The Relationship between Agroforestry and Ecosystem Services: Role of Agroforestry in Rural Communities

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Declaration

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Abstract

Rural livelihoods are affected by numerous factors (poverty, unemployment, lack of adequate education, basic infrastructure, and food security), but poverty is the most critical. As poverty in South African is rooted in unemployment, communities adjacent to forest plantations and natural resources, are highly depended on these natural resources to sustain their livelihoods.

Agroforestry systems have addressed the problem of poverty worldwide and have been designed specifically for rural development. These systems are efficient in terms of resource use, but are also economically and environmentally friendly. Therefore, this study identified agroforestry systems that might improve sustainable rural development in communities adjacent to the plantations of Komatiland Forests.

The study was conducted in Limpopo, KwaZulu-Natal and Mpumalanga provinces of South Africa where the plantations of Komatiland Forests are located. Data for the study was collected between June and July 2015 through questionnaire surveys of 30 randomly selected households in two communities per province to determine and evaluate ecosystem services utilised in the six communities.

Results indicated high levels of unemployment, large family sizes, income levels not adequate to sustain household sizes, water scarcity and silvopasture as the main agroforestry system practiced in the plantations of Komatiland Forests. Although agroforestry has been practiced by a limited number of households, communities are interested in it as an alternative way to increase food security. Future agroforestry interventions by Komatiland Forests should thus rather focus on agrosilvicutural systems than silvopastural systems.

Opsomming

Landelike gemeenskappe word deur verskeie faktore beïnvloed (armoede, werkloosheid, gebrek aan voldoende opleiding, basiese infrastruktuur en kos sekuriteit) met armoede as die mees kritiese faktor. Aangesien armoede in Suid Afrika verband hou met werkloosheid, is gemeenskappe langs bosbouplantasies en natuurlike hulpbronne meer afhanklik daarvan vir daaglikste oorlewing.

Agrobosbou sisteme kan verskeie probleme ten opsigte van armoede wêreldwyd aangespreek en is dit ook spesiaal ontwerp vir landelike ontwikkeling. Hierdie sisteme is effektief deurdat dit volhoubare natuurlike hulpbron gebruik aanmoedig, asook ekonomies en hulpbron vriendelik is. Daarom het hierdie studie ‘n paar agrobosbou sisteme geïndetifiseer wat kan help met die volhoubare bestuur van landelike onwikkeling langs bosbouplantasies van Komatiland Forests.

Hierdie studie is uitgevoer in die Limpopo, KwaZulu-Natal en Mpumalanga provinsies van Suid Afrika, waar Komatiland Forests plantasies geleë is. Data was ingevorder gedurende Junie en Julie 2015 deur middel van vraelyste in 30 ewekansig geselekteerde huishoudings. Twee gemeenskappe per provinsie was ingesluit in die studie om ekosisteem produkte en dienste wat gebruik word te identifiseer en te evalueer.

Resultate dui op hoë vlakke van werksloosheid, groot families, inkomste nie voldoende vir die grootte huishoudings, water skaarste asook silvopasture as die hoof agrobosbou sisteem wat beoefen word in die plantasies van Komatiland Forests. Alhoewel agrobosbou slegs deur ‘n beperkte aantal huishoudings beoefen word, is gemeenskappe daarin geïnteresseerd as alternatiewe manier om voedsel te bekom. Toekomstige agrobosbou projekte van Komatiland Forests sal dus eerder moet fokus op agrosilvicultural as silvopastural sisteme.

Acknowledgements

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I am grateful to have a wonderful, caring and outstanding mother, Mashudu Patricia Tahulela. Your support, guidance, teachings and prayers have made me who I am today (Malachi 50:10, Joel 2:25, Deuteronomy 28:1-4).

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Above all I am thankful unto the Almighty God for His plans in my life, wisdom and knowledge throughout and for the favour that chases me down everywhere I go (Matthew 6:8; Isiah 3:2, James 1:2-4).

Dedications

I would like to dedicate this study to my one and only late brother **Dakalo Tshikwatamba** and my late granny **Tshinakaho Tahulela**.

‘Would have loved to share the joy of this success with you but everything is in God’s hands and whatever he does is perfect’

Matthew 21:42

It is indeed God’s work

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List of Acronyms

CWP – Community Women Project

ED - Enterprise Development

EDR – Economic Dependency Ratio

ES - Ecosystem Services

JCF - Joint Community Forum

KLF – Komatiland Forests

KZN – KwaZulu-Natal

L – Limpopo

M - Mpumalanga

PDR – Population Dependency Ratio

PES – Payment for Ecosystem Services

SA - South Africa

SAFCOL - South African Forestry Company Limited

SED - Social Economic Development

Chapter 1: Introduction

1.1. Background

Agroforestry is defined as “a collective name for land use systems and technologies in which woody perennials are deliberately combined on the same land management unit with herbaceous crops and or animals” (Nair et al. 2008). It is distinguished from other systems as an intentional practice of integrating crops, trees and or animals on a single unit of land where the physical and biological interactions between components are intensively managed (Missouri Centre of Agroforestry 2013; Tewari 2008).

Agroforestry systems can be categorized according to structural, functional, socio-economic and ecological basis (Figure 1) and include silvopastoral, agrisilvopastoral and agrisilvicultural systems, which are temporally or spatially arranged. Based on the socio-economic criteria of production, it is grouped as commercial, intermediate and subsistence agroforestry systems. These practices are designed to suit different environmental conditions from humid/sub-humid to, arid/semi-arid or highlands, and have both protective (soil conservation, wind breaks etc.) and productive functions (food, fuel wood, fodder, water etc.) (Missouri Centre of Agroforestry 2013; Tewari 2008).

While agroforestry has been adopted in many African countries it is not well integrated into South African agriculture and forestry development initiatives. The White Paper on Sustainable Forestry Development (RSA, 1997) groups agroforestry with farm forestry and village plantings under the concept of Community Forestry. Community forestry is defined as “forestry designed and applied to meet local social, household, and environmental needs and to favour local economic development. It is implemented by communities or with the participation of communities and includes farm forestry, agroforestry, community or village planting, woodlots and woodland management by rural people, as well as tree planting in urban and peri-urban areas” (RSA 1997). Within the definition of community forestry it is thus possible to define agroforestry as the combination of trees and other crops in ways that will promote socio-economic development.

It is, however, also important to consider that the practices/technologies of agroforestry have the potential to compliment ecosystem services (ES). The Millennium Assessment (2005) classifies ES into provisioning, regulating, supporting and cultural services. Agroforestry systems have the capacity to render provisioning, regulating and supporting services (Dhanya et al. 2014; Kenny et al. 2011), while receiving beneficial ES from other ecosystems such as pollination by insects. ES from non-agroforestry land may also be impacted by agroforestry practices (Kragt and Robertson 2014; Dale and Polasky 2007).

The recognition of the interaction between agroforestry systems and ES brought about a view of agroforestry as a holistic combination of trees and other land uses in the landscape. The shift is linked to land use pressure in rural environments. Rural areas face challenges in obtaining basic needs such as food, fuel, water, and shelter (Leakey et al. 2005). The integration of trees, crops and or animals in the agricultural land is seen as a broad sense of multiple land use and stratified production in space and time (Howes and Rummery 1978) that will improve livelihoods in rural communities.

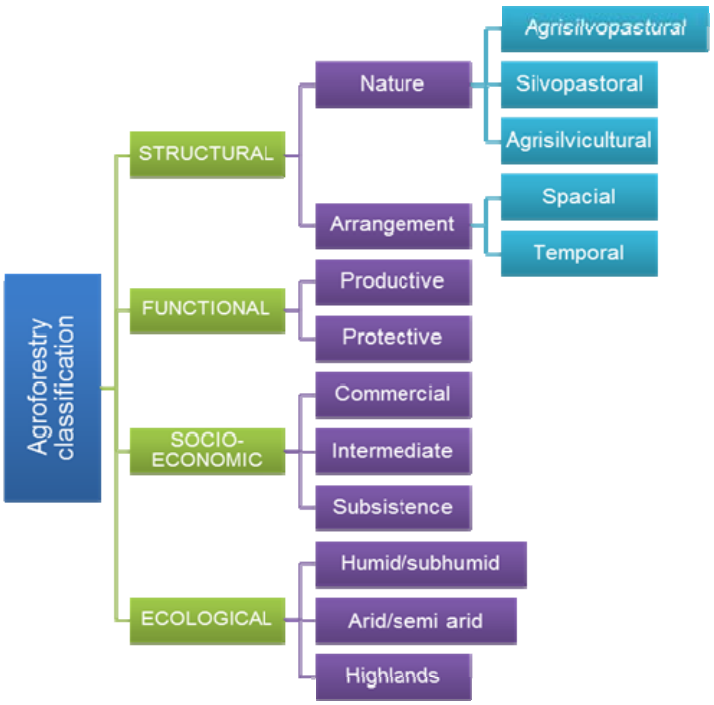


Figure 1: Agroforestry classification adapted from Tewari (2008).

If agroforestry is considered as the purposeful integration of trees and crops in the landscape to enhance ecosystem services, it could align closely to conservation agriculture and land restoration (Scherr et al. 2012; Milder et al. 2011). The question remains how this practice can be adopted to simulate social and economic development of communities living in close proximity to Komatiland Forests (KLF) plantations in South Africa (SA) while reducing ES pressure.

1.2. Problem statement

There is increasing pressure on South African plantations to consider the needs of adjacent communities. This is due to the fact that most plantations are situated around rural areas where communities have restricted resources, poor education and high unemployment (Montagnini and Nair 2004; Pandey 2002). These communities place pressure on natural resources as they seek basic services such as food, fodder, fuel, and water to improve their livelihoods (Mander 2012; Engel et al. 2008).

In areas where communities have lodged claims against forestry land there is also expectations of employment, economic development and new business. Forestry companies will have to consider future land claimants as business partners and consider ways and means of involving them in their day to day actions (Ham et al. 2010). A possible option could be to consider the development of agroforestry systems that can supplement basic needs and serve as vehicles for business development. These systems should be seen as complimentary to the normal commercial forestry operations.

1.3. Research objectives

1.3.1. General objective

The main objective of the study is to identify agroforestry practices that will advance sustainable rural development.

1.3.2. Specific objectives

Specific objectives of this study include:

- To identify key ES that benefit local communities in close proximity to KLF plantations.
- To assess local communities' perceptions, awareness and expectations on agroforestry systems that can enhance ES.
- To review background information on agroforestry projects conducted by KLF in the past.
- To recommend agroforestry systems that could be implemented in future.

1.4. Research questions

In order to achieve the specific objectives listed above, the following questions were addressed:

1. Which ES are used by local communities adjacent to KLF plantations?
2. Which agroforestry systems have been used by KLF in the pass and how successful were these systems?
3. Which agroforestry systems will be best to support ecosystem use and stimulate social and economic development?

1.5. Research methodology

1.5.1. Selection of study site

Study sites in the Limpopo; Mpumalanga and KwaZulu-Natal provinces were identified. Two communities were selected in consultation with KLF in each province, Tshakhuma Maungani (referred to as Maungani throughout the document) and Vondo in Limpopo; Tsakani and Oshoek in Mpumalanga; and Mooiplaas and Ntendeka in KwaZulu-Natal province. Factors such as conflicts and land claims were considered in the selection of these communities.

1.5.2. Data collection

Both primary (data collected by researcher) and secondary were used (Tran Thi Ut 2013; Hox and Boeije 2005) from the following sources:

- **Secondary data sources**

Secondary data formed the basis for theoretical and conceptual frameworks of the study. The relevant literature from existing studies, reports, relevant websites, and district records on agriculture and poverty were reviewed (Andrews et al. 2012; Onwuegbuzie et al. 2012).

- **Primary data sources**

Primary data was collected through the use of questionnaires, semi-structured interviews and transect walks. Primary data formed the basis for explanations, generalizations, conclusions and recommendations for the study (Dudwick et al. 2006).

1.6. Main contributions of the study

This study and its development bring together participatory forest management with the implementation of agroforestry in the areas around KLF plantations. The research will be helpful to KLF and the communities around which KLF plantations are based. The results of the study will be used to develop agroforestry based recommendations that could potentially raise the standard of living and the quality of the rural life. Equally important future implementation could provide jobs for unskilled and unemployed workers and increase the supply of: fuel wood for domestic use, small timber for rural housing and fodder for livestock. It can also help to create recreational forests for the benefit of rural and urban population.

Chapter 2: Literature review

Forests are linked to rural poverty due to the fact that most rural people residing close to the forests are dependent on forest services (Sundelin and Ba 2005).

2.1. Poverty and forests

Poverty has been defined as “a pronounced deprivation of well-being related to lack of material income or consumption, low levels of education and health, vulnerability and exposure to risk, no opportunity to be heard and powerlessness” (World Bank 2001). Social factors such as education and health are considered in addressing poverty since it is not only a matter of low income. Internal and external factors create, influence and maintain poverty in rural areas. These factors include large and rapidly growing families with high dependency ratios; inadequate physical infrastructure such as roads, electricity and water supply systems; and undefined property rights or unfair enforcement of rights to agricultural land and natural resources (Jaizary et al. 1992). The link between poverty and ecosystem degradation resulting in rural livelihood degradation is illustrated in Figure 2.

As a result of poverty, rural communities tend to use forests for food, timber, fruits, fodder and medicinal plants. Thus as rural communities depend on forests, it places pressure on forests which, when enforced by human activities (fuel gathering, overgrazing, agricultural expansion and human induced fire), contributes to deforestation and degradation of forests (Kissinger et al. 2012; Pandey 2002). This is even worse in situations where forest use is not monitored or controlled (Pouliot et al. 2012; Somorin 2010; Shackleton 2004).

Deforestation also has environmental, social and economic impacts. Environmentally deforestation contributes towards climate change, biodiversity loss, soil erosion, and watershed degradation. From a socio-economic perspective, deforestation leads to the destruction of traditional lifestyles and loss of economic opportunities when ecological services related to for instance fisheries protection and irrigation systems are negatively impacted upon (Festus 2012).

Continuous use of forest resources without limit and overconsumption leads to scarcity of available resources and unavailability for future use (Sharma1992). The key behind degradation of biodiversity and ES is that ES are not always captured in commercial markets nor quantified (Büscher and Büscher 2011).

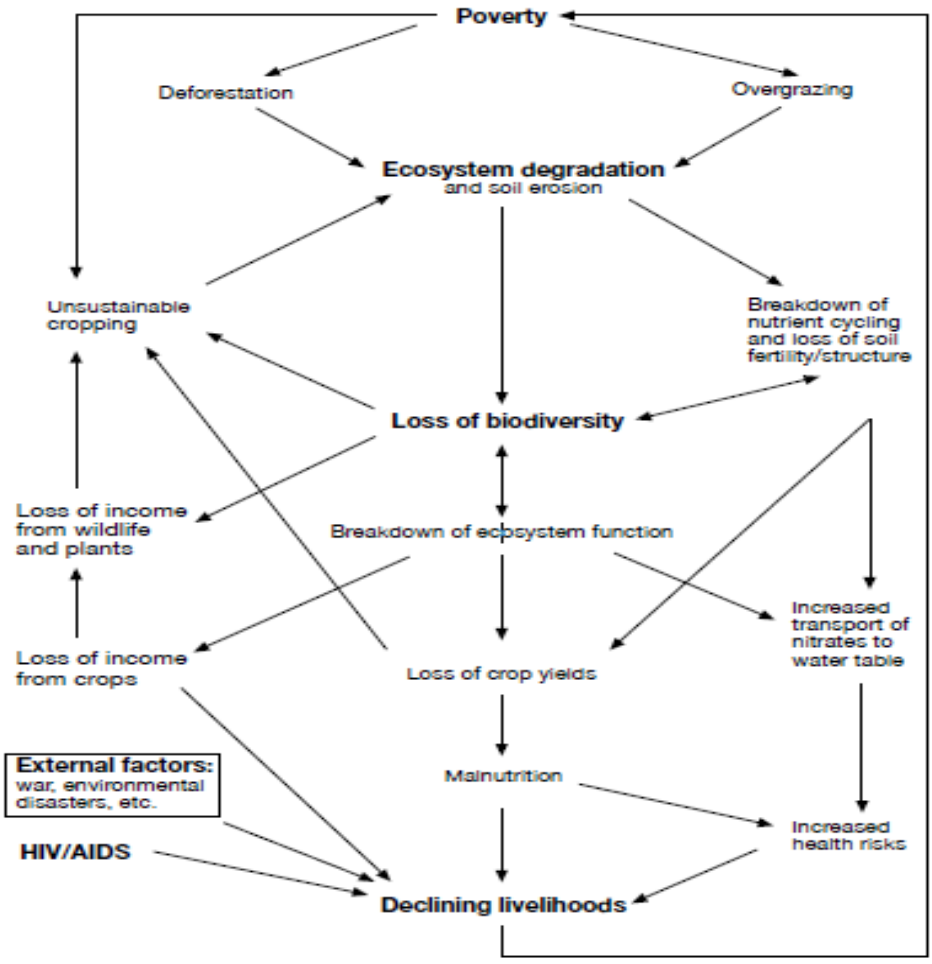


Figure 2: The cycle of biological and socio economic process causing ecosystem degradation (Leakey et al. 2006).

2.2. Forests and rural livelihood

Forests provide a wide variety of services, such as timber, fuel wood, fruits, fodder, and medicinal plants on which rural communities depend (Gregerson et al. 1995; Hall 2008; Imboden et al. 2010; Kenny et al. 2011), it serves as a source of food security for both people and livestock, as well as income generation (Mulenga et al. 2012; Jumbe et al. 2003) for improving living standards. Generally the link between forestry and poverty is described as (Sunderlin and Ba 2004):

- A cause and effect relationships between the transformation of rural livelihoods and dramatic changes in forest cover because they occupy shared geographical space and have occurred in roughly the same time period.
- Rural areas are largely dependent on goods and services from forests for their sustenance.
- Rural people have derived great benefit through employment, conversion of timber and other forest products into income and capital.

2.3. Functions of forests

While forests play an important role in supporting rural livelihoods (Mulenga et al. 2012), it also provides large scale services to society. Some of these services to both environment and humankind are carbon sequestration and storage, water protection, biodiversity protection, and land scape beauty (Wunder 2005).

2.3.1. Carbon sequestration and storage

Global climate change and forests are linked through the sequestration of carbon by forests (IPCC 2007). Forests sequester and store carbon below and above ground (Jose 2009; Montagnini and Nair 2004) reducing the amount of greenhouse gases emitted to the atmosphere (van Kooten 2009). Climate change directly affects forests through changes in atmospheric carbon dioxide, and indirectly through complex interactions in forest ecosystems. It will in future have a bigger impact on forest productivity, health, structure and functioning since the long lifespan of trees does not allow for rapid adaption to environmental changes (Lindner et al. 2010; Ray 2008).

2.3.2. Watershed protection

Trees maintain the regulation of water quality and quantity of water runoff. They prevent runoff especially on steep slopes, can intercept groundwater movement and prevent water-logging and salinity down slope (Postel and Thompson 2005; Gregerson et al. 1995; Gosselink et al. 1990). As water is essential in an ecosystem for growth; provisioning services are shaped by water flows (Boelee 2011).

