and Central Africa Programme, 2003). According to the research results in Table 5.12, fruit orchards are found in every farm and they are a symbol of adoption of agroforestry in Thulamela municipality. Fruit trees are found in every household and species like Mangifera *indica* and avocado are very common. Most of these fruit trees produce a high yield of fruits and such smallholder famers tend to sell these fruits in the markets or streets. By selling fruits, these farmers get income and that income can be used for various things in the household thus alleviating poverty within the family and community. According to ICRAF East and Central Africa Programme 2003, there is increasing evidence that potential for agroforestry to reduce poverty is real and can be put to efficient use in Poverty Reduction Strategies of countries in the region. According to World Agroforestry Centre 2009, trees may have a positive effect on the incomes of associated crops as in the case of windbreaks.

Again the fruits improve the dietary diversity of the households' level thus enhancing food security and poverty alleviation. The nutrition level of the households will improve since vitamin c from fruits would have been added in the diet of the family. In Thulamela Municipality, many children are being taken to school using money from the sales of vegetables and fruits. Those educated pupil will then enrich the community in the near future. This also indicates the way in which agroforestry can alleviate poverty. Table 5.8 shows common fruit trees which are available in the community.

5.7.2 Soil fertility for poverty alleviation

Enhanced soil fertility results in increased yield of crops due to the residual effect of the soil fertility enhancing trees. In Thulamela municipality, households tend to apply less fertilizer to a plot which previously was an improved fallow. This results in less cash outflow to buy fertilizers which can be used to purchase food stuff. According to the research results, in Thulamela Municipality many farmers they use tree leaves for mulching and these will increase the nutritious value of the soil thus increasing the yield in the field. Intercropping is not really being practised in full force instead trees are mainly being used for windbreak and shade if they are to be in the field. Mangifera *indica* and Diospyros *mespiliformis* are some of the common tree species which are used for mulching in the study area. This is shown in figure 5.5 above.

5.7.3 Live fencing, woodlots and fodder for poverty alleviation.

A household does not need cash to purchase barbed wires and poles but rather time to plant live fence. This also results in saved cash which can be used for other things. Agroforestry technologies can contribute to improving the livelihood of 60% of

Tanzania's resource- poor households (Policy Brief, 2009). Agroforestry is a powerful tool for tackling emerging local and global challenges. Also it can improve crop and livestock production by providing relatively less costly, more affordable and locally available inputs for fodder and soil amendments to the smallholder farmer.

5.8 *Poverty in Thulamela municipality.*

Poverty is the state of being without resources, often associated with need, hardship and lack of resources across a wide range of circumstances (Wikipedia, 2007). Respondents in Thulamela municipality were asked to provide information on their employment status and monthly income so as to detect if the standard of living and/or adoption of agroforestry technologies can be associated with their employment status. Again this will help in assessing the percentage of people who will be vulnerable to poverty and therefore dependent on agroforestry for resources and income.

5.8.1 Employment status

In Thulamela municipality those who are employed work in different organisations like mines, shops, government departments and other formal jobs. Those who are self employed usually do crafts, carpentry and other related works with which they get income. Those who are not employed at all, they get income from their children who will be formally employed and also some get social grants from the government.

Figure 5.10 shows that 18.8% of the respondents are employed, 28.1 are self employed and 53.1% are not employed. The highest percentage is of those who are not employed showing that they are vulnerable to poverty. The unemployed and self employed are therefore likely to rely on the lifestyle that is cheap and to depend directly on the natural resources like trees as their most reliable source of living. This group needs to use cheap ways like use of manure and leaves to increase soil fertility and to feed livestock. Also 28.1% are self employed and some of them are even involved in the selling of fruits as a full time job.