2.3.3. Biodiversity

Forest diversity enhances landscape beauty, and save habitat for species that live in different environmental systems. The diversity is moreover useful in preventing soil erosion and water run-off; maintaining the chemical balance of soil, air and water; vital to watershed protection and plays a major role in climate regulation (Imboden et al. 2010; Hall 2008; Gregerson et al. 1995).

2.3.4. Landscape beauty

Forest biodiversity contributes to the landscape's beauty, which is enhanced by trees, fruits, and different colours of flowers which attract people to forest areas for relaxation, photography, birdwatching, hiking, cycling, picnicking and fishing (Mander 2012; Gregerson et al 1995). Through this people are encouraged to live healthy, have active lifestyles and also improve mental well-being by connecting with nature (Smith 2010). It must also be noted that the nature of the ecosystem and conditions of the ecosystem in the landscape shapes human beliefs, culture, values and knowledge systems in rural communities (Tengberg et al. 2012). Some of the cultural services in forest areas include spiritual enhancement, emotional and social development, and maintenance of cultural heritage (Daniel et al. 2012; Tengberg et al. 2012; McAdam et al. 2009).

2.4. Rural development through forestry

Deforestation and biodiversity degradation have led to a major shift in forest resource management. The shift favours a people oriented approach known as community forestry or participatory forestry (Islam et al. 2011). This approach aims at improving socio-economic conditions of participating communities, protect and advance the right of healthy environment, promote equitable access and sustainable use of benefits of forest resources as well as sustainable development of forestlands (Pulhin et al. 2007).

Agroforestry is one such a people oriented approach to forestry and rural development. It has the potential to reduce pressure from forests, thus decreased access to forest resources at local level; reduce poverty in rural communities, and

increasing the range of available resources in communities (Mbow et al. 2014, Sebukyu and Mosango 2012, Quandt 2010, Kalaba et al. 2013).

Agroforestry seeks to address the following challenges (World Agroforestry Centre 2013):

- **Livelihood improvement by reducing**:
    - Poverty
    - Hunger
    - Inequity (rights, gender, negotiation, recognition, access)
    - Malnutrition and human health
    - Energy scarcity

- **Landscape improvement by reducing:**
    - Land degradation
    - Climate change
    - Deforestation and habitat loss
    - Water scarcity
    - Biodiversity loss.

Agroforestry practices have the capability to sustain ES, food production and biodiversity (Schroth and McNeely 2011). The practices are categorised into traditional and innovative or modern land use systems where trees are managed together with crops and or animals. Traditional practices include home gardens, composite swidden system/ shifting cultivation while innovative systems include alley cropping, wind breaks and shelter belts, and taungya systems (National Agroforestry Policy 2014; Missouri Centre of Agroforestry 2013; Tewari 2008). Possible agroforestry systems and practices are summarised in Table1.

Table 1: Agroforestry systems with possible agroforestry practices (Nair 1993)

Agroforestry systems	Agroforestry practices
Agrisilvicultural system	Home gardens Alley cropping Shelter belts and windbreaks Multipurpose trees
Silvopastural system	Trees on rangeland or pastures Protein banks Plantation with pastures and animals
Agrosilvopastural system	Home gardens with animals Multipurpose woody hedgerows Aqua forestry Multipurpose woodlands

Below ground interactions associated with resource use and above ground interactions associated with light interception (Ong and Leakey 1999) develop positive ecological interactions between elements of agroforestry systems. These interactions provide a range of short and long term ecological, environmental, social, and economic benefits (British Columbia 2010; Angima 2009).

Vegetation, especially trees, could be very vulnerable to land use change (Bishaw and Abdelkadir 2003); however the diversity of species in agroforestry systems creates a more resilience system. Such a system is able to face impacts of climate change related to climatic variability, drought, floods, and frost which reduce crop yield (Moench 2005).

Agroforestry is more supportive to biodiversity than mono-crops (McNeely and Schroth 2006). It retains native biodiversity and contributes to conservation of threatened ecosystems and organisms (Schroth and McNeely 2011). Studies done by Smith (2010); Jose (2009) and McNeely and Schroth (2006) documents five major roles of agroforestry in conserving biodiversity:

- Provide habitat for species that tolerate certain level of disturbance;
- Help preserve germplasm of sensitive species;

- Help reduce the rate of conversion of natural habitat by providing a more productive, sustainable alternative to traditional agricultural systems that may involve clearing natural habitats;
- Provide connectivity by creating corridors between habitat remnants which may support the integrity of these remnants and the conservation of area-sensitive floral and faunal species; and
- Helps conserve biological diversity by providing other ecosystem services such as erosion control and water recharge, thereby preventing the degradation and loss of surrounding habitat.

2.5. Link between ecosystem services and forestry

Ecosystems are composed of living and non-living organisms which affect each other's functioning in the system. The more components in the ecosystem, the more biodiversity which allows for more provisioning of ES (Jain 2005). Changes in an ecosystem such as land cover, erosion and or chemical usage affect provisioning of services from both agricultural land and non-agricultural land (Baral et al. 2014). It is therefore important to understand how ecological systems work under different conditions and management regimes such as hunting, harvesting and fire (Pastur et al. 2012; Dale & Polasky 2007). The integrated framework of components that influence productivity/benefits (goods and services) obtained in a system is illustrated Figure 3.

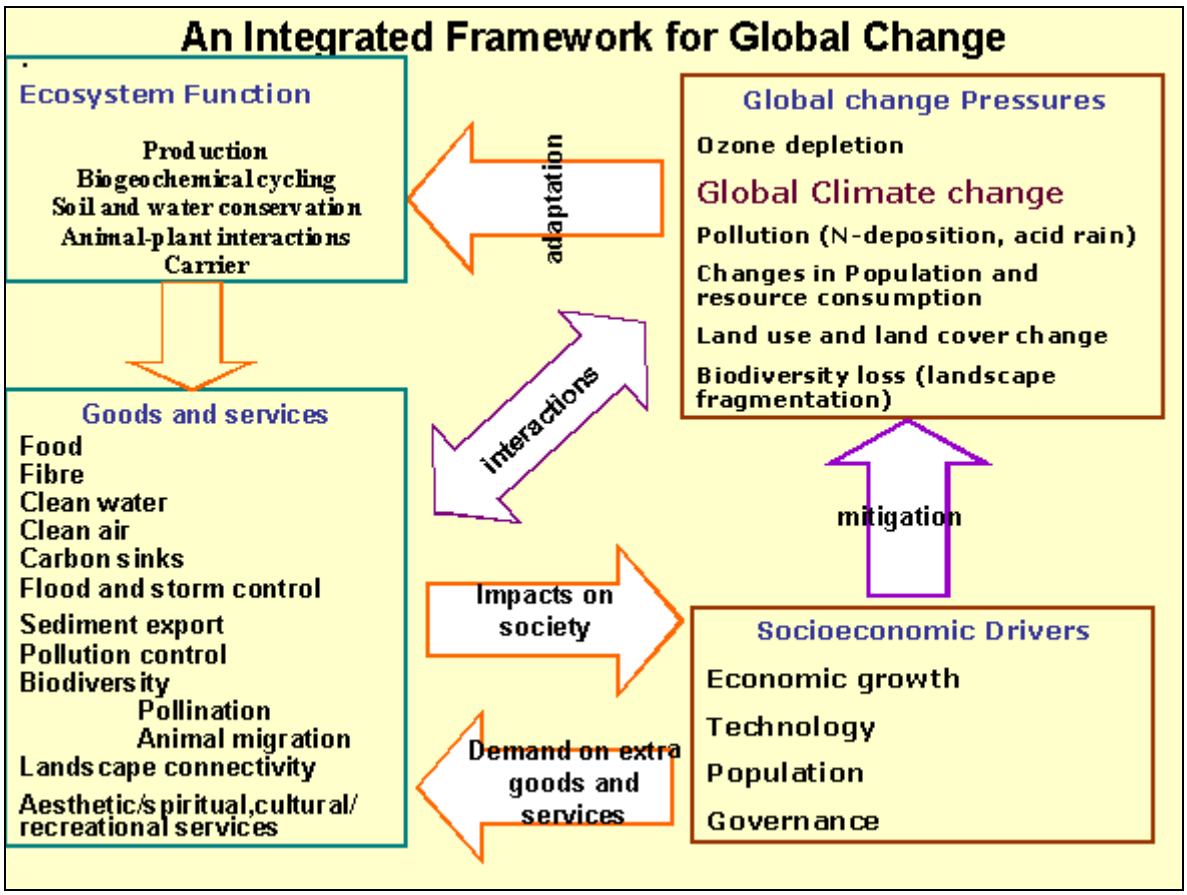


Figure 3: An integrated framework of change (Ramsar COP8 DOC. 11 2002).

Ecosystem functions beneficial to human are known as ES. The Millennium ecosystem Assessment (2005) classifies ES into provisioning, regulating, supporting and cultural services (Figure 4) which include carbon sequestration and storage, watershed protection, biodiversity protection and landscape beauty (Wunder 2005). These services are important to human being's daily lives and hence crucial to conserve them.

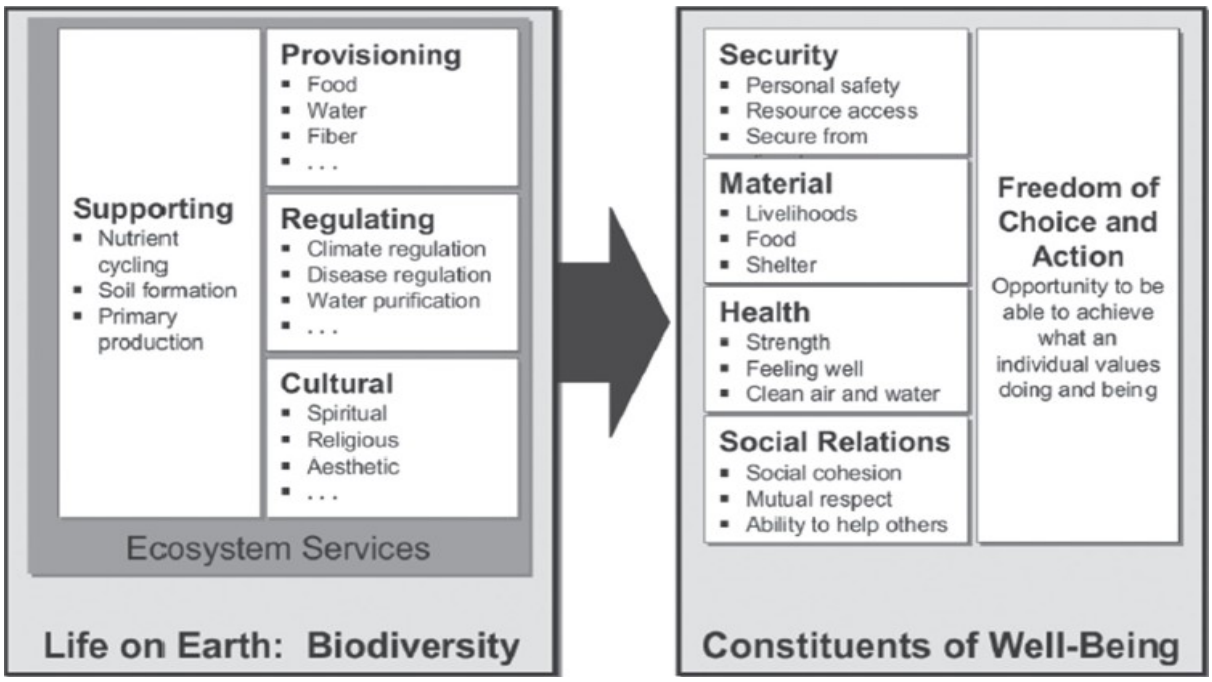


Figure 4: Conceptual linkage between ES and human well-being (Millennium Ecosystem Assessment 2005).

There is a trade-off that exists between provisioning and regulating services (Dhanya et al. 2014) and a link between supporting services, regulating and provisioning services of agroforestry systems and natural ecosystems. Multipurpose trees and shrubs produce a wide range of products which include shade, fruits and fuel wood; moreover growing multipurpose trees will enhance soil fertility, stability, and also promote water conservation (Carsan et al. 2014; Dawson et al. 2014). For instance planting *Tamarindus indica*, a multipurpose leguminous tree will create symbiotic relationship between roots and soil, thereby fixing nitrogen in soil, enhance soil stability and prevent water runoff. It can be used as a shade tree; its fruits are edible and could be used in jams, blended into juices or sweetened drinks and used as traditional medicine or for carpentry (Morton 1958; Parle and Dhamija 2012).

The relation between agroforestry and ES is that they both generate a variety of provisioning, supporting and regulating services. Agroforestry systems receive beneficial ES from other ecosystems such as pollination by insects and in return ES on non-agroforestry land may be impacted by agroforestry practices (Kragt and Robertson 2014; Dale & Polasky 2007).

The difference lies in that ES occurs naturally while agroforestry services are derived from an intentional practice of integrating crops, trees and or animals on a single unit of land which is intensively managed (Missouri Centre of Agroforestry 2013; Tewari 2008). In addition agroforestry is not attached to any cultural service since it is an intentional practice wherein the main purpose is to fulfil social, economic, ecological and environmental benefits.

2.6. Benefits of agroforestry and ecosystem services

Agroforestry systems and ES produce more than just trees. They contribute positively to the economic, environmental, ecology and social wellbeing of society.

2.6.1. Ecological and environmental benefits

Ecological and environmental benefits are closely related to ecosystem processes and include:

Favourable environment for sustainable production

Windbreaks and shelterbelts create a favourable and sustainable environment for production through protection of crops and area from wind damage (Rahman et al. 2011) by reducing velocity of prevailing wind and deflecting air currents (Missouri Centre of Agroforestry 2013; Tewari 2008). A protected system, sustainably managed, will optimise production of food, fuel, fodder, timber, fibre, fruits, etc. in that particular system (Tellström 2014; Smith 2010).

Natural forest systems and agroforestry systems are self-maintaining when it comes to nutrition. They improve soil structure, stability, fertility and health of soil. The litter fall is also essential for protecting moisture content in soil (Linger 2014; Roig et al. 2005). Soil stability and health contribute to the yield generated in the system for community usage (Murthy et al. 2013; Jose 2009).

Improve the environment

Agroforestry systems reduce the pressure on forests exploitation and therefore resource conservation. Species diversity is improved and threatened species and ecosystems are retained (Schroth and McNeely 2011). Forest and agroforestry trees are also useful in climate regulation (National Agroforestry Policy 2014) and pollution reduction as chemical fertiliser usage will be reduced (Rahman et al. 2011).

Carbon sequestration

Agroforestry systems and forests have the potential to sequester carbon (Nair et al. 2009) but this varies depending on the system, species composition, management practices, and environmental factors (Jose 2009). Storage is higher than equivalent land use without trees (Murthy et al. 2013). Carbon sequestration gain or loss in agroforestry systems is represented by the net ecosystem productivity (Montagnini and Nair 2004), however, increasing rotation age could increase the amount of carbon sequestered (Jose 2009).

Biodiversity protection

Biodiversity of forests and agroforestry systems provide habitat for birds, insects, and other animals (Rahman et al. 2011) and contribute towards the aesthetic value of the landscape (Jose 2009). The greater the biodiversity, the more products are obtained from the system. Moreover heterogeneity and species composition (Mchowa and Ngugi 1994) in agroforestry and natural forest systems protect each other from pest and diseases resulting in reduction of pest and diseases hence lower infestation rates from pathogens in the system (Ashton 2000).

2.6.2. Socio-economic benefits

Socio-economic benefits of agroforestry are evaluated in terms of productivity, stability and sustainability (Tellström 2014; Alao and Shuaibu 2013) and include:

Increased productivity

Increased productivity is derived from the diversity of trees, crops and or animals in the system (Murthy et al. 2013; Smith 2010). Short term and long term productions enables a continuous flow of these products (Rahman et al. 2011). Productivity

improves the rural standard of living from sustained employment and higher income obtained from marketable products (Murthy et al. 2013).

Employment

Agroforestry systems create employment which increase household income (National Agroforestry Policy 2014; Jumbe et al. 2003) and empower local people with skills (Smith 2010) necessary for optimising productivity.

Culturally compatible

Forests are culturally compatible (Rahman et al. 2011). It enhances spiritual wellbeing through bonding with nature (Smith 2010) and cultural believes and values are revived in forests.

Income generation

Value added on forest products and post harvesting of fruits, leaves, fuel wood, fibre, bark and roots (Summer 1999) could generate income through business enterprises such as making juices, jam, dried fruits, spices, herbs, and for medicinal purposes (Mulenga et al. 2012; Linger 2014; National Agroforestry Policy 2014). Products could change from time to time depending on demand and market (Rahman et al. 2011). Timber obtained could for instance be used for carvings but the carving market is regulated by tourist demand (Shackleton and Shackleton 2004).

The carbon market is seen as a reward tool for landscape conservation and restoration (Schroth and McNeely 2011) meaning forestry and agroforestry projects could benefit economically from carbon sequestration and storage. Table 2 illustrate carbon storage potential of agroforestry systems in different eco-regions of the world.

Table 2: Carbon storage potential of agroforestry systems in different ecoregions of the world (Murthy et al. 2013).

Continent	Eco region	System	Potential (Mg Cha^{-1})
Africa	Humid tropical high	Agrosilvicultural	29-53
South America	Humid tropical		39-102
	Low dry lowlands		39-195
Southeast Asia	Humid tropical		12-228
	Dry lowlands		68-81
Australia	Humid tropical low	Silvipastoral	28-51
North America	Humid tropical		133-154
	High humid tropical		104-198
	Low dry lowlands		90-175
Northern Asia	Humid tropical low		15-18

2.7. Summary

The wellbeing of rural communities adjacent to plantations is connected to the forests which led to forests being linked to rural poverty reduction. These communities depend on forest services for livelihood and as a result of resource extraction environmental degradation and deforestation occurs especially if there is no monitoring in respective areas. ES and agroforestry produce more than just trees for communities as they contribute to the economic, environmental, ecological and social wellbeing of communities. In order to know the ES used by the communities it is important to consult communities, evaluate their ES use through ethically cleared questionnaires.

Chapter 3: Research Methodology

3.1. Description of study area

The study was conducted in Limpopo, KwaZulu-Natal (KZN) and Mpumalanga provinces of South Africa. Vhembe district municipality in Limpopo (Figure 5), with a population of 1 294 772 (Statistics SA 2011) was selected for the study. It took place in the Tshakhuma Maungani community (under the Mphempu cluster) and Vondo community (under the Tshivhase cluster) located within the Makhado and Thulamela local municipalities.

The Zululand district municipality in KZN (Figure 6), with a population of 803 575 (Zululand IDP 2014/2015; Statistics SA 2011), was also selected for the study. It took place in the Mooiplaas and Ntendeka communities under the Ngome cluster within the Abaqulusi local municipality.

In Mpumalanga (Figure 7), the Gert Sibande and Ehlanzeni district municipalities were selected. Gert Sibande district municipality consists of seven local municipalities with a total population of 1043 194 (Statistics SA 2011). Ehlanzeni district municipality consists of five local municipalities with the total population of 1 688 615 (Ehlanzeni district municipality IDP 2013/14; Statistics SA 2011). The Oshoek community falls under the Redhill cluster, while the Tsakani community falls under the Mapulane cluster. These communities are part of the Chief Albert Luthuli and Thaba Chweu local municipalities.

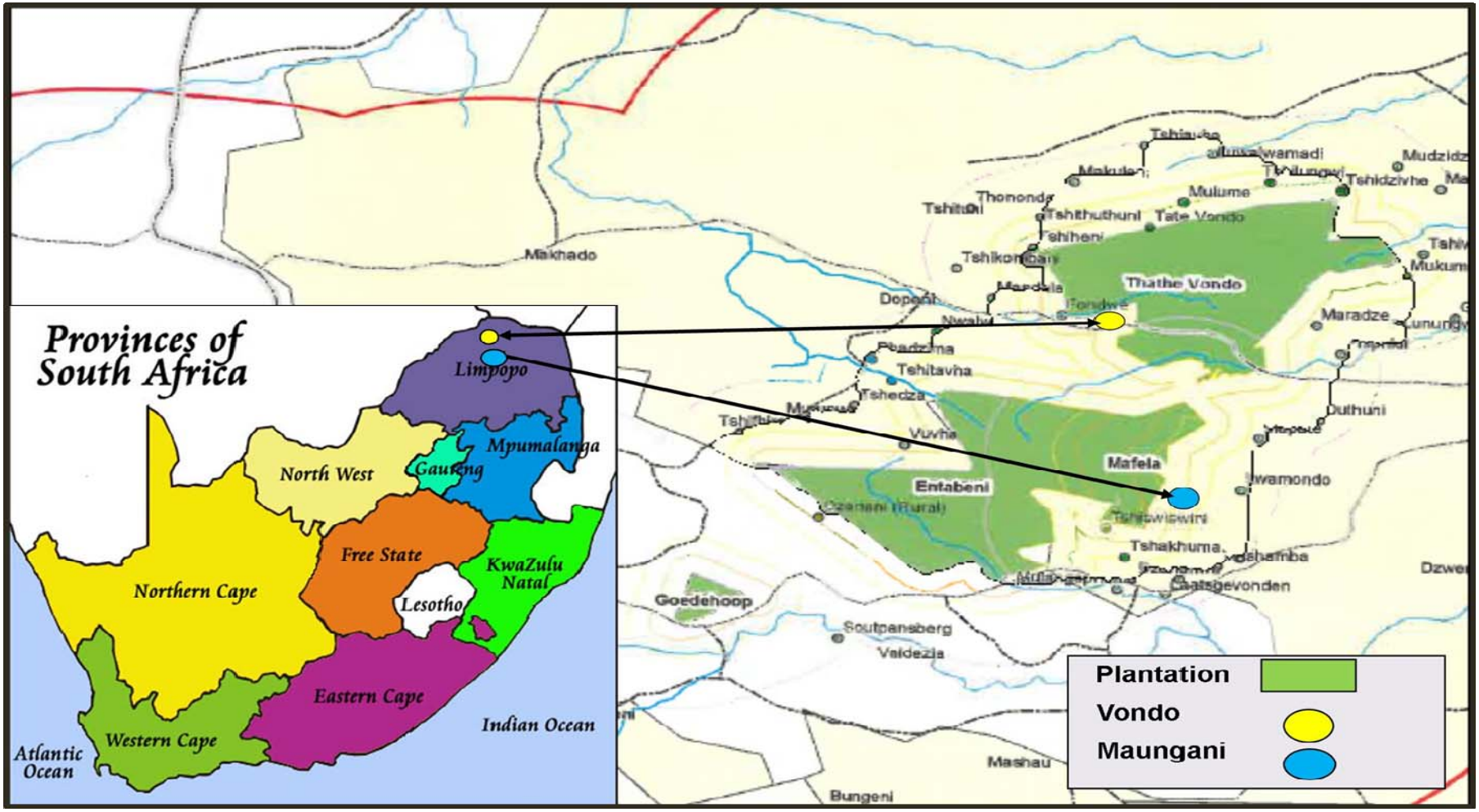


Figure 5: Limpopo Study sites (KLF plantation map 2012; Google maps 2015).

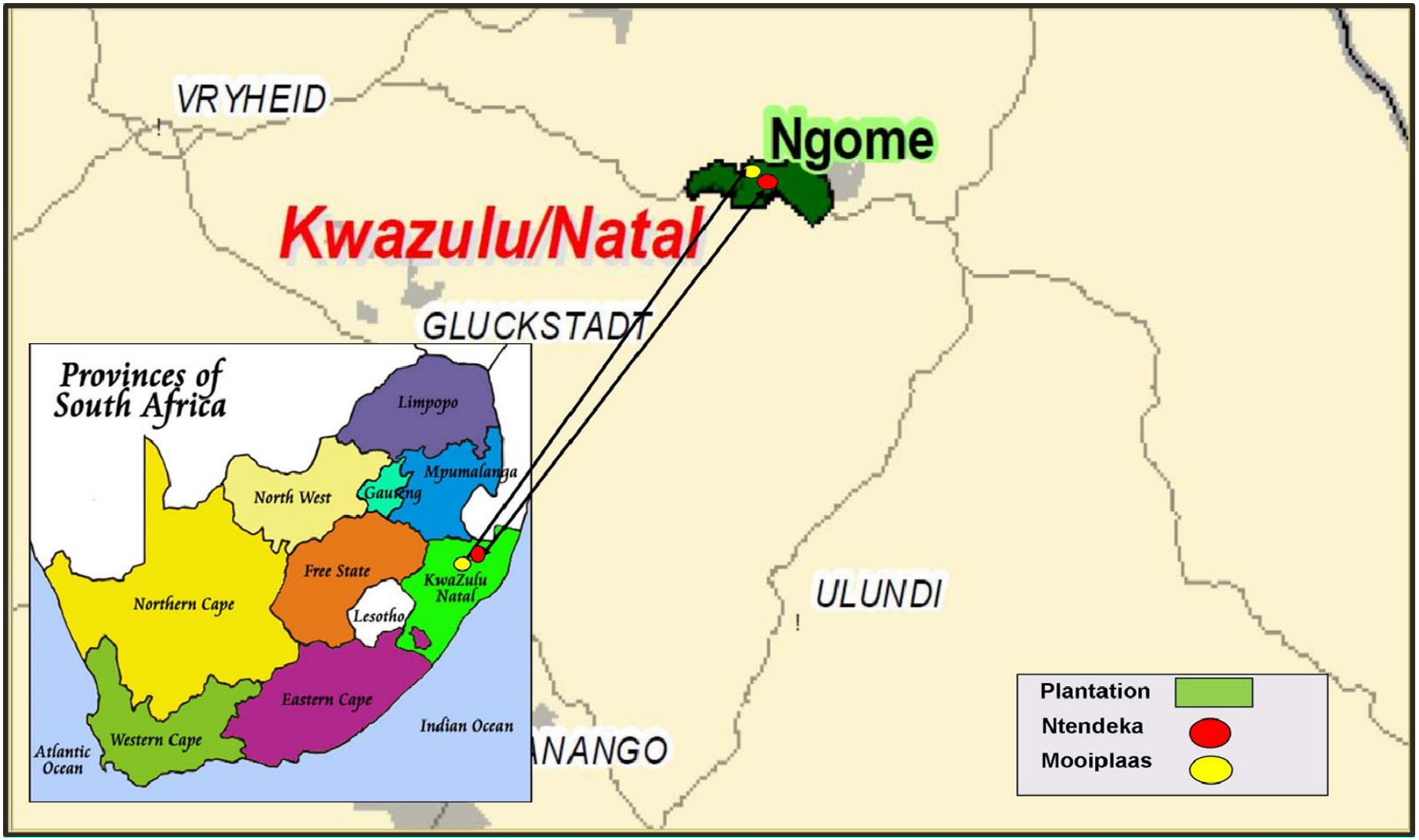


Figure 6: KZN study sites (KLF plantation map 2012; Google maps 2015).

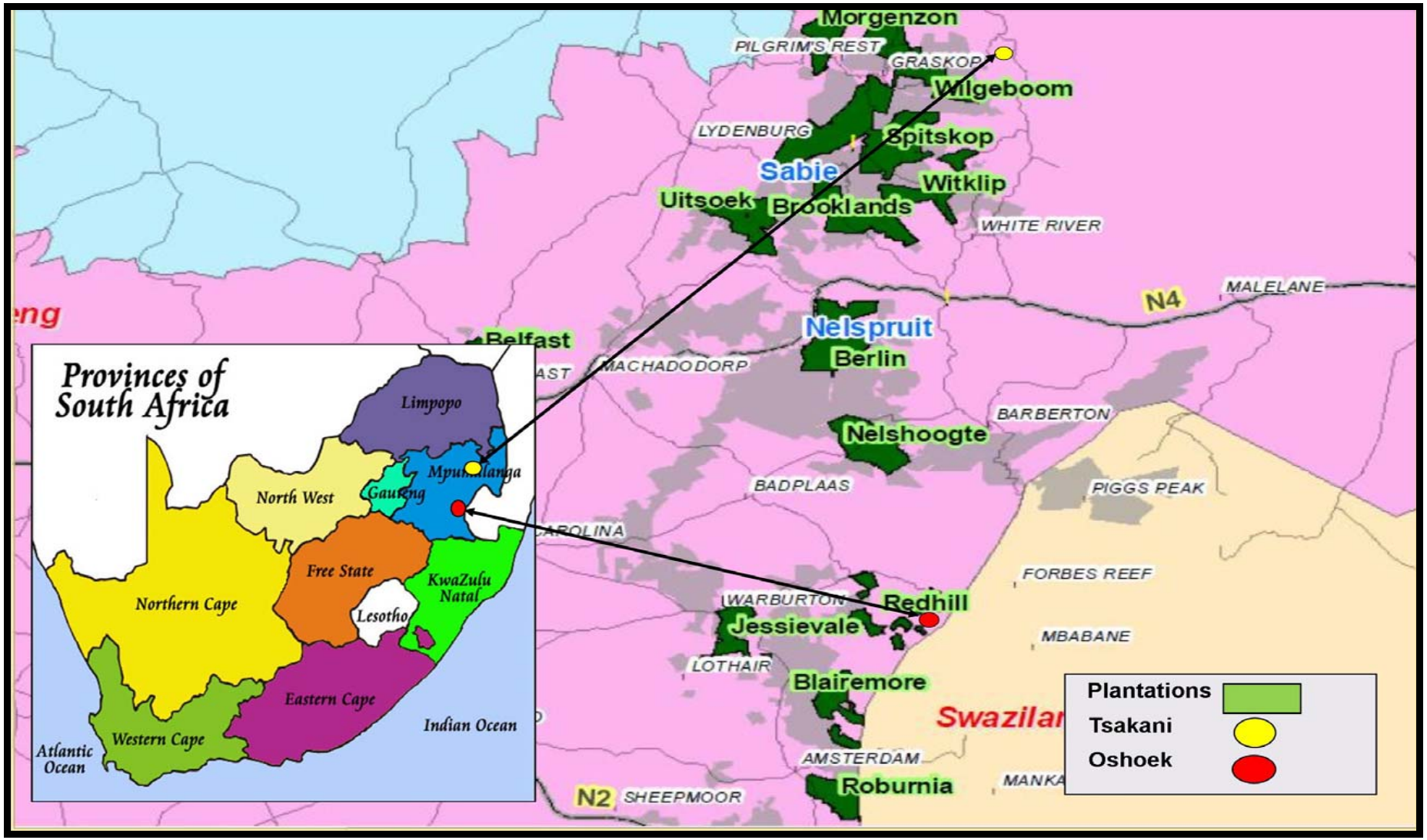


Figure 7: Mpumalanga study sites (KLF plantation map 2012; Google maps 2015).

3.2. Sample selection

KLF assisted in identifying the two sample communities in each province. Communities were selected based on potential conflicts, land claims and their closeness to KLF plantations. Sampled households in each community were used as collection of data is less time consuming, less costly and more accurate than it would be with whole communities (Bless et al. 2006; de Vos 2005). Furthermore, it is more practical to collect household data when the population size is large (Bless et al. 2006).

A sample size of 30 households per village was identified in advance before collecting data (Mazumdar and Bang 2008), amounting to a total of 180 households surveyed. Households were randomly selected and one individual was interviewed per household. Selection of the sample size has been linked to methods of data collection (de Vos 2005; Kelley et al. 2003), such as interviewing and observation. These methods are time consuming and costly as costs of research are proportional to hours spent on data collection (Bless et al. 2006). Therefore, 30 households per village were deemed an acceptable minimum for continuous data (Boos and Hughes-Oliver 2000).

Random sampling was used in selecting households for interviews as each household had an equal chance of being included in the sample (Welman et al. 2005; Kelley et al. 2003). The survey was started at any point in the sampled community with no prediction value of the next household number, until reaching the sample size (Bless et al. 2006; de Vos 2005).

3.3. Pre-testing

Pre-testing (pilot test) is a trial run in preparation before a study is convened. It can identify weakness, problems of research procedure and questions that might offend participants or hinder them from providing relevant information, willingness of individuals to participate, and identifying unforeseen attributes that could lead to project failure (Simon 2011; Hassan et al. 2006). Therefore, before the actual field work, a pilot test was conducted in one of the communities to ensure that the research process and data collection methods were appropriate and able to achieve research objectives as set out in this study (Simon 2011; Arain et al. 2010). The households that took part did not participate in the main study to limit repetition. After the pilot study, unclear questions were either rephrased or removed. Since participants are rich in information, and provide illumination to the topics in question (Patton 2002); space was also included in the questionnaire for open ended comments on the study and procedures of conducting research (see annexure B).

3.4. Data collection

Field work was conducted during June and July 2015. The main method of collecting data was through household surveys that was cleared the university ethical clearance. Since rural communities are headed by chiefs and their headmen (Grischow 2008; Zakwe 2001), chiefs were consulted for permission into their respective villages.

Joint Community Forum (JCF) meetings were held in each village for introduction before the actual data collection. Aspects of the survey were discussed in these meetings and background information was collected. The meetings were attended by the community selected representatives, chiefs, municipality representative, KLF Enterprise Development (ED) specialist representatives and KLF Social Economic Development (SED) representatives. The issues that were discussed in the meeting included the following:

- Social development matters arising in communities;
- Progress of confirmed needs assessment for 2015;
- Land issues;
- Community training needs; and

- Fire and fire awareness.

3.4.1. Household surveys

Face to face household surveys were chosen as the main instrument for data collection because it was anticipated that some respondents might be illiterate and therefore the interviewer will have to ask the questions, soliciting feedback and recording the answers for interviewees. Data collection was through the use of a semi-structured questionnaire (Wengraf 2001, Schensul et al. 1999), which was designed to obtain relevant information from the community members. The questionnaire contained both closed and open end questions (Taylor-Powell 1998; McLeod 2014).

The questionnaire was structured around the following main sections:

- Household demographic information;
- Household properties and income structure;
- Economic viability (any other income sources such as those derived from livestock sales and farm activities);
- ES usage and its quantification;
- Impact ES exploitation have on the environment;
- Enterprise and income generation through the use of ES.

In participatory rural research it is important to use local language (Ghaffari and Emami 2011; Cavestro 2003) to accommodate those that are neither literate nor English speaking (Swanepoel and de Beer 2006). The purpose of the study was explained and participants had an option to take part in the study. If they chose not to participate, the next household was approached hence no order of household selection applied.

3.4.2. Personal observation and transect walks

Transect walks as a tool ‘’for describing and showing the location and distribution of resources, features, the landscape, and main land uses along a given transect’’ (World Bank 2005), was conducted in the communities. It involved walking around the community with community members, observing, asking questions and listening (Kar 2005; Thomas 2004). Transect walks were useful in identifying observable environmental degradation and conditions in the area (Adebo 2000; Mahiri 1998), to

supplement information gathered in the questionnaire. Direct observations were made of forests and community settlements (houses, farmland) during the study period.

3.4.3. Data collection from KLF to capture past agroforestry projects

Data on past agroforestry practices was obtained from previous KLF studies and SAFCOL annual reports (Meyer et al. 2015, SAFCOL 2010, 2013). The information contained in these documents focused mainly on development projects at plantation level.

3.5. Dependency ratios

Population dynamics has an influence on the population and economic dependency ratios.

3.6.1. Population dependency ratio

Population dependency ratio (PDR) is an indicator of the amount of people of non-working age compared to working age (Simon et al. 2012; Heskett 2006; Titu et al. 2012). Low dependency ratio indicates that there are more adults working in relation to young and old people (Simon et al. 2012) while high dependency ratio indicates that those working face the burden of supporting non-working people and an aging population (Titu et al. 2012; Ingham et al. 2009). This ratio is calculated through adding the dependents (those under the age of 15 and ≥ 55 years) divided by the total potential productive population (between 15->55 years), expressed in percentage. The formula is given by:

$$PDR = \frac{(number\ of\ people\ aged\ 0\ to 14 + people\ aged \geq 55)}{(number\ of\ \ people\ aged\ 15\ to\ 55)} \times 100$$

3.6.2. Economic dependency ratio

Economic dependency ratio (EDR) is an indicator of the number of unemployed persons per one employed person (Ingham et al. 2009), indicating the number of people supported by every working person. It is calculated by dividing the total number of people in the sampled households by the total number of employed people in the sample households. The formula is given by:

$$EDR = \frac{Total\ number\ of\ people\ in\ sampled\ households}{Total\ number\ employed\ \ in\ sampled\ population\ between\ ages\ 14\ and\ 55}$$

3.6. Data analysis

Microsoft Excel computer package was used to encode data, while analysis was done with R Commander software. Descriptive statistics was used to compare communities in terms of demographic and livelihood profiles. While data is norminal, statistical tests (t-test for correlations using Pearson‟s correlation coefficient, ANOVA, linear contrasts) were performed to check whether there was any difference observed between the communities in each province at a 5% (0.05) confidence significant level (Gao 2013). Frequency distribution, pie charts and tables were used for visual presentation and explanation of the data analysis.

3.7. Summary

Methods of data collection in in the study were semi structured questionnaires, and direct observation. Random sampling was applied in the selection thirty households in ach community. Microsoft Excel computer package was used to encode data, while analysis was done with R Commander software.

Chapter 4: Research Results

4.1. Village overview

Overviews of the villages, obtained through transect walks, were as follows:

4.1.1. Limpopo

Households were clustered together and houses had access to electricity, but water was scare. Agricultural activities dominated, for example banana and avocado orchards in the Maungani area and a tea estate in the Vondo area. Home gardens had plenty of fruit trees and thus a high tree cover. Use of indigenous forests in the area was highly restricted especially the collection of firewood for domestic use. The distance from the communities to the nearest plantations (Thathe Vondo and Entabeni) was about 4 km.

4.1.2. KZN

Households were sparsely distributed with no electricity and water. Agricultural activities were absent with no trees in the home gardens (low tree cover). However, plantations were the major form of tree cover as communities are within the plantation area.