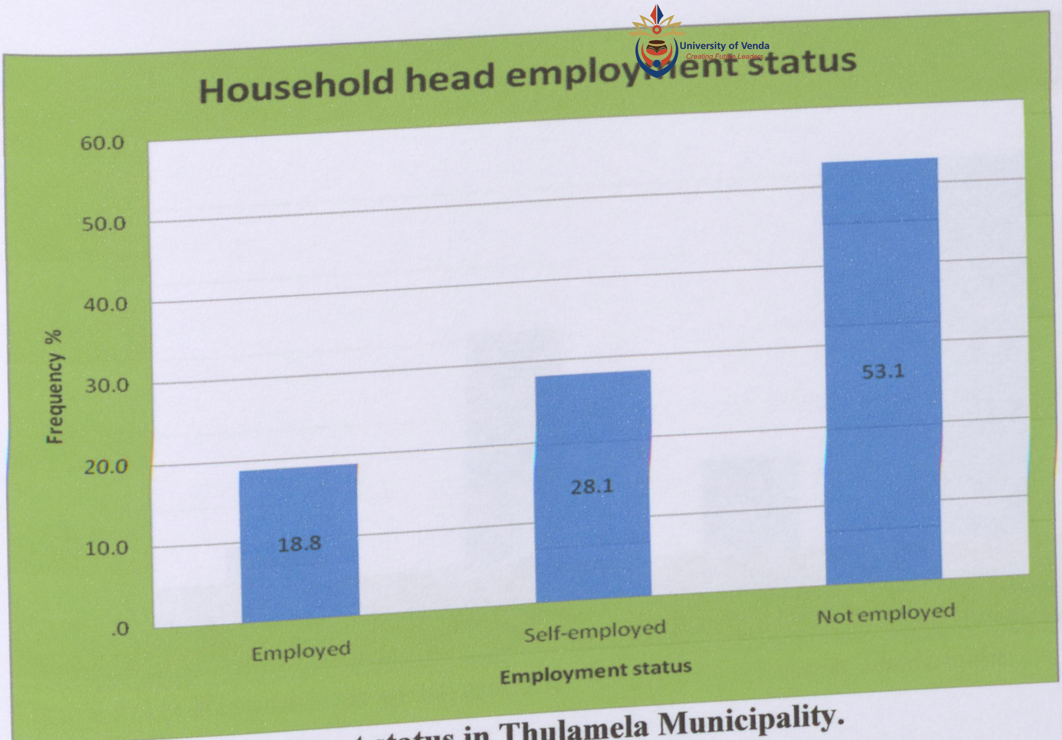


Figure 5:10: employment status in Thulamela Municipality.

5.8.2 Respondents monthly income

The respondents' monthly income was assessed in order to generally determine the state of their vulnerability to poverty. Its monthly income was also assessed in relation to their access to households' basic needs such as food and energy. Figure 5.11 shows the respondents' monthly income in Thulamela municipality.

Data in figure 5.11 shows that 51.6% of the respondents are not earning anything and it's the largest group and as such they are likely to be vulnerable to poverty and could engage themselves into activities such as selling of fruits to earn a living and cutting down trees as a source of energy in order to meet their basic needs thus posing the problem of environmental degradation.

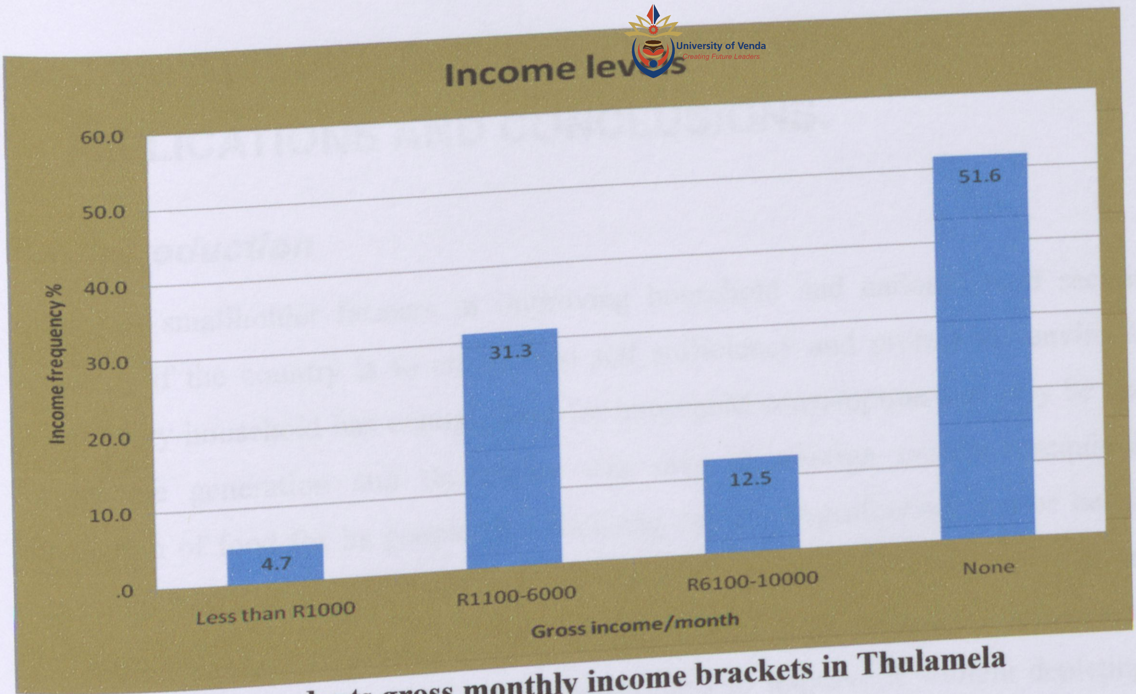


Figure 5:11: Respondents gross monthly income brackets in Thulamela Municipality.

6 CHAPTER SIX: RECOMMENDATIONS, POLICY IMPLICATIONS AND CONCLUSIONS.

6.1 Introduction

Efforts of smallholder farmers in improving household and national food security is necessary if the country is to attain food self sufficiency and protect the environment. When every household has enough food for household consumption and may be surplus for income generation and the nation can save on foreign currency required for importation of food for its people thus reducing poverty. Agroforestry can be helpful in improving food security to poor farmers since it can provide cheap and sustainable alternative ways of using the land and feeding livestock. Smallholder farming systems need support from a wide spectrum of stakeholders to improve it without depleting the environment. The support should come from groups such as extension agents, subsidies and also to benefit from input support schemes by local and International Non Governmental Organisations. The main thrust of this study was to assess the contribution of agroforestry technologies to poverty alleviation. Socio-economic impacts on the well being of the smallholder famer's household were also analysed.

Agroforestry has been sidelined as a traditional farming practice in favour of more advanced options such as heavy reliance on inorganic chemical fertilizers all of which are expensive to smallholder farmers and have adverse effects on the environment. Recently it has become a bone of contention within many stakeholders since researchers are trying to come up with agricultural options that are environmentally friendly and can contribute to conservation of forests at the same time alleviating poverty. Agroforestry has therefore been the major option especially for smallholder farmers. Adoption of agroforestry technologies will result concomitantly in improved yields, nutrition, reduced soil loss through erosion, improved scenery, health and overall food security hence reduction in poverty among the smallholder community. This chapter provides an overview of the analyses and results in the preceding chapters and discussion of the major findings in a detailed way. It will also present an elaborate analysis of the major policy implications.

6.2 Recommendations and policy implications

- The agroforestry systems are affected by lack of support services ranging from extension to provision of credit and inputs (like seeds). This study therefore recommends that relevant public institutions such as Department of Agriculture should strive to improve the provision of agricultural knowledge, either through training and extension or through supply of inputs and incentives. Also water shortages have been cited as one of the constraints in taking up agroforestry together with seeds shortage. Government needs to increase water points in Thulamela by introducing more borehole points where farmers can obtain water easily. The government should turn an open eye towards small- scale agriculture as it reduces the burden of importing additional food to feed the rural population as there would be food secure at the household level.

- There is need for the local and international organisations whether government owned or donor agencies to explore fully and educate the smallholder farmers on the merits and demerits of agroforestry both on their small plots and overally on the environment.

- Exotic fruit tree species are very common with small holder famers and yet there are various multipurpose indigenous fruit trees in the area. There is need to promote domestication of indigenous trees and to educate the community on the importance of conserving our indigenous trees. These indigenous trees are also multipurpose and can be used for various things like health issues.

- Policies should promote fertilizer trees and other integrated soil fertility management approaches in order to make the most efficient use of fertilizer trees and getting rid of mineral fertilizers that degrade the environment.

- The government should implement the national agroforestry strategy and target scaling up the technology in full force.

- Provide more agroforestry technology training opportunities to government agriculture extension staff so that they will help to provide latest information on the technologies and scale them up to communities.

- Government should support agroforestry products for markets and even commercialize them within the region and this will encourage farmers to be involved in use of trees for poverty alleviation.