4.1.3. Mpumalanga

Households in Tsakani were clustered together while it was more sparsely distributed in Oshoek. In the Tsakani community the natural forest was degraded as the community collected firewood (low tree cover), while the Oshoek community was dominated by grassland and livestock graze (low tree cover). The distance from Oshoek to the nearest plantation (Jesseville) was approximately 6 km while distance from Tsakani to the nearest Wilgeboom plantation was approximately 56 km. Although the Tsakani community is quite far away from a plantation, it is a KLF land claimant and the company wanted to assist them in rural development.

4.2. Location

The number of people per survey village varied between 58 at Ntendeka and 427 at Tsakani (Table 3). The majority of respondents in all the communities (83% Maungani, 70% Vondo, 63% Mooiplaas, 73% Ntendeka, 77% Tsakani and 83% Oshoek) were females.

Table 3: Distribution of respondents according to village and gender

Village	Total no households	Sampled households	Percentage sampled	Gender of respondents	
				Male	Female
Limpopo Province					
Tshakhuma-Maungani	90	30	33	5	25
Vondo	300	30	10	9	21
TOTAL	**390**	**60**	**43**	**14**	**46**
KwaZulu-Natal Province					
Mooiplaas	69	30	43	11	19
Ntendeka	58	30	52	8	22
TOTAL	**127**	**60**	**59**	**19**	**41**
Mpumalanga Province					
Tsakani	427	30	7	7	23
Oshoek	105	30	29	5	25
TOTAL	**532**	**60**	**36**	**12**	**48**

4.3. Age

Respondents for all the villages were grouped into five age classes (Figure 8): Younger respondents (age 18 to 24 and 26 to 35); middle aged respondents (age 36 to 46 and 46 to 55); and older respondents (older than 55).

There were significantly less young respondents between age groups in Vondo and Tsakani ($p<0.0001$) than older ones. There was also significantly less 46-55 years, middle aged people in Maungani and Oshoek ($p<0.0001$) than young and older respondents between age groups.

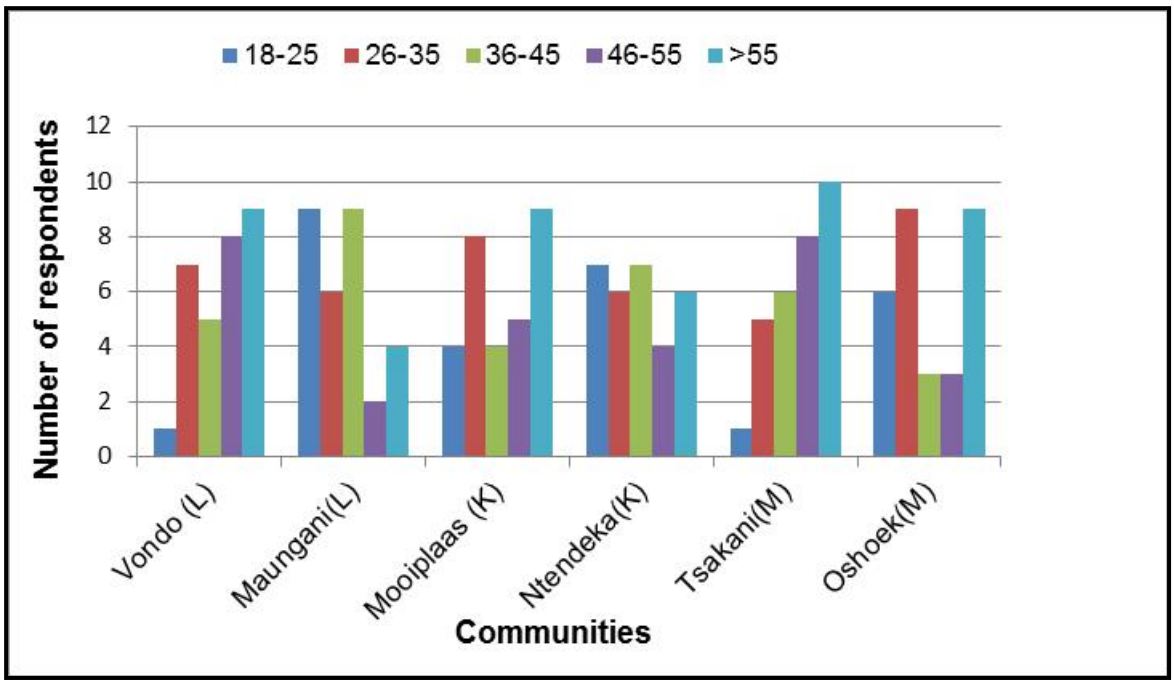


Figure 8: Age distribution of respondents (n=30 per community), L=Limpopo, K=KZN, M=Mpumalanga.

4.4. Education

Across communities, more than 50% of the respondents attended secondary schools (grade 8 to 12) (Figure 9). The highest levels of illiteracy (people with no schooling) were observed in Mooiplaas, Oshoek, Tsakani and Maungani, while no respondents with tertiary education (university/further education training) were present in the KZN villages. As secondary schools are not close by, respondents only attended primary schools due to high transport costs. In the two Mpumalanga communities there was a higher proportion of females attending schools (57% and 68% of respondents) than males (43% and 38% of respondents). There was a correlation between illiteracy and older people ($p=0.011$ in Limpopo, $p=0.006$ in Mpumalanga and $p=0.000$ in KZN) in all the villages.

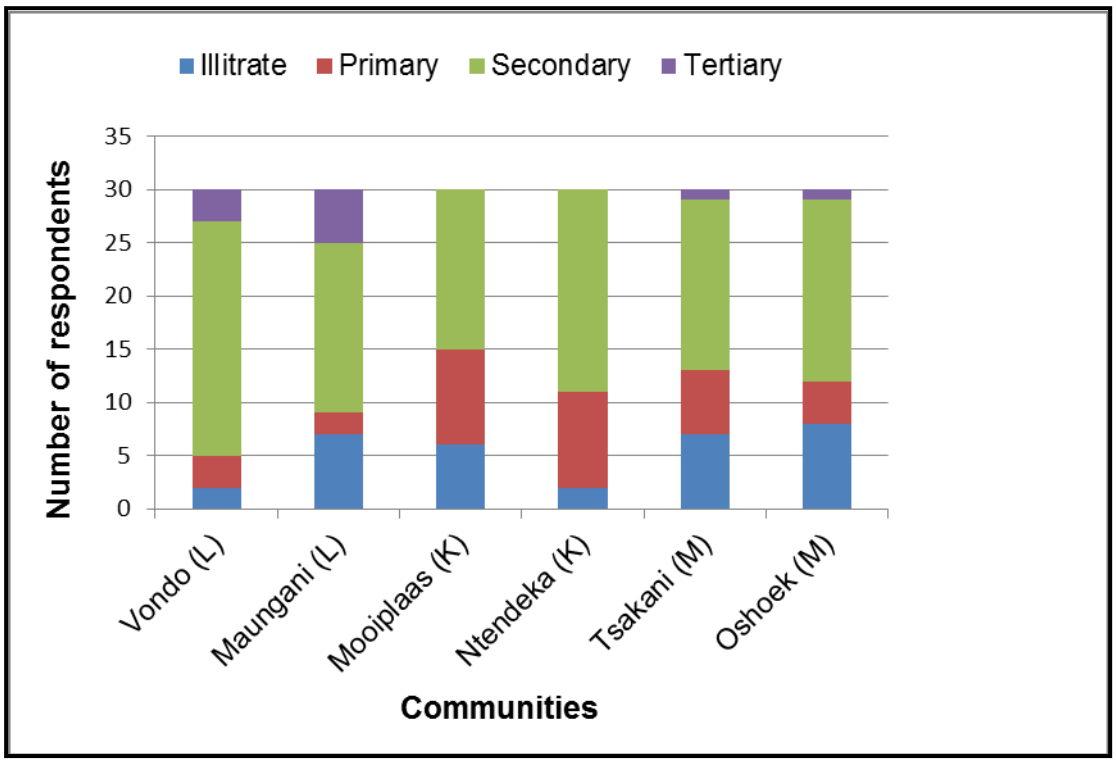


Figure 9: Distribution of education level (n=30 per community), L=Limpopo, K=KZN, M=Mpumalanga.

4.5. Household size and property

Family size ranged from one to 13 in Maungani and Vondo communities, two to eight in Mooiplaas, four to 13 in Ntendeka, two to 18 in Tsakani and four to 13 in Oshoek (Figure 10). The larger families in KZN communities consisted of everybody with the same surname (for example Ngwenya), while in other communities, parents had their own household and when children got married, they moved to their own house.

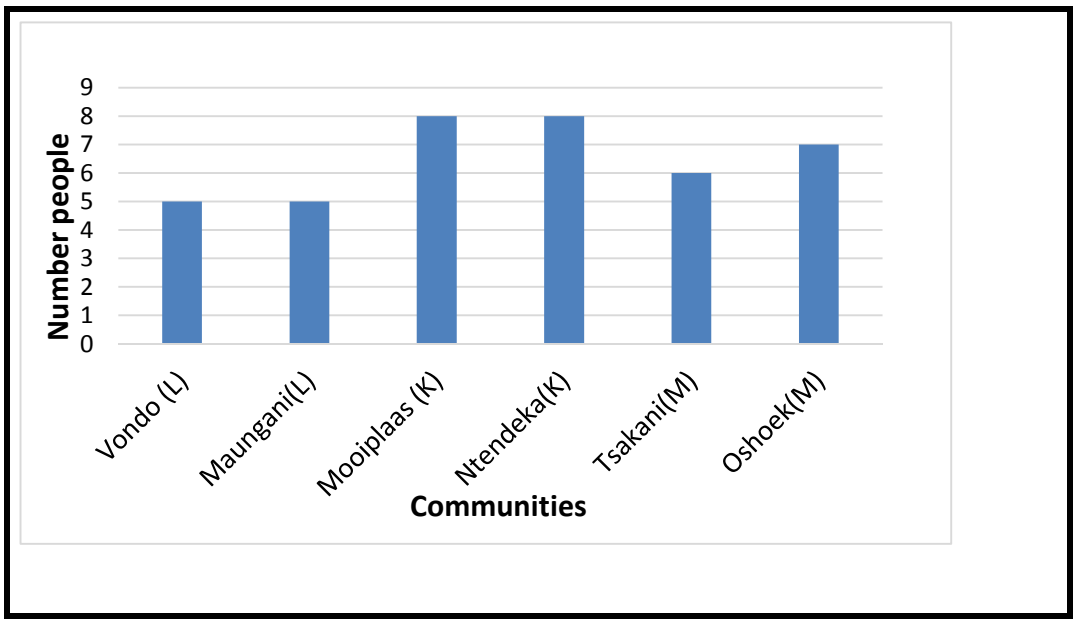


Figure 10: Average household sizes (n=30 per community), L=Limpopo, K=KZN, M=Mpumalanga.

4.5.1. Employment

All the interviewed households had a high level of unemployment of more than 60% (Figure 11), with Ntendeka the highest (100%). In the Limpopo (*p=0.830*) and KwaZulu-Natal (*p=0.878*) provinces there was a low correlation between education level and employment security per province while in Mpumalanga (*p=0.003*) province there was a correlation between education level and employment. While unemployment levels were high, households seemed to secure money for household needs by various means.

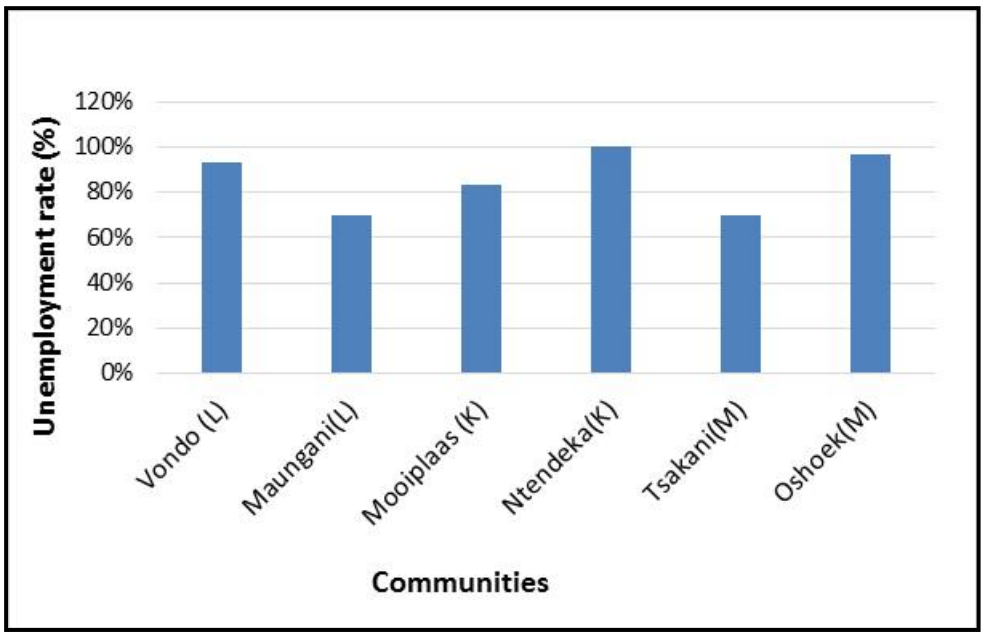


Figure 11: Unemployment rate amongst sample households (n=30 per community), L=Limpopo, K=KZN, M=Mpumalanga.

4.5.2. Population dependency ratio

The sample households had in general a high dependency ratio across communities (Figure 12). This means that one person of working age (15 to 55 years) had to support between 13 (Vondo) and 37 (Tsakani) non-working individuals.

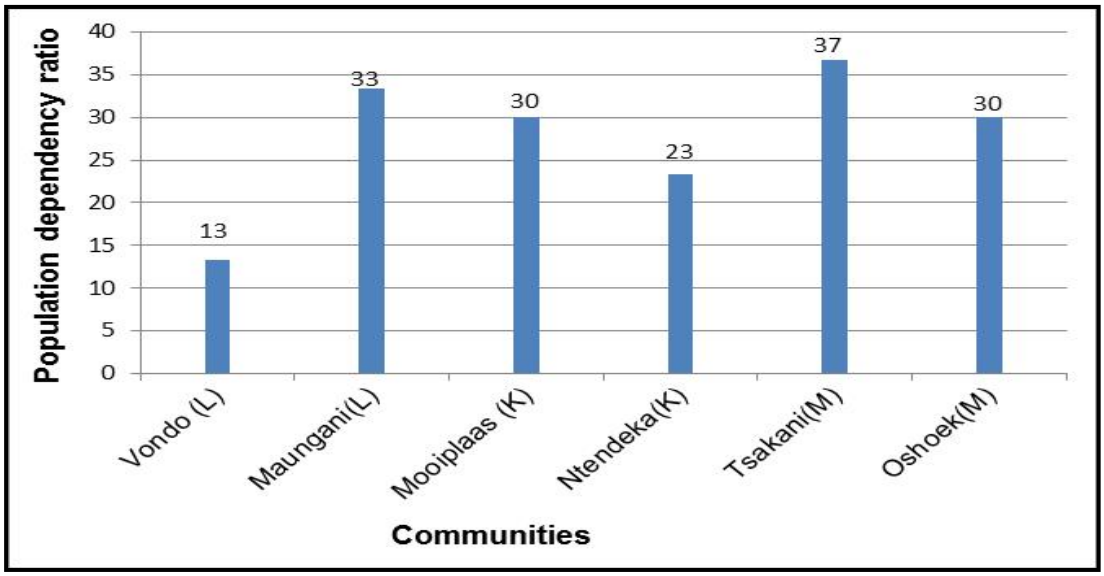


Figure 12: Population dependency ratio (n=30 per community), L=Limpopo, K=KZN, M=Mpumalanga.

4.5.3. Economic dependency ratio

In all the villages, there were a high number of people to support for every working individual (Figure 13). For examples, in Vondo and Oshoek, every working individual has to support between 15 and 30 unemployed individuals. Ntendeka community had no working individuals amongst the respondents.

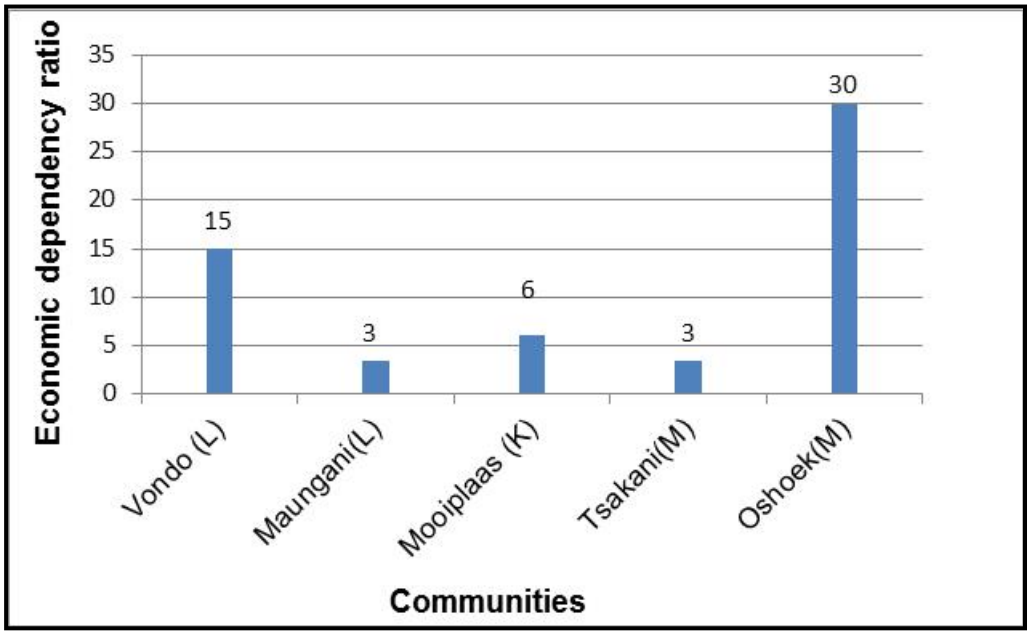
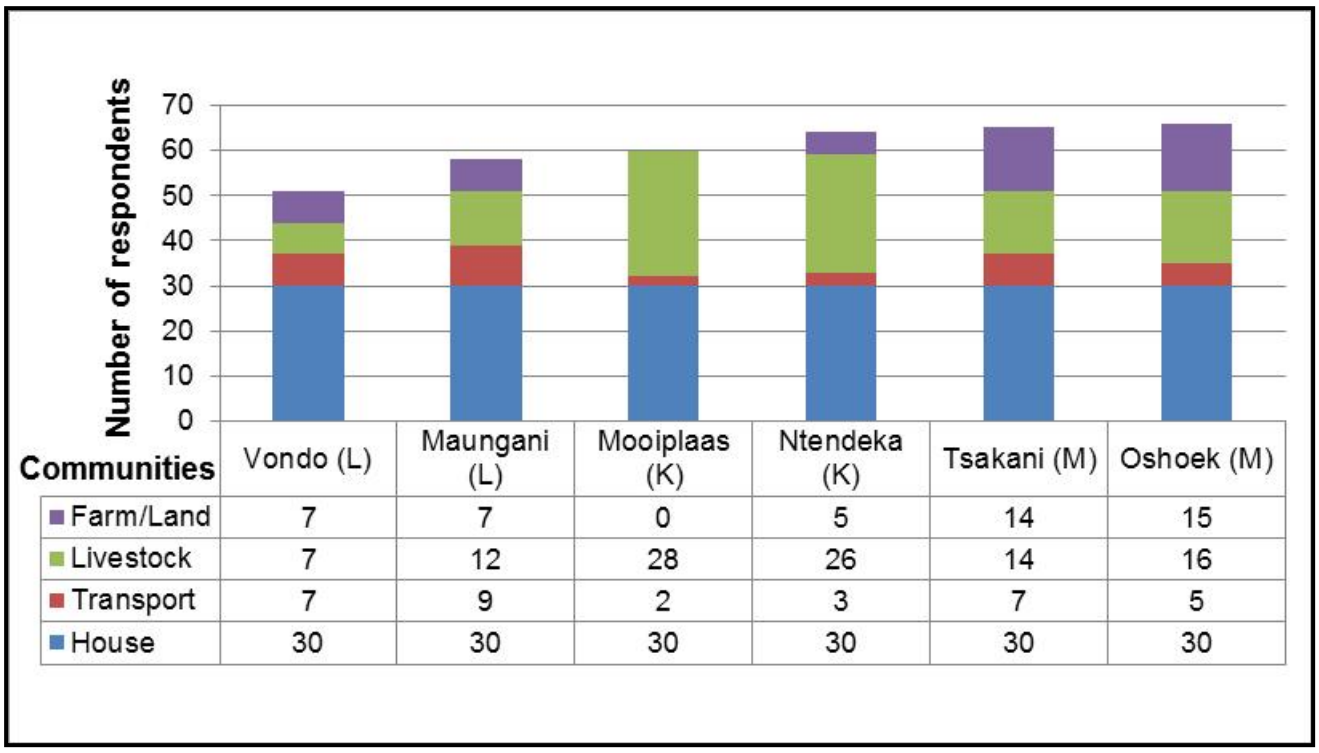


Figure 13: Economic dependency ratio (n=30 per community), L=Limpopo, K=KZN, M=Mpumalanga.