6.3 Areas for further research

Agroforestry in smallholder farming systems of South Africa has not been well documented in literature. Researchers in Africa have focused much of their attention to countries like Tanzania, Kenya, Malawi, Zambia and Zimbabwe. It has been significantly proven in this study that agroforestry has great potential in improving the livelihoods of households and also other researchers in other countries have proved it but its extent has not been explored fully in Limpopo province. It will be much more beneficial if there would be a further analysis of the impacts of the research on the soil fertility and fruit production with the smallholder farmers and also the best strategy to improve farmer adoption of agroforestry in Thulamela municipality.

Agroforestry technologies have been proven successful on monitored research stations and also farmer trials and farmer field schools in other countries and this need to be introduced in Thulamela municipality. Also agroforestry need to be investigated in urban areas if it's also contributing to household food security. Again agroforestry need to be investigated as an environmental reclamation aspect by monitoring soil fertility enhancement and their impacts on the livelihoods of a number of farmers. There is need for some further research into the smallholder farming systems and how agroforestry can be incorporated smoothly without constraints on the scarce land, water and seeds.

The study can be broadened by focusing on an evaluation of the comparative advantages between the urban and rural farming environments to assess the compatibility aspects of the agroforestry systems in the two settings. The adoption patterns can also be assessed for the urban and rural farmers and the results will enrich the body of knowledge on these systems and also helps in alleviating poverty.

6.4 Conclusion

This study seeks to give answers to questions arising from the first hypothesis that: ***Thulamela Municipality has unique socio-economic conditions which need specific agroforestry species and technologies.*** Testing of this hypothesis involved a detailed analysis of the socio economic factors like education level, age and gender, family size, employment status and monthly income. The community is poor and this was indicated by the 53.1% of the respondents who are unemployed. According to the findings, about 51.6% of the respondents do not earn any salary. These people mainly depend on selling fruits and vegetables. Some even sale poles and firewood to other people within the area. These items sold are products of agroforestry.

The community uses various tree species within the community and these species are indicated on Table 5.8. Specific agroforestry technologies had been accepted and these were influenced by the socio economic conditions of the area. According to the research findings, Thulamela Municipality practise agroforestry but not on full force. Only those who are aware of the benefits of agroforestry were proved to be the one practising agroforestry. Those who do not practise agroforestry were siting shortage of water, space, little knowledge and other resources. Government departments which are disseminating the technology to the community are not doing it at full force. DWAF is said to be the main government department which provide extension services to the community.

According to the research findings, fruit orchards are one of the agroforestry technologies which are practised at large in the Thulamela municipality. The fruit trees mainly grown are the exotic trees and this is because the extension officers in the area are promoting growing of fruit trees more than any other trees. Also the exotic fruit trees have immediate benefits unlike any other trees so they are appreciated fast. Again there is ready market for the fruits. Farmers who are having livestock are mainly the ones utilizing fodder banks. These farmers feed their livestock with the indigenous trees together with exotic fruit trees. But this technology of fodder bank is well appreciated in Thulamela municipality by small holder farmers who possess livestock. Again even those farmers who are having livestock, some of them proved not to know about the technology.

Also smallholder famers are ignorant of practising the agroforestry technologies at full force because there is little knowledge about the benefits it produces and some farmers are reluctant in practising the technologies. Technologies such as use of trees for live fencing are the least accepted agroforestry technology. Most common agroforestry technology known by farmers is fruit tree production since they are a characteristic feature of most homesteads. There is significant difference in agroforestry knowledge between the farmers participating in agroforestry and those not participating in agroforestry.

Therefore having seen all these possibilities and statistics, we accept the null hypothesis indicating that Thulamela Municipality has unique socio-economic conditions which need specific agroforestry species and technologies. Socio-economic conditions like family size, unemployment and education are some of the socio economic conditions which influence the agroforestry species and technologies being used in Thulamela Municipality.