4.5.4. Capital

Household capital included houses, livestock, transport, farm and or land (Figure 14). All interviewees had houses while few had transport and own land. Although both communities in KZN had a high percentage of livestock (93% of respondents in Mooiplaas and 87% in Ntendeka), none of the respondents in Mooiplaas owned a piece of land or farm. There was, however, no significant difference in farmland and transport ownership between communities within the three provinces ($p=0.324$ in Limpopo, $p=0.704$ in Mpumalanga and $p=0.490$ in KZN).



Communities	Vondo (L)	Maungani (L)	Mooiplaas (K)	Ntendeka (K)	Tsakani (M)	Oshoek (M)
Farm/Land	7	7	0	5	14	15
Livestock	7	12	28	26	14	16
Transport	7	9	2	3	7	5
House	30	30	30	30	30	30

Figure 14: Household capital (n=30 per community), L=Limpopo, K=KZN, M=Mpumalanga.

The typical houses of respondents in Mooiplaas (93% of respondents), Ntendeka (73% of respondents) and Oshoek (50% of respondents) were made out of timber (Figure 15.1), with stones and mud (Figures 15.2 and 15.3). Maintenance of these houses was intensive as they dilapidated faster than brick houses, requiring more poles and thatch grass to maintain (Figure15.4). The roofs were made from thatched grass in Mooiplaas (63% of respondent houses), Ntendeka (43% households), and Oshoek (50% households), while zinc or tiles and bricks were used in the remaining communities.

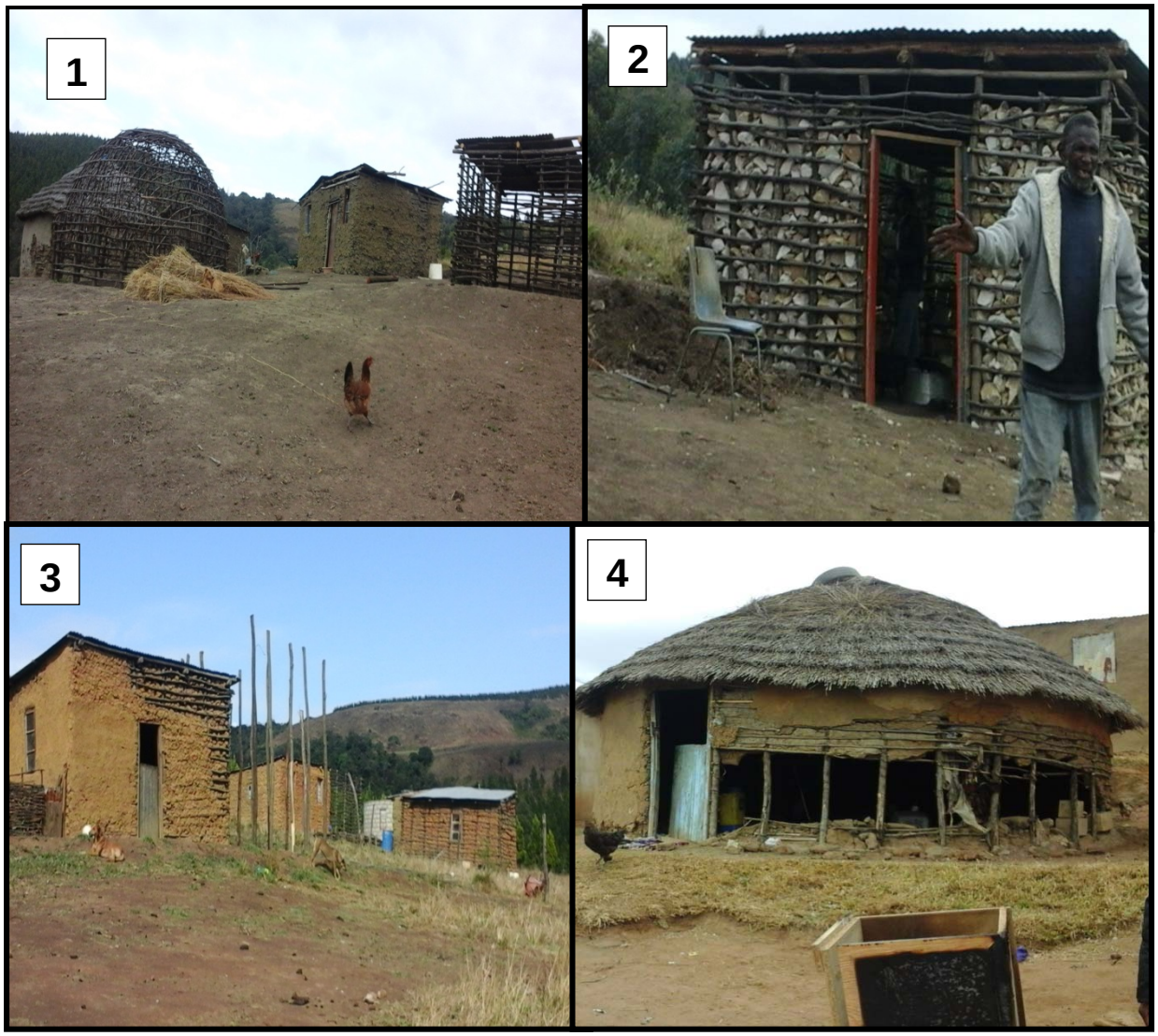


Figure 15: Housing infrastructure at Mooiplaas (KZN). 1=Timber house structure, 2=Stone cover, 3=Mud cover, 4=dilapidated house.

4.6. Source of livelihood

Source of livelihood comprised of agriculture, business, labour, social grants, self-employed, child grants, part time jobs and pension (Figure 16). The main source of income was social grants at Maungani (33% of households), Mooiplaas (43% of households), Ntendeka (37% of households), Tsakani (43% of households) and Oshoek (40% of households). However, the main source of income in Vondo was agriculture (33% of households).

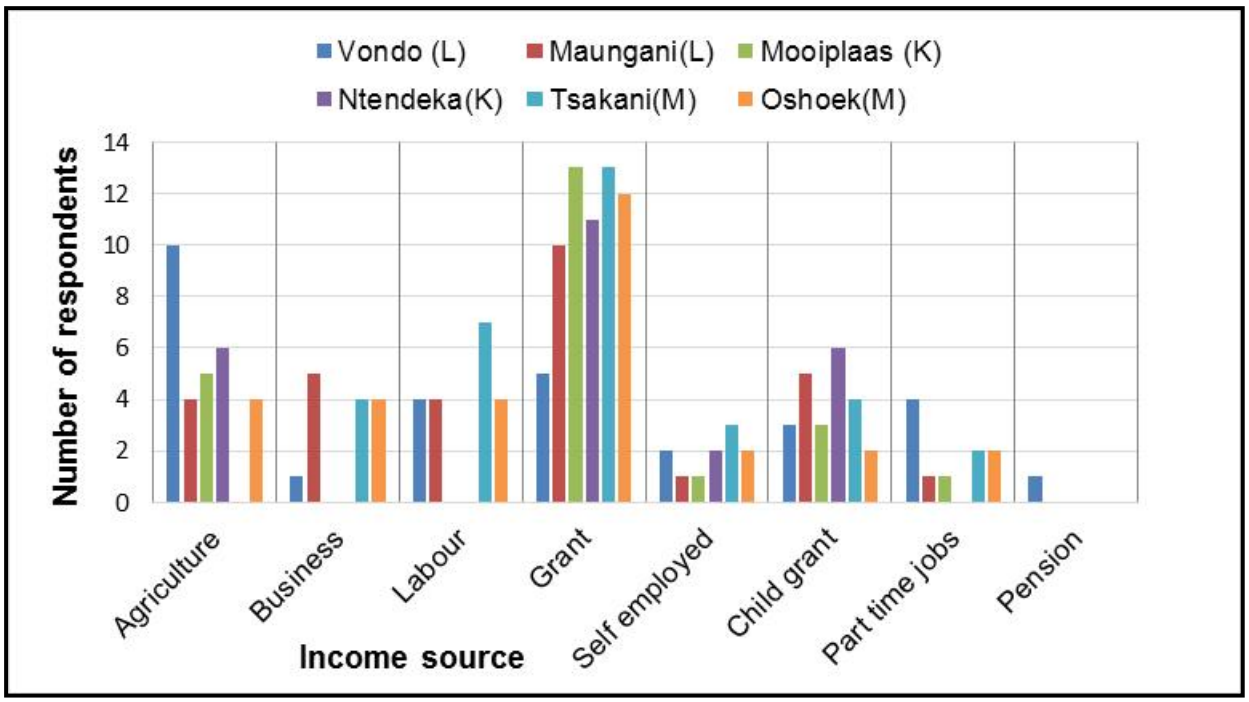


Figure 16: Source of income per month (n=30 per community), L=Limpopo, K=KZN, M=Mpumalanga.

The average income per community is summarised in Figure 17 and ranged from R1 000 to R5 000 per month. However, it was not adequate to sustain the size of the average households in the communities. Households were therefore highly dependent on the number of pensioners and young children in a household who received grants.

The high number of people who were staying in each household seemed to contribute to total household income but income was not linked to household capital. There was a correlation between the number of people in a household and the income level obtained within communities in all province ($p<0.0001$). There was, however, no correlation between income and household capital within communities in each province ($p=0.018$ in Limpopo, $p=0.017$ in KZN, $p=0.313$ in Mpumalanga). For instance, one could find that two households with the same income level had different household capital.

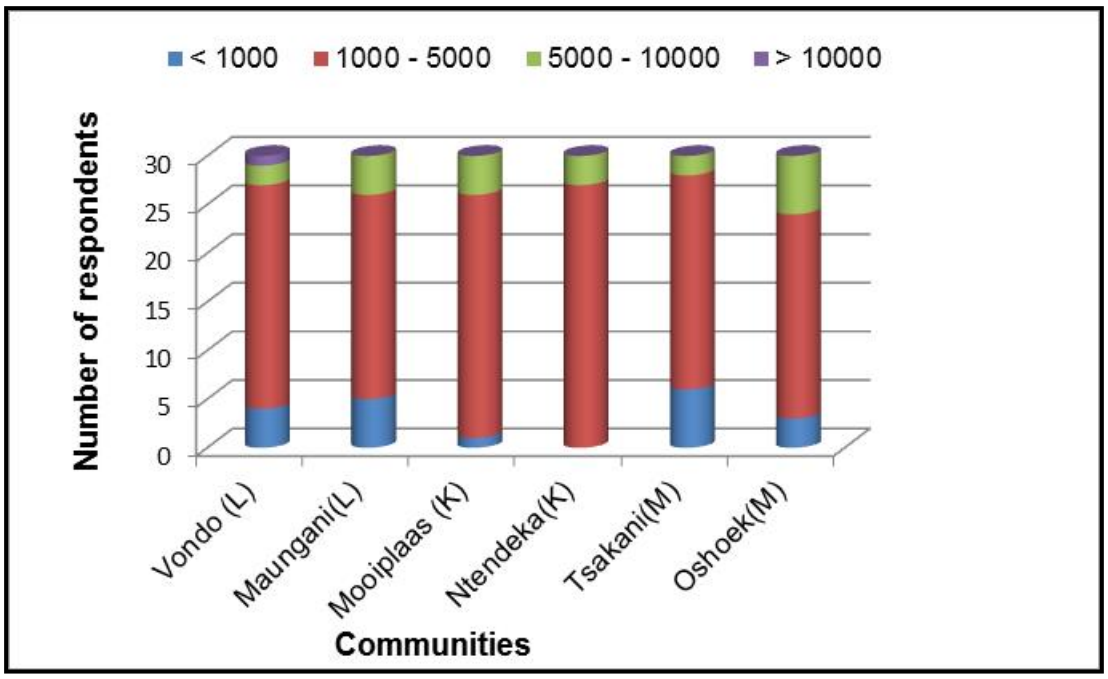


Figure 17: Level of income per month (n=30 per community), L=Limpopo, K=KZN, M=Mpumalanga.

4.7. Livestock

Livestock per household included chickens, goats, pigs, and cattle (Figure 18), with chickens the most popular in all communities. Mooiplaas (93% of respondents) had the highest and Vondo (23% of respondents) the lowest number of respondents who maintained livestock. In the other communities between 40% and 53% of respondents kept livestock.

Livestock was reared mainly for home consumption (income and manure) but differed between communities. At Mooiplaas, Ntendeka and Oshoek 100% of respondents reared livestock while at Tsakani, Vondo and Maungani 86%, 71% and 67% of respondents respectively, reared livestock. In KZN livestock was also reared for cultural activities such as family meetings and weddings, while income generation and food security were more important in both Limpopo and Mpumalanga communities. Livestock was mostly sold based on demand and availability and prices were mainly for mature livestock (Table 4). Respondents in Vondo (57%) sold the most livestock, followed by Oshoek (13%), Maungani (8%) and Tsakani (7%).

Table 4: Average selling price for livestock

	Maungani	Vondo	Oshoek	Tsakani
Chicken	R 55	R 60		
Goats	R750		R600	
Pigs	R1400			R600
Cattle			R6000	

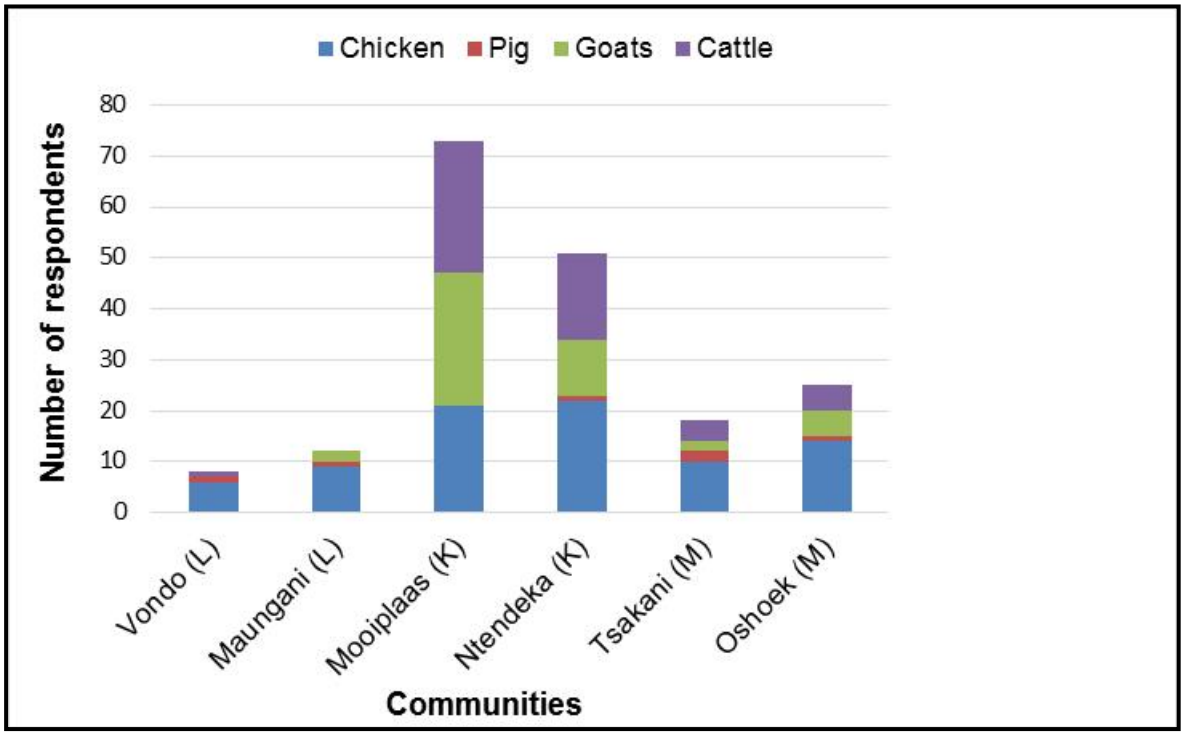


Figure 18: Livestock reared (n=30 per community).), L=Limpopo, K=KZN, M=Mpumalanga

4.8. Land and land use

A low number of respondents owned their own land or a farm and it differed between provinces (50% in Mpumalanga, 23% in Limpopo and less than 17% in KZN). The average land size in communities was: 1.9 ha in Mpumalanga, between 1.6 and 1.8 ha in Limpopo and 0.25 ha in KZN. Although respondents might own land or a farm, it was not always planted with crops. In Maungani (Limpopo) most respondents had planted crops in the Mauluma orchard where they spent most of their time tending it. They also bought ES (e.g. *Abemoschus esculentus, Amaranthus hybridus*) from individuals who collected it from nearby forests. The main method of cultivation in all the communities was hand hoeing. However, approximately 17% of respondents in

Maungani and 13% in Oshoek used ox-drawn ploughs. Owners of larger pieces of land used hand hoeing and tractor ploughs.