The second hypothesis of the study was that: ***Existing agroforestry technologies contribute significantly to household food security.*** Food security is the condition in which all have access to sufficient food to live healthy and productive lives (World Bank, 1986). Food security is dependent on agricultural production, food imports and donations, employment opportunities and income earnings, intra-household decision-making and resource allocation, health care utilization and caring practices (Maxwell and Frankenberger, 1992). The sustainable production of food is the first priority of food production. Sustainable food production through the use of regenerative technologies can lead to poverty alleviation. Again use of nature conservation based agriculture or farming approaches and technologies can build and enhance the health and diversity of available natural resources without depleting them. In many countries like Zimbabwe, forests and farm trees play an important role in household food security. According to the research findings, farmers practising agroforestry produce a lot of maize and other cereals unlike those not practising agroforestry. The average tonnes of yield obtained per household practising agroforestry are 7.048tonnes/yr compared to 2.198tonnes/yr for non-practising agroforestry farmers. The average cereal requirement of an individual is 0.750kg/yr. Those practising agroforestry are having surplus of 2.446 tonnes / household of cereals per year. This was because there was a lot of income coming from various activities which involved selling of poles, fruits and vegetables. Tree leaves are being used for manure and soil fertility in the fields. This improves the productivity of the land. Again they get a lot of money from selling fruits and this help them to have income for buying fertilizers and chemicals which are needed to increase production thus improving food security and livelihood.

According to the results of the research, those practising agroforestry are also having surplus for sale and they do not depend on food aid thus indicating that the majority of the households can meet their annual food requirement. Households that have access to better income opportunities are less likely to become food insecure than those households who have no or little access.

Therefore existing agroforestry technologies contribute significantly to household food security indicating that we accept the null hypotheses. This is indicated by the smallness of the p-value ($p<0.05$).

The third hypothesis of the study was that: ***Different factors contribute to adoption of agroforestry technologies in Thulamela municipality.*** This focused on the major factors that affect the adoption of agroforestry between the two groups of farmers. The results of the logistic regression have shown that adoption of agroforestry is likely to increase with education, household size (family size), and ownership of land and labour being the effective variables. These variables are significant variables differentiating between the adoption of agroforestry and non adoption of agroforestry. The larger the family size, the better the availability of labour for agriculture activities. Agroforestry is a labour – intensive practice, only 1% increase in labour and 3% in household size will increase the odds (Exp B likelihood of participating in agroforestry. Gender, marital status, age, ownership of livestock and food requirements were not significant in affecting the adoption of agroforestry technologies and were negatively related in affecting the adoption. Farmers to fully appreciate and adopt a technology, they should at least be well versed with the technology in terms of its advantages and disadvantages among other factors.

After looking at all the possible factors which might affect adoption, the conclusion is that different factors contribute to the adoption of agroforestry technologies in Thulamela Municipality therefore we accept the null hypotheses considering that the p value is small.

The final hypothesis of the study was that: ***A strategy can be developed for poverty alleviation through agroforestry technologies.*** According to the research findings, 51.6% of the respondents no source of income and are not employed and it's the largest group and as such they are likely to be vulnerable to poverty. They engage themselves into activities such as selling of fruits to earn a living and cutting down trees as a source of energy in order to meet their basic needs thus posing the problem of environmental degradation. The results of the research shows that 18.8% of the respondents are employed, 28.1 self employed while 53.1% are not employed. The highest percentage is of those who are not employed showing that they are vulnerable to poverty. They are therefore likely to rely on the lifestyle that is cheap and to depend directly on the natural resources like trees as their most reliable source of livelihood. This group needs to use cheap ways like use of manure and leaves to increase soil fertility and to feed livestock. The 28.1% who are self employed are often involved in the selling of fruits as a full time job.

In Thulamela municipality, households tend to apply less fertilizer to a plot which previously was an improved fallow. This results in less cash outflow to buy fertilizers which can be used to purchase food stuff. According to the research results, in Thulamela Municipality many farmers use tree leaves for mulching and these will increase the nutritious value of the soil thus increasing the yield in the field. Intercropping is not really being practised in full force instead trees are mainly used for windbreak and shade if they are to be in the field. Mangifera *indica* and Diospyros *mespiliformis* are some of the common tree species which are used for mulching in the study area.

According to the research results fruit orchards are found in every farm and they are a symbol of adoption of agroforestry in Thulamela municipality. Fruit trees are found in every household and species like Mangifera *indica* and avocado are very common. Most of these fruit trees produce a high yield of fruits and such smallholder famers tend to sell these fruits in the markets or streets. By selling fruits, these farmers get income and that income can be used for various things in the household thus alleviating poverty within the family and community.

Therefore we accept the null hypotheses and conclude that a strategy can be developed for poverty alleviation through use of agroforestry technologies.

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8 APPENDICES

8.1 Appendix 1: Questionnaire

AN ASSESSMENT OF THE CONTRIBUTION OF AGROFORESTRY TECHNOLOGIES TO POVERTY ALLEVIATION IN THULAMELA MUNICIPALITY

Name of enumerator…………………………………………………………………………

Area (District and village)……………………………………………………………………

Date ………………………………………………………………………………………

Section A: Demographic profile

A1. Household Head status……………………………………………………………

1. Male 2.female 3. Child- headed

A2. Position in the family …………… 1.Father 2. Mother 3. Son 4. Daughter

5. Other (specify)

A3. Marital Status…………………………………………………………………………

1. married 2. single 3. divorced 4. widowed 5. other (specify)

A4. Age of household head………………………………………………………………

A5. Household Head's level of education………………………………

1. Never attended 2.Primary 3. Secondary 4. Tertiary

A6. Size of household……………………………………………………

A7. Type of ownership of land use………………………………………………

1. Owned 2. Rented 3. Institutional 4. Other (specify)……………

Section B: small scale farming and Food Security Issues

B1. Do you have a field/garden/plantation? 1. Yes 2. No (tick where appropriate)

B2. How many acres/ha do you have?………………………………………………

B3 What is the distance of the field/garden/plantation from the house (m)?

B5 What are the current major crops grown on the field/garden/plantation?

B6.Do you have livestock ? 1.Yes 2.No

B7. If yes name them………………………………………………………………

B8. What do you use to feed the livestock?..

B9. Where do you get labour?

B10.How much does labour cost?

B11. Do you use the following inputs in your plots?

Input	Use: 1.Yes 2. No
(a) Hybrid seed	
(b) Retained seed	
(c) Organic manure	
(d) A.N Fertilisers	
(e) Compound Fertilisers	
(f) Pesticides	
(g) Herbicides	
(h) other (specify)	

B12. What were your yields for the past 2 seasons **(yields from fields)?**

Crop	**Yields**	
	2007/08 / unit area	**2008 /09 /unit area**
(a)		
(b)		
(c)		
(d)		
(e)		

B13. Are you meeting your food requirements through farming? 1. Yes 2. No

B14. Do you get some food from donors? 1. Yes 2. No

B15. Did you produce any surplus crops/livestock for sale this year?

1. Yes 2. No

b. Complete the table below.

Crop/Livestock	**Quantity sold**	**Price (specify units)**	**Market**	**Total Income**

(a)				
(b)				
(c)				
(d)				

B16. What are your major sources of food? (Tick)

1. Own production in fields and purchases from retail markets
2. support by donors
3. Retail markets only
4. Purchase from other farmers and retail markets
5. Get handouts from government and purchase from retail markets
6. Get grain donations from relatives and purchase from retail markets
7. Other (specify)

Section C: Household Income

C1. Household head Employment status

1. Employed 2. Self-employed 3. None

C2. Gross Salary per month as at December 2007 (tick the applicable)

1. Less than R1000 2. R2000- 6000 3. R7000-10000 4. Above R10000

C3. What are your other sources of income?(Rank from highest to lowest)
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………

Section D: Agro forestry

D1. Do you have any agriculture/ environmental training? 1. Yes 2. No

D2. What level of agricultural training do you possess?

1. O'level 2. Certificate 3. Diploma 4. Graduate 5. Master farmer

D3. Have you ever received any agricultural or environmental extension services from any source? 1. Yes 2. No

D4. What is the source?

…………………………………………………………………………………

D5. Have you ever heard about growing trees together with crops on the same field?

i) yes ii) no

(ii) If yes state source of information……………………………………………

……………………………………………………………………………………

D6. If yes is it helpful in combating poverty within the family and how?

D7. What are the types of multi-purpose trees that you know and use, **name them**?

a. soil fertility enhancing trees …………………………………………
b. indigenous and exotic fruit trees…………………………………………..
c. fodder trees…………………………………………………………………
d. live fences…………………………………………………………………..
e. Fuelwood…………………………………………………………………
f. Other (specify)……………………………………………………………

D8. Which of the farming practices with trees are you practicing in your field and name trees?

Tree Practices	**Yes/No**	**Tree name**
Trees on fallow fields		
Trees for windbreaks		
Trees around homestead		
Trees as live fences		
Trees for fruits		
Trees to provide leaves for mulching		
Trees for fodder to livestock		
Trees for woodlots		
Trees for fruits		

D9. What are the other uses/benefits of trees you know?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

………………………

D10. Does having trees in the field/garden/homestead have a significant impact on your social life?