Methods of soil fertility improvement included inorganic fertilisers and compost or animal manure. Inorganic fertilisers were used by approximately 43% of respondents in Maungani, 27% Oshoek and 13% in Tsakani. Compost or animal manure was used by 33% of respondents in Vondo, 20% Ntendeka, 20% Oshoek and 67% in Tsakani. No fertilisers were used by approximately 7% of respondents in Oshoek and 13% in Tsakani, while both organic and inorganic fertilisers were used by respondents in Vondo (67%), Maungani (43%), Oshoek (47%) and Tsakani (7%). Some households in Oshoek were subsidised with manure by the local government (50kg of manure annually).

Respondents in Vondo (33%) mainly sold their crops, while 86% of respondents in Maungani used crops mainly for home consumption. However, approximately 17% of respondents in Vondo had a shortage of water. In Mpumalanga crops were mainly used for home consumption, while in KZN it was used for a combination of income generation and home consumption.

Mealies were the main crop planted in Vondo, Maungani and Oshoek, and spinach the main one in Tsakani (Figure 19). Crops were sold to local markets and shops, such as Spar, at prices ranging from R6 to R90 (Table 5). In Vondo, one of the people that had a piece of land owned a nursery wherein avocado, leaches, mangoes, macadamia, naartjie and lemon trees were produced. These trees were all sold at R20 each locally and in urban markets.

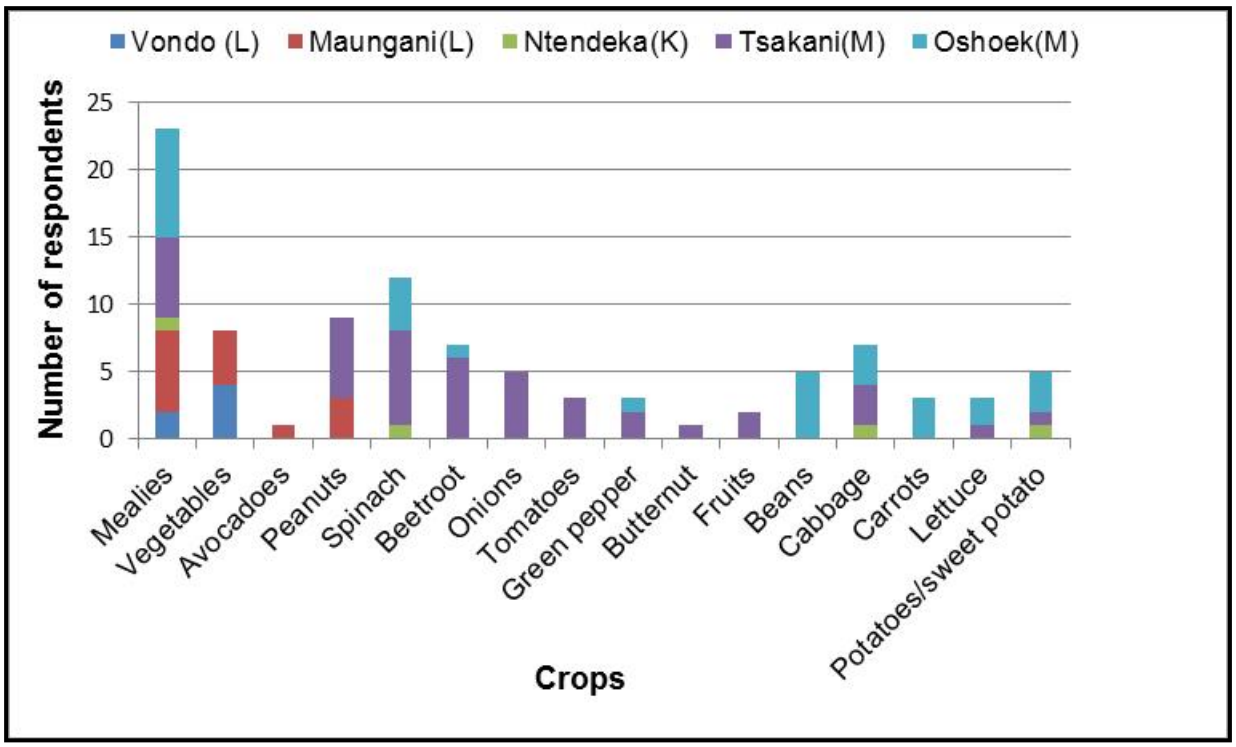


Figure 19: Products planted at the different villages (n=30 per community), L=Limpopo, K=KZN, M=Mpumalanga.

Table 5: Average selling price for planted crops in Maungani, Vondo and Ntendeka

	Maungani	Vondo	Ntendeka
	Selling price		
Avocadoes	R60/crate		
Tomatoes		R90/crate	
Cabbages	R5/bundle	R5/bundle	R6/bundle
Spinach/Mastered	R5/bundle	R5/bundle	R6/bundle
Garlic		R8/bundle	
Potatoes			R35/10Kg

4.9. Ecosystem services use and environmental degradation

4.9.1. Ecosystem service use

Different ES were extracted from forests and plantations by communities adjacent to them including timber, water, medicinal plants, food sources, construction material, crafting materials and forage (Figure 20). Most extracted resources were: water in Vondo (77% of respondents) and Ntendeka (100% of respondents); firewood in

Maungani (73% of respondents) and Tsakani (63% of respondents); timber in Oshoek (83% of respondents), and construction material in Mooiplaas (93% of respondents) and in Ntendeka (73% of respondents). The ES extracted depended on the needs of the communities. Respondents in Vondo (47%) Maungani (92%), Tsakani (23%) and Oshoek (23%) indicated that they collected these ES once per week. However, food products were usually collected when available (seasonal) and while collecting firewood in order to save time for household duties such as cleaning and cooking.

The average travel time to forests where firewood and water were collected, was approximately 3.5 hours in Tsakani, 3.2 hours in Vondo, 2.8 hours in Maungani, and 1.5 hours in Oshoek. The KZN respondents travelled for less than an hour to collect ES. The longer the travel time, the lower the ES use; however in KZN communities, ES use was low because they were situated within forest plantations.

Communities paid people with cars to extract timber or firewood for them. The average cost paid for timber/ firewood extraction with the use of a bakkie in Vondo was R437, R519 in Maungani, R650 in Oshoek and R400 in Tsakani. The above costs included transportation and cutting while those that cut timber or firewood themselves paid R140 in Vondo, R267 in Maungani and R200 in Tsakani for transportation.

With regard to firewood collection, respondents at Vondo used more timber (22% of respondents) than firewood, while Maungani used more firewood (42% of respondents). As timber collection in Vondo was under police control, respondents were afraid of being caught and fined for cutting down trees. Collection of timber at KLF plantations in Limpopo required a permit and a R35 entrance fee was paid to collect timber after harvesting. Moreover entrance for a vehicle to collect wood costed R85. Examples of firewood and timber collections are shown in Figure 21.

Construction material was an important resource in KZN communities and was extracted by 30% of respondents in Mooiplaas and 22% in Ntendeka. These two communities were rich in livestock and required construction material for fencing, and for cattle, goat and chickens kraals (Figure 22).

There was no correlation between ES use within communities in the provinces and:

- household size in Limpopo (*p=0.812*), Mpumalanga (*p= 0.89*) and KZN (*p=0. 987*),
- income level in Limpopo (*p=0.640)* in Mpumalanga (*p=0.168*) and in KZN (*p=0.330*),
- level of education in Limpopo (*p=0.565*), in Mpumalanga (*p=0.521)* in and in KZN (*p=0.192*) and
- capital in Limpopo (*p=0.287*), in Mpumalanga (*p=0.833*); however there was correlation between ecosystem service use and capital in KZN (*p=0.021)*.

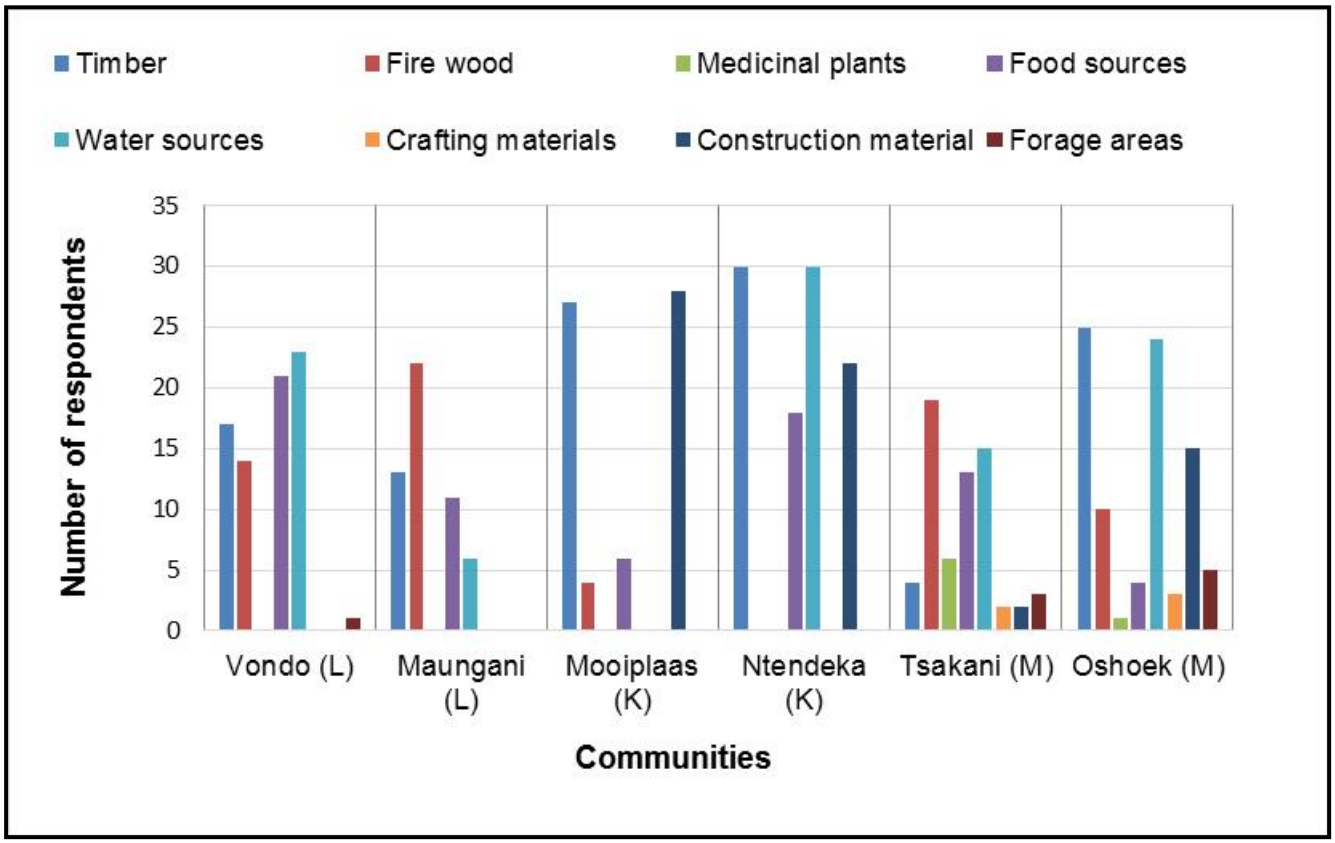


Figure 20: Ecosystem services extracted (n=30 per community), L=Limpopo, K=KZN, M=Mpumalanga.

Figure 21: Examples of timber and firewood collected. A1 and A2=firewood, B=timber.

Figure 22: Construction materials used for livestock.

Over and above the ES that were currently extracted from forests resources, respondents also indicated that there were ES that they wanted to collect but were not easy to obtain as illustrated in Figure 23.

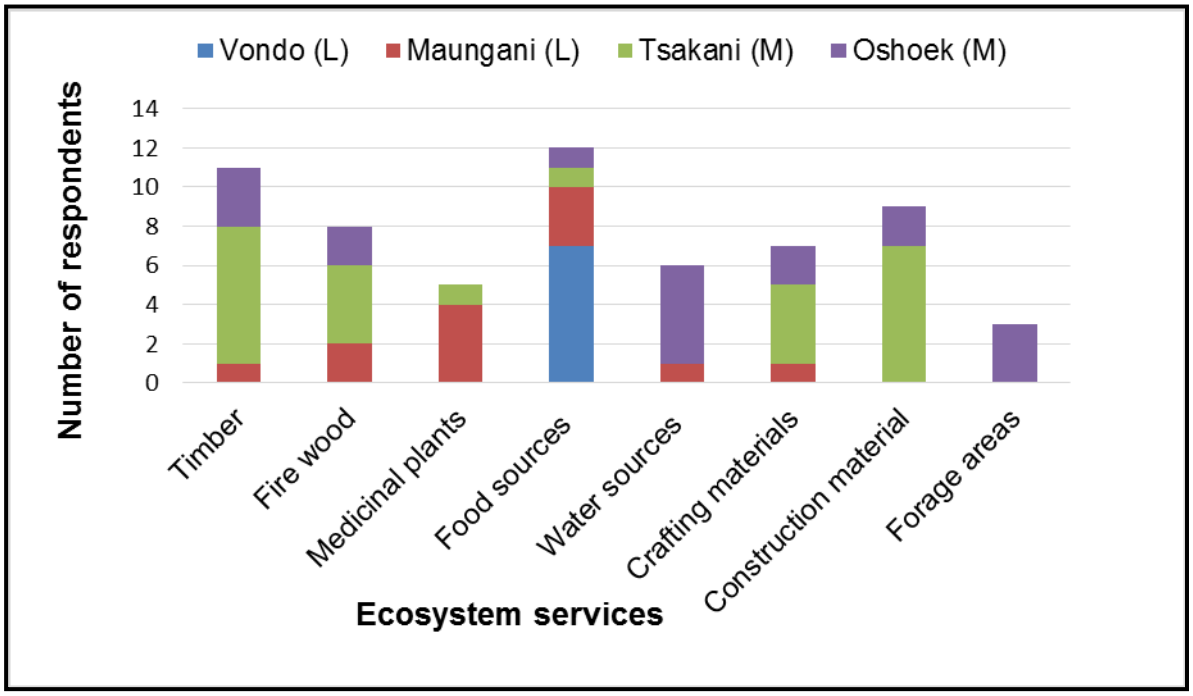


Figure 23: Ecosystem services communities wanted to obtain or were in need of (n=30 per community), L=Limpopo, M=Mpumalanga.

4.9.2. Impact of extracting ES from plantations and or indigenous forests

Respondents indicated whether or not environmental degradation, crop production, fruit production, sufficiency in forest products, time spent in forest products collection and local food security were stable, decreasing or increasing in their communities (Figure 24). Results obtained were as follows:

Environmental degradation

Environmental degradation was seen to be prominent in Maungani and Vondo (reported by 77% and 70% of respondents respectively) due to man-made fires, house maintenance and/ or illegal harvesting of trees. An increase in degradation was linked to an increase in population numbers (more houses, food etc. needed).

Respondents indicated that environmental degradation was stable in Mooiplaas and increasing in Ntendeka (reported by 50% and 57% of respondents respectively). This was evident in the distances that individuals needed to walk to collect forest products

such as firewood. Individuals collected firewood to save electricity. However, a lack of rain was also reported as a contributing factor to environmental degradation.

In Oshoek, 50% of respondents reported that environmental degradation was decreasing and could be attributed to an increase in crop planting in home gardens in the absence of a natural forest.

Sufficiency in forest products

Sufficiency in forest products (availability of forest products) was reported as decreasing by 50% of respondents in Vondo, 70% in Maungani, 90% in Oshoek and 60% in Tsakani while 63% and 83% of respondents respectively indicated it to be stable in Mooiplaas and Ntendeka communities. A decrease in Vondo was due to uncontrolled fires and climate change; while in Maungani harvesting of trees, fires and house extensions contributed to a decrease in products. Lack of rain water in Oshoek and Tsakani could possibly also contribute to a decrease in sufficiency of forest products due to drought stress affecting the growth conditions of forests. This did not seem to be the problem in Mooiplaas and Ntendeka, although individuals needed to walk long distances to reach the forest.

Time spent on forest products collection

Respondents at Maungain (100%) and Tsakani (67%) indicated that they spent most of their time to collect forest products. However, the majority of respondents in Vondo (100%), Ntendeka (100%), Mooiplaas (77%) and Oshoek (60%) spent less time on collecting forest products. Safety is one of the main concerns when it came to collecting firewood in Vondo due to an increase in murders and rapes in the area. Spraying of the forest area with herbicides also destroyed food sources, limiting the availability of edible forest products such as *Agaricus bisporus, Abemoschus esculentus, Amaranthus dubius, Amaranthus hybridus, Momodica foetida, Momodica charantia.*

In KZN communities faced poverty, lack of water and unemployment. The limited use of the forests were mainly due to the high number of older people residing in these villages coupled with the distance that they had to walk to collect forest products.

Crop and fruit production

Most respondents in Vondo (97%) and Maungani (63%) had seen a decrease in crop production mostly due to a lack of water, rain or unemployment (less money available to buy seed and/or manure). However, fruit production was stable in both communities due to good soil conditions for avocado, banana, lychee and mango production.

The majority of respondents also indicated that crop and fruit production (100% in Mooiplaas, 60% and 93% in Ntendeka, 83% and 87% in Oshoek respectively) were decreasing due to a lack of water. In KZN, water was mainly from seasonal streams and rivers, therefore communities struggled to obtain clean drinking water. In Oshoek livestock also destroyed crops because there were no fences and crop production was limited due to the low pH of soils (needed added lime which was expensive). Two crop production projects that had been started in Oshoek failed due to lack of water, seeds and lime. A Community Women Project (CWP) was operational; however they were also struggling with the same issues. Although respondents in Tsakani (40%) indicated that crop and fruit production was stable and increasing, it was affected by a shortage of seeds and livestock damaging crops. However, production was sustained through households that had their own home gardens wherein different crops were planted mainly for home consumption.

Local food security

Most respondents in Mooiplaas (100%), Ntendeka (100%), Vondo (93%) and Oshoek (87%) indicated that food security was decreasing. According to respondents in Vondo the lack in rain affected crop production and thus food security severely. High rates of unemployment, insufficient land for crop production and water shortages in Mooiplaas, Ntendeka and Oshoek; contributed to a decrease in food security. The high number of old aged people in KZN who were not able to walk long distance to collect forest products, also contributed to a decrease in food security.

Respondents in Maungani (80%) and Tsakani (70%) indicated that food security was seen to be stable. Food security in Maungani was sustained through the Tshakhuma market that had been developed to sell fruit from surrounding communities, while stability in Tsakani was due to home gardens and availability of water.