D11. If yes, how?

D12. What agroforestry technologies do you know and their benefits?

D13. Do you have any problem in getting seeds, seedlings and other inputs ?

D14. How many trees on your farmland are falling in following category?

Category	Number	Species
Planted		
Naturally occuring		

D15. Are you able or expecting to increase planting more trees? Yes…..

Why?...No…

Why………………………………………………………………………

D16. List incentives that led or are motivating you to adopt/continue use of agroforestry Technology.

Agroforestry Technology	Incentive/motivation

D17. List the items on which you spend the revenue generated from this agroforestry practice (in decreasing order of priority).

Item	Amount spent (Rand)	Other source
Build house		
Education for myself		
Education for kids		
Buy fertilizers and other inputs for agriculture		
Pay electricity or other energy sources		
Purchase car		
Purchase clothes		
Pay on medical services		
Going for holidays		

D18. Do you belong to any group or cooperative which deals with trees? 1. Yes 2.No

D19. If yes what is the name of the organization?.......................................

D20. What kind of support do you get from DWAF and other institutions/ stakeholders concerning agroforestry?

Support from DWAF	**Support from other institutions/ stakeholders**

D21. Do you know other organizations which are helping in agroforestry? 1. Yes 2.No

D22.If yes name them…………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

D23.What do you think should be done to promote use of trees within the community?

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

D24. Are you aware that agroforestry can be helpful in alleviating poverty? 1.Yes 2.No

D25. If yes how?……………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

END

8.2 Appendix 2: Variables in the equation

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Gender(1)	-126.470	28741.710	.000	1	.996	.000
	Marital			.000	3	1.000	
	Marital(1)	-10.255	42643.726	.000	1	1.000	.000
	Marital(2)	19.669	49654.453	.000	1	1.000	3.486E8
	Marital(3)	-83.357	36150.932	.000	1	.998	.000
	Age	8.385	11612.446	.000	1	.999	4381.693
	Education			.000	3	1.000	
	Education(1)	75.596	49673.986	.000	1	.999	6.773E32
	Education(2)	-43.153	55806.394	.000	1	.999	.000
	Education(3)	-5.499	19992.657	.000	1	1.000	.004
	Sizehshold	24.500	4108.767	.000	1	.995	4.368E10
	Ownership(1)	-5.018	27119.423	.000	1	1.000	.007
	Hectares	-43.749	5294.582	.000	1	.993	.000
	Familylabour(1)	-134.957	39795.561	.000	1	.997	.000
	Heademployment			.000	2	1.000	
	Heademployment(1)	-147.049	77035.064	.000	1	.998	.000
	Heademployment(2)	-99.430	68205.667	.000	1	.999	.000
	Salary@December			.000	3	1.000	
	Salary@December(1)	85.080	63957.200	.000	1	.999	8.905E36
	Salary@December(2)	170.915	56093.984	.000	1	.998	1.689E74
	Salary@December(3)	73.772	43918.642	.000	1	.999	1.093E32
	Sellinfruitsource(1)	59.165	29394.386	.000	1	.998	4.954E25
	Traininglevel			.000	4	1.000	
	Traininglevel(1)	103.478	32208.041	.000	1	.997	8.704E44
	Traininglevel(2)	24.581	47205.571	.000	1	1.000	4.737E10
	Traininglevel(3)	126.066	26369.793	.000	1	.996	5.621E54

	Traininglevel(4)	36.586	6946.865	.000	1	.996	7.746E15
	Agrictraining(1)	-144.582	13512.919	.000	1	.991	.000
	Livestock(1)	-43.802	5719.704	.000	1	.994	.000
	Foodreq(1)	-7.994	12475.648	.000	1	.999	.000
	Constant	158.599	69216.308	.000	1	.998	7.561E68

a. Variable(s) entered on step 1: Gender, Marital, Age, Education, Sizehshold, Ownership, Hectares, Familylabour, Heademployment, Salary@December, Sellinfruitsource, Traininglevel, Agrictraining, Livestock, Foodreq.

Correlations

		Age of household head	Tree which were planted on farmland
Age of household head	Pearson Correlation	1	-.108
	Sig. (2-tailed)		.398
	N	64	64
Tree which were planted on farmland	Pearson Correlation	-.108	1
	Sig. (2-tailed)	.398	
	N	64	64