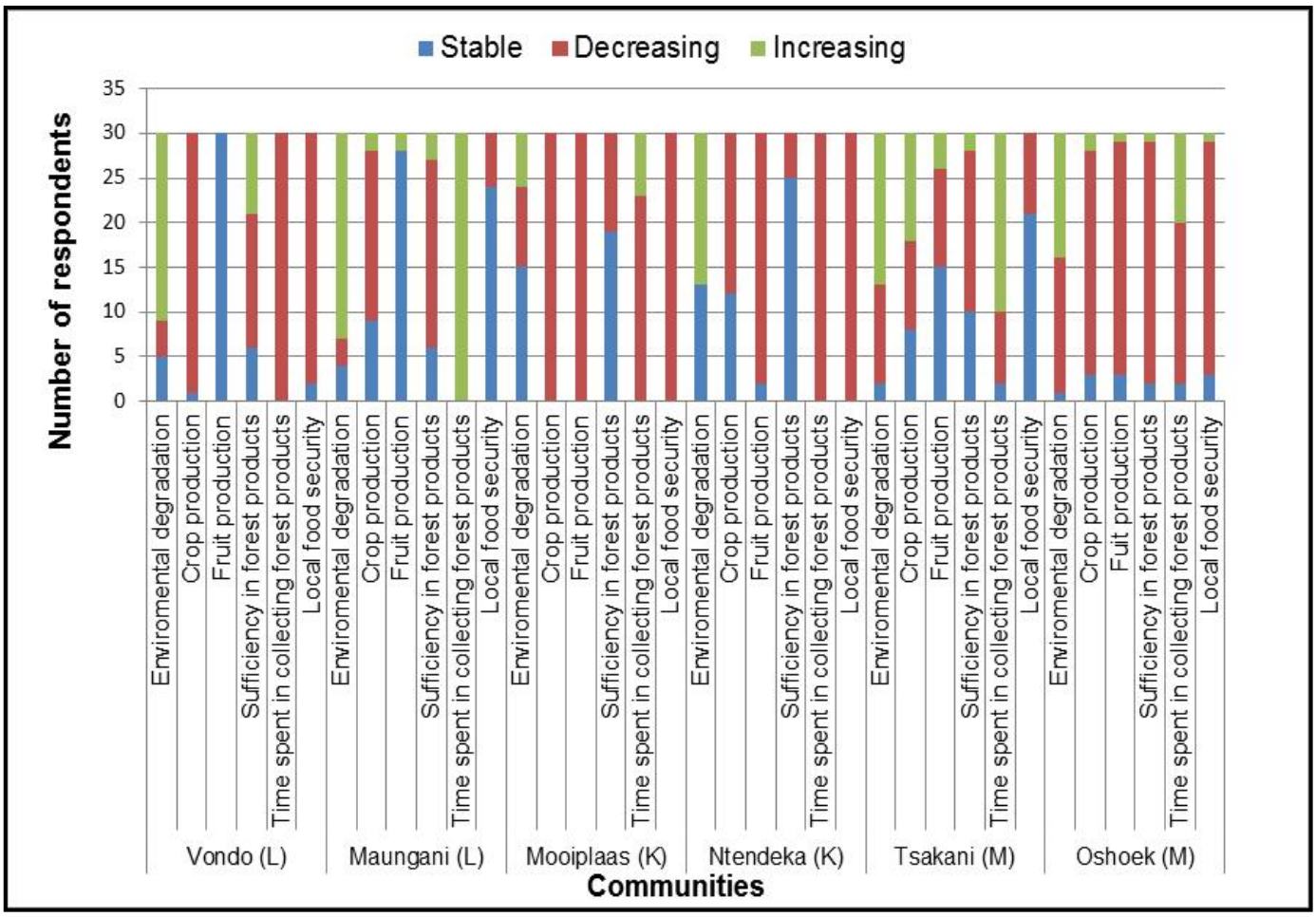


Figure 24: Impact of extracting ES (n=30 per community), L=Limpopo, K=KZN, M=Mpumalanga.

4.10. Enterprise and income generation

Most of the Vondo respondents (87%) indicated that they did not benefit from timber and non-timber products processing. Respondents indicated that there were no forest based products processing activities in the area. All respondents in Maungani indicated they did not benefit from timber and non-timber products processing and there had not been any forest based products processing conducted in the area.

Furthermore, only 17% of Vondo respondents benefited from job opportunities on the tea estate in the area.

The benefits obtained in the KZN and Mpumalanga communities from timber and non-timber forest products are illustrated in Figure 25. There was a higher usage of construction material in Mooiplaas, Oshoek and Ntendeka (indicated by 63%, 50% and 43% of respondents respectively) than in the other communities.

Extraction of thatch grass from the forest required a free permit in KZN communities. Construction materials were bought from the nearest timber processing mill and used for house structures. Timber was collected from plantations after clear-felling and used for constructing livestock kraals.

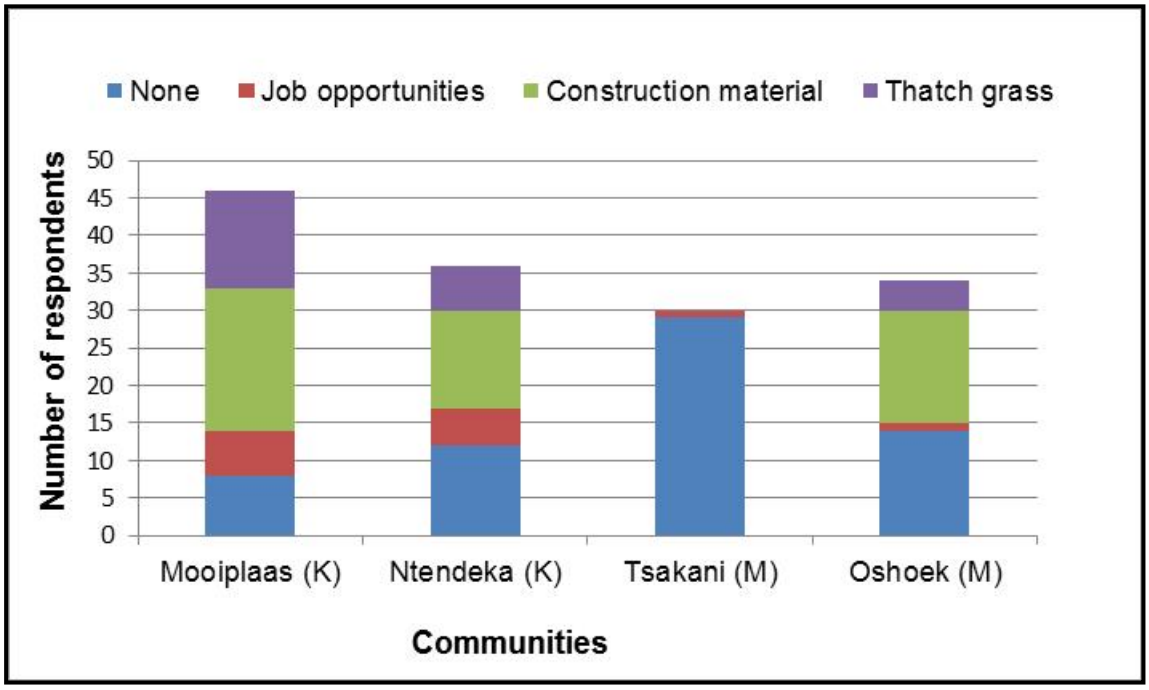


Figure 25: Benefit from timber and non-timber forest products (n=30 per community), K=KZN, M=Mpumalanga.

Communities would like to start new businesses based on available natural products and crop production (Figure 26). For example respondents in Mooiplaas (61%), Vondo (54%), Ntendeka (50%), Tsakani (39%) and Oshoek (40%) were interested in gardening, while some of the respondents in Maungani (32%) wanted to process fruits (juices, jams and dried etc.).

The wide range of projects in Oshoek was due to the fact that there were no shops close to the area that they could use to purchase goods. The closest place they could

go to was Swaziland, however some goods were not allowed to cross the border and therefore they had to travel more than an hour to Ermelo to buy food.

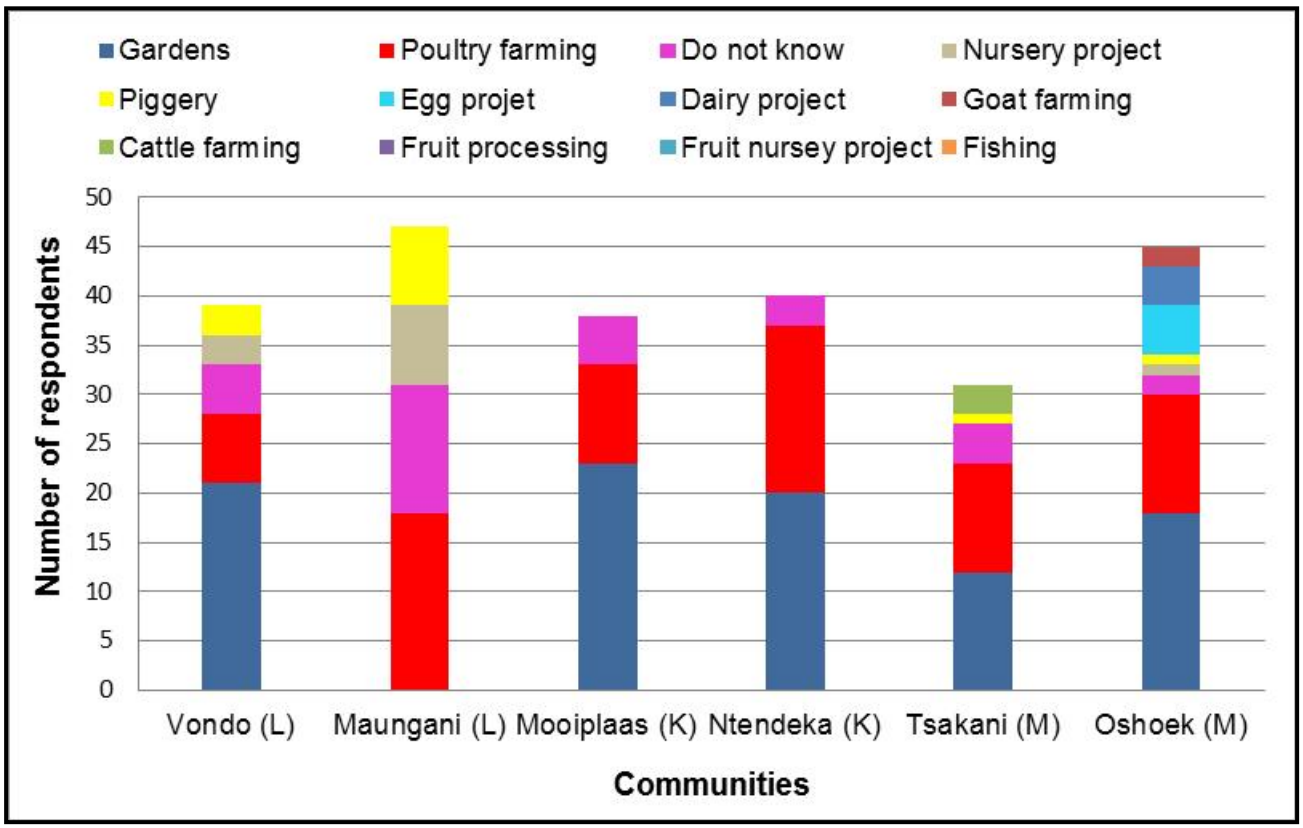


Figure 26: Natural products and farming businesses communities would like to start (n=30 per community), L=Limpopo, K=KZN, M=Mpumalanga.

The majority of respondents mentioned that a need for training of younger people existed to alleviate poverty (Figure 27). Respondents also emphasised that markets would need to be developed for new businesses and that they needed assistance in selling products.

Maungani community already had access to the Tshakhuma local market where they sold most of their fruits. Despite access to this market some fruits still gone to waste as there was not a big enough market for all fruit and products.

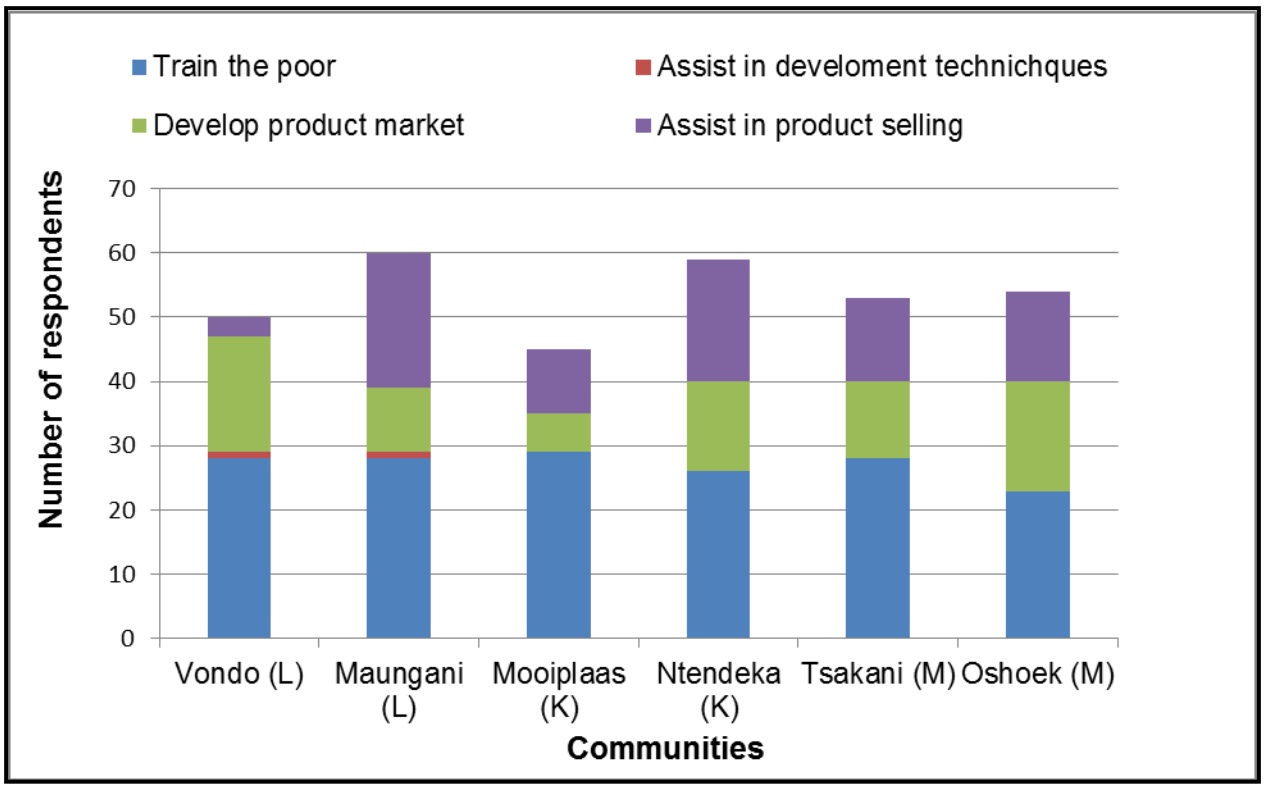


Figure 27: Suggested opportunities to increase income for poor households (n=30 per community), L=Limpopo, K=KZN, M=Mpumalanga.

4.11. Literature review of agroforestry systems in KLF

SAFCOL annual reports highlighted that the company wanted "to establish and drive socio-economic development projects and to develop new sustainable enterprises that will aid in poverty alleviation" (SAFCOL 2013). To achieve this, SAFCOL and KLF needed to enter into social compacts with communities within 20km radius of their operations (SAFCOL 2010). To date, about 13 social compacts had been signed with communities.

SAFCOL's SED and ED were viewed as the company's pillar to society transformation (Arrikum 2014). Projects dealt with by the SED and ED team had a strong emphasis on teaching and learning resources, environmental education and conservation, health care, small business and contractor development, infrastructure, corporate social investment contribution, and prevention of women and child abuse (Arrikum 2014; SAFCOL 2013). Various projects including building of schools, crèches, community halls, old age homes and gardens were facilitated by the SED and ED team on request of the communities. Among projects that were completed in

2012/2013 were the Makambane vegetable gardening in KZN and Pilgrims Rest vegetable gardening in Mpumalanga (SAFCOL 2013).

With the company having 63% of its land claimed, agroforestry was seen as a golden opportunity to obtain buy-in of the land claimants and to become a partner of choice as both parties could benefit financially. It could also alleviate poverty and increase food security in rural communities. About 50% of KLF plantations had agroforestry operations on-going with cattle farming (43%) the most prominent. Damage to young trees and exceeding of carrying capacity had been the main problem related to cattle grazing. A total number of 2 998 large and 408 small livestock units belonging to communities and employees utilised an estimated amount of 27% of KLF's grazing capacity. Other agroforestry related activities included firewood and mushroom collection, bee farming and crop production (Figure 28, Table 6 and Appendix A).

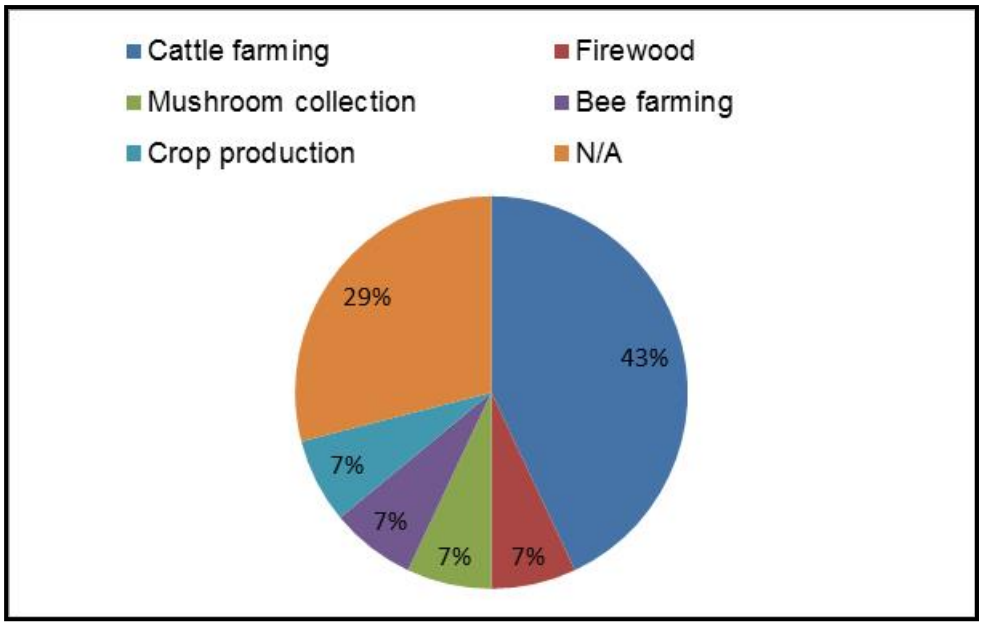


Figure 28: Agroforestry operations in KLF plantations (Meyer et al. 2015).

Income generation activities were conducted by women in Tzaneen who sold peanuts planted in one of SAFCOL's plantations. Furthermore, firewood was collected at Entabeni plantation and sold at the local market (Mdhovu 2015). At Pilgrims Rest a vegetable gardening group sold vegetables to the local restaurants and hotel (SAFCOL 2013).

Table 6: Agroforestry projects in KLF plantations and their status (Meyer et al. 2015)

Plantation	Type of projects	Status
Belfast	None	None
Berlin	Cattle grazing	Ongoing
Blyde	None	None
Brooklands	None	None
DM Highveld	Cattle grazing Firewood collection Mushroom collection	None
Entabeni	Grazing Crop production Bee farming	Ongoing
Jessievale	Cattle grazing	Ongoing
Nelshoogte	Cattle grazing	Ongoing
Ngome	Cattle grazing	Ongoing
Robunia	Grazing	None
Tweefontein	None	None
Witklip	None	None
Bergvliet	None	None
Wilgeboom	None	None
Uitsoek	None	None

Eighty percent of the plantation managers in KLF plantations indicated that there was a possibility of success in implementation of agroforestry operations if “there was support from senior management, dedicated persons to drive the process; right procedures and methods and if people involved were fully committed”. They also highlighted effective communication and the relationship between KLF and communities as requirements for success. Managers also indicated that for agroforestry to work in the company it should be managed by trained extension foresters to allow for better focus while foresters continued to manage their plantations (Meyer et al. 2015).

Appendix A presents an example of how successful agroforestry projects within KLF plantations can function.

4.12. Summary

The study communities had high levels of unemployment, poor housing infrastructure, high household sizes and low income levels. This impacts on the economy of the country and the working generation and therefore a solution that will reduce the impact is required. The most extracted ES by the study communities were water, firewood and construction material. Land use in these communities was mainly for planting crops with mealies being the most planted on land. Most respondents indicated that for future income generation they would like to have garden projects in their communities. However, they require training to equip them with skills and knowledge on how to run the projects.

Chapter 5: Discussion of research findings and results

5.1. Demographics

When considering agroforestry systems the well-known quote of Westoby (1967, cited in Hobley 2005) that “Forestry is not about trees, it is about people, and it is about trees only insofar as trees can serve the needs of people” comes to mind. It is not possible to design agroforestry interventions without considering the needs of people. The demographic information gathered from the questionnaire survey indicated that age, education and unemployment are important factors influencing livelihoods with special emphasis on age.

5.1.1. Age

There is not a clearly definable age trend visible from the survey data. Communities such as Vondo and Tsakani, however, had significantly less young people compared to other communities. According to Statistics SA (2011) there is a general increase in older people among communities in Limpopo (42.1% in 2001 to 48.2% 2011). In the Mpumalanga province the age class distribution is skewed towards younger people (70 % of respondents), an observation supported by SERO (2014) that 0 to 4 years are the most prominent age group. This leads to high population and economic dependency ratios hence working individuals face the burden of supporting young and old (Titu et al. 2012; Ingham et al. 2009).

Generally, rural areas are expected to have a low proportion of old people compared to urban areas, due to lower life expectancies and access to health services (Anríquez and Stloukal 2008). The higher proportion of older people observed in Mooiplaas and Tsakani could be because older people prefer to remain in rural areas with low costs of accommodation (KZN Department of Community Safety and Liaison 2010).

In most villages the 46 to 55 year group was smaller than the other age groups. This can be due to the lack of working age individuals that immigrated to urban areas in search of employment, leaving behind old people and young children (Brown 2010; Human Settlements 2010; Anríquez and Stloukal 2008). Emigration is one of the factors that contribute to changes in size of population as it affects the origin and

destination population (Khoo and McDonald 2011). Another possible reason could be the effect of HIV/AIDS. AIDS primarily strikes adults in their prime working-ages (Ashfold 2006), affecting mortality rate (Drimie 2002). Its impacts on rural community erode developmental prospects (KZN Department of Community Safety & Liaison 2010). In rural communities AIDS leaves older people with responsibilities to take care of those afflicted and their children (Barrientos 2008).

5.1.2. Education

Education is essential in reducing poverty and improving living conditions of rural communities (Aref 2011). Rural community schools have the same policies, national legislation and curriculum as all other public schools, however at provincial and district level conditions are not equal. Some of the rural community schools deals with issues such as lack of classrooms, libraries, clean running water, and poor access to services such as electricity. These conditions are not good enough to provide sound education to young people (Gardiner 2008).

Aref (2011) and Gardiner (2008) stated that it is important to consider the concerns and interest of rural communities before discussing their educational matters because it is not only poverty, employment and lack of resources that affects education but also socio-economic conditions. The survey indicated that villages do not attend secondary education due to issues such as transport costs. As compared with other schools, performance in rural schools is low (Table 7), possibly affecting percentage of respondents that achieved a tertiary education.

Table 7: Pass rates from the grade six systemic evaluation, 2006 (Gardiner 2008)

Type of school	Language	Mathematics	Natural Sciences
	Pass rate percentage		
Urban	64	46	58
Township	40	26	42
Rural	29	22	35
Remote rural	23	19	30
Farm	34	24	37

5.1.3. Dependency

The study observed large average household sizes (5.4 Limpopo, 6.3 Mpumalanga and 8.2 KZN) compared to the provincial average household sizes (KZN =3.4, Limpopo=3.7 and Mpumalanga=3.7) and South Africa's national average household size of 3.4 (Indicator data 2015). The number of people that are unemployed plus dependents outweighs the proportion of the people employed (Brown 2010) resulting in an increased dependency ratio.

Generally in SA dependency ratio has been increasing over time (Titu et al. 2012; Standish and Boting 2006). The growing dependency ratio is not only due to decline in total fertility (Mid-year population estimates 2015; Joubert and Bradshaw 2006) or aging population but also from the impact of HIV/AIDS (Bloom et al. 2011; Joubert and Bradshaw 2006; Angelo 2003). This increase in dependency ratio impacts on SA retirement funds and place a burden on working individuals who face the burden of supporting non-working people and the aging population (Titu et al. 2012; Ingham et al. 2009; Standish and Boting 2006).

5.1.4. Income

South Africa is plagued by low economic growth and high levels of employment. National unemployment rates increased from 22% to 25% in 2014 (Statistics SA 2015). Unemployment rates in the case study villages are substantially higher than national average and ranged between 70% and 100%.

The main source of income in these villages was social grants. These grants assist in alleviating poverty (Abimbola and Oluwakemi 2013; Neves et al. 2009) but are not enough to sustain high rural household sizes. The larger the household size in adult equivalent the higher the probability to participate in varied income sources (Beraka and Abrha 2014; Chirwa and Matita 2012). Rural households develop strategies to cope with vulnerability of agricultural production through diversification, migration and/ or intensification (Abimbola and Oluwakemi 2013). Although diversification is seen as a process created through pressures and opportunities, it is beneficial for rural people (Ellis 1999) as it help stabilize or increase their income (Johny et al. 2014).

Income diversification in this study included agriculture, self-employment, part time jobs, business and labour. Socio-economic characteristics influence household decision-making on income diversification choice (Awotide et al. 2012), which include push factors such as risk management, population pressure, cope with economic shock and pull factors such as enhancement of rural development, income increase and risk stabilisation (Zhao and Barry 2014; Barret et al. 2001).

Education is one factor that determines non-farm income (Barret et al. 2001) and most respondents do not have the required skills and education to make use of business opportunities. Over and above the need for skills, business opportunities have high barriers to entry or accumulation in terms of land, human capital, and other productive assets (Davis 2014). This is a possible reason why more of the survey respondents rather depended on social grants than businesses to supply household income.

Income levels in the surveyed communities were dependent on the number of old aged people and young children who earn social grants. Child social grants are perceived as means of increasing household income through teenagers falling pregnant and for teenagers as a way of increasing pocket money (Hall et al. 2011; Kanku and Marsh 2010; Macleod, 2006).

Rural poor also diversify their livelihoods by both increased migration and more local non-farm employment (Lay and Schuler 2008). It is therefore important to understand the effects of diversification on rural household income since “it will allow public sectors to design policies that are better suited to the needs and characteristics of rural constituent” (Zhao and Barry 2014).

5.2. Household capital

Capital owned by the survey communities varies from house, livestock, transport, farm or land. All these capital are equally important to the communities except for transport, which could be substituted by public transport means. People make use of livestock to generate income; however the study found that although KZN communities were rich in livestock, it was not used to generate income.

5.2.1. Land

Poor rural communities are mostly affected by land tenure and land restitution because wealth in poor communities is also measured by access to land (Abdulai et al. 2007; Cotula et al. 2006). Access to land is the basis for shelter, food production and economic activities. In poor communities, land could contribute to poverty reduction through agriculture wherein the poor can have food security and income generation (GLTN 2008; Cotula et al. 2006).

In this study communities have access to land but cannot own it due to unresolved land claims. Informal land tenure is less valuable, result in ownership disputes and it is more difficult to access finance with informal land tenure than in the case of private or well defined land ownership (Smith et al. 2007).

In South Africa, there is high level of poverty and inequality. The problem lies in the absence of formal property rights on the assets owned by the poor. Capitalism can be made to work for the poor by formalising their property rights in houses, land and small businesses (Kingwill et al. 2006; Cousins et al. 2005; deSoto 2000).

The value of land to the poor includes the following (Brown-Luthango and Smit 2007):

- Land is a natural asset that provides space for other physical assets such as housing;
- Land can give access to infrastructure (roads, water, sanitation, electricity);
- Land can be an economic asset that can be sold or bequeathed to one's heirs and that can potentially be used as collateral or credit; and
- Land can be used for income generation purposes.

However without formal tenure rights, property rights inconveniences the poor since it will be difficult to make use of land, gain full value land assets, protect or use assets to create wealth and it cannot be used effectively for economic purposes (Mooya and Cloete 2005; Gilbert 2002). De Soto (2000) refers to this lack of tenure security and associated inability to leverage economic activity as "dead capital".

Kingwill et al. (2006) stated that “de Soto's views have not been properly examined and debated in the South African context” and that the views have limited use in SA because (Kingwill et al. 2006; Cousins et al. 2005):

- Titling does not necessarily promote increased tenure security or certainty;
- Formalisation of property rights does not promote lending to the poor;
- The urban and rural poor already have some access to credit; and
- Formalisation through registered title deeds creates unaffordable costs for many poor people.

It is therefore relevant only for those who are already on the way out of poverty.

5.2.2. Houses

Houses observed in the study range from mud to brick constructions. The main building materials are timber, bricks, thatch grass and corrugated zinc for roofing. Building materials are important when it comes to housing as they add value to human life and therefore should be free from any decay such as being rotten, warp, knot, fungi, mould or termite (Adebara et al. 2014).

The quality of the house is measured by the structural condition (India Infrastructure Report 2007). Housing conditions in rural areas are generally poor with a majority of rural housing being structurally unsafe (Human Settlements 2010). In this study, timber was found to be the main product for building house structures in KZN and some houses in Oshoek with thatched roofing. However, the timber structure deteriorates with time due to lack of quality timber utilization for building construction and therefore requires replacement regularly with increased maintenance costs. The quality of the timber is species dependent (Adebara et al. 2014) and influences the stability of the structure. Some of the communities in this study are using timber that is not tested for its strength and durability and since mud is mostly used to cover up the structure, it increases levels of humidity during rainy seasons, increasing physically deterioration (Almusaed and Almssad 2015).

In the other communities as opposed to Oshoek, Ntendeka and Mooiplaas, houses are mainly built from bricks with corrugated zinc roofs. Although this is the ideal combination of building material (Gaugris et al. 2006), it is too expensive for rural communities (Human Settlements 2010). One of the reasons for not using thatched

roof is that it takes longer to complete than corrugated zinc and availability of grass could be a limiting factor (Gaugris et al. 2006).

5.2.3. Livestock

Livestock contributes significantly to the livelihood of rural communities (Olowa 2010; Heffernan 2004). Households have different incentives to keep livestock because of a wide variety of benefits provided such as food, income generation, manure for fertiliser, social roles and as a way of investment (Pica-Ciamarra et al. 2011; Olowa 2010; Heffernan 2004; Maltsoglou 2004; Waters-Bayer and Bayer 1992). In the study livestock was mainly kept for household consumption, cultural activities and as an indicator of wealth (Mutambara et al. 2012).

Although livestock is seen as an important source of income in poor households, few people sell livestock. This can be due to lack of incentives for commercialisation of livestock and products, weak links of livestock producers to markets (Kazybayeva et al. 2006), and the maintenance costs for large ruminants associated with animal health care and feed (Pica-Ciamarra et al 2011; Heffernan 2004).

5.3. Ecosystem services

Dependence on ES in rural poor communities is due to poor living conditions (McMichael et al. 2005). In this study, ES use differed between communities depending on the needs and available time in that particular community (Villamagna et al. 2013); moreover they relied on ES to compliment and substitute income.

5.3.1. Ecosystem services use

A range of ES, including timber, firewood, water, food sources, forage areas and construction material were used by communities consulted in this study.

Managing access to a service is crucial to all successful natural resources institutions (McMichael et al. 2005); however conflicts arise over policies that restrict access to natural resources for local communities (TEEB 2010). Respondents stated that they were afraid to get fined when harvesting trees or firewood from the forests. However, the challenge is to obtain a balance in protecting or preserving natural forest for

future use and meeting immediate needs of the community (Boon and Ahenkan 2007).

Protecting ecosystems is crucial for the growing population whose survival is dependent on subsistence agriculture, collection of safe drinking water, and the harvesting of forest products (Turpie et al. 2009). Payment for Ecosystem Services (PES) is a potential strategy/mechanism to account for environmental sustainability and protection of ES. In this study, payment was made for timber collection and grazing in Limpopo plantations.

Understanding the relationship between PES and poverty is essential to adopt the correct schemes to reduce poverty and risk. Ignoring or not considering the effect of PES could be a lost opportunity to reduce poverty (Lee et al. 2007). PES schemes will work best when the cost of providing the services is low and the value of ES to beneficiaries is high (Mayrand and Paquin 2004).

5.3.2. Degradation

Dependence on ES damages the capacity of ecosystem to deliver ES sustainably (McMichael et al. 2005). The survey indicated that the use of ES led to environmental degradation in most of the communities. The main threat and pressure to forests and natural resources is increasing number of household stands (population size) and illegal harvesting of trees which has led to the partly deforestation of the natural forests.

In parts of Africa and South Africa clearing of vegetation and overgrazing is a problem when it comes to degradation. This is because rural communities are characterised by high number of people and livestock, thus increase in grazing and vegetation removal for fire wood (Wessels et al. 2007).

Studies showed that a total of 4.8% (5.8 million ha) of Limpopo province was mapped as degraded (Wessels et al. 2007), while KZN is badly affected by soil erosion (Palmer and Ainslie 2002; Zakwe 2001). And in Mpumalanga soils are highly susceptible to erosion (Le Roux 2007).

5.4. Enterprise development

One of the assumptions of participatory rural development is that communities possess knowledge and skills that can be used in the process of developing their communities (Trollip and Boshoff 2001); however this study shows that the communities lack skills and training. Rural communities require training which will give them opportunity to develop their skills in business management, market, packaging and pricing (Tersoo 2012; Collet and Gale 2009).

5.4.1. Women empowerment

The majority of respondents in this study were women who are identified as key agents for sustainable rural development (Handy and Kassam 2004) particularly in niches such as vegetable gardens (IFAD 2003). This is most likely the reason why the majority of respondents in all communities indicated gardens as their preferred agroforestry practice to elevate them from poverty and increase food security. Women should therefore be empowered and encouraged to improve their practice of home gardening (Musotsi et al. 2008). Training women will enable them to think entrepreneurially, analyse their situation and identify income generating activities (Collet and Gale 2009).

5.4.2. Integrating training and enterprise

Integrating training and enterprises goes beyond equipping rural communities with skills to benefit from (Collet and Gale 2009). More than 60% of respondents indicated that training is essential in developing their communities.

Integrating training with enterprises assist in improving the quality of goods and gaining higher prices in the market (Collet and Gale 2009), because as competition increases there is a need for competitively priced products (Desai 2013). Moreover this can help women to take advantage of new agricultural opportunities as well as helping prospective entrepreneurs become successful (Collet and Gale 2009; IFAD 2003).

5.4.3. Market development

One of the reasons rural communities cannot improve their livelihood standards is that they have no access to markets (Collet and Gale 2009; IFAD 2003). During this study, respondents in Maungani and Vondo indicated they need help with marketing their products, while a lack of markets in the remaining communities was also highlighted. The nerve centre for rural development is marketing as it is concerned with the flow of goods and services from urban to rural areas (Ahmed 2013; IFAD 2003), therefore rural marketing has to be seen and implemented as investments for a better tomorrow (Desai 2013).

Constraints that can be encountered in rural marketing includes lack of understanding business, lack of investment and working capital, limited business and negotiating skills. Lack of organisation/institution that could give bargaining power to interact on equal terms as well as remote locations and high transport costs prevent them from accessing markets (IFAD 2003).

Agricultural land gains greater value in areas where markets emerge (IFAD 2003).In these areas rural markets principles adopted should consider lifestyle, needs and consumer behaviour. Rural market principles for innovation as stated by Desai (2013) are innovation of product, process, price and promotional.

5.5. Agroforestry interventions

While the current KLF focus is on silvopastoral systems and the management of grazing, the survey indicated a need for agrisilviculture systems, especially gardens. Agriculture has been the main source of food in rural communities (Aliber and Hart 2009) and therefore increasing agricultural productivity would lead to a reduction of food insecurity and poverty (Matshe 2009).

Gardens are part of agriculture and food production systems in many developing countries (Musotsi et al. 2008). Although gardens may be vulnerable to harsh environmental conditions such as drought and floods (Musotsi et al. 2008), they provide more than just food security. They have environmental, ecological, economic and social benefits (Galhena et al. 2013; Wilson 2011; Kearney 2009).

Trees and crops in gardens contribute to the reduction of soil erosion, increasing diversity of species and the provision of shade for animals. Community's health is improved through nutritional security and or herbs that can be incorporated in the gardens (Adekunle 2013). Moreover they contribute to income generation, improved livelihoods, and household economic welfare as well as promoting entrepreneurship and rural development (Galhena et al. 2013; Earl 2011; Wilson 2011; Musotsi et al. 2008). Gardens can reduce the pressure on ES since communities will no longer depend that much on environmental sources at the same time benefiting with services they want in the natural environment or forest (Mattsson 2013).

5.6. Summary

Study communities are interested in improving their livelihoods though agroforestry based ventures. However, there is need for assistance especially when it comes to training on agroforestry projects management, enterprise development and marketing of products produced.

Chapter 6: Conclusion and recommendations

The objectives underlying this study included identifying key ES that benefits case study communities; assessing local communities' perceptions, awareness and expectations on agroforestry for ES; reviewing background information on agroforestry projects conducted by KLF in the past and recommending agroforestry systems that could be implemented in future.

Case study communities' dependence on ES varies according to their needs and demands. The ES that benefited these communities included water, firewood, timber and construction material. Since there is degradation of ES and scarcity of water in the case study communities, some of the promoted actions could be agroforestry development for protection of the existing ES such as water, biodiversity and to create new agriculture and business opportunities for the communities. Although water is a scares resource in all communities, those that can afford extract water from the forest though the use of pipes to their household for basic use and watering crops among those with home gardens.

Respondents are familiar with ES, agroforestry and its benefits. They showed willingness to change their land use practices to more sustainable ones that could improve their livelihoods. This is seen in most communities trying to plant crops in their own homesteads in order to improve their livelihood despite lack of water in the communities. Their expectations are mainly to sustain local food security through crop production and generation of income thereof. Respondents indicated that the only way to go about this is through training and being equipped with skills to access market potentials of their resources.

Agroforestry projects that are on-going in KLF plantation's contradicts with the communities' needs. While there are more of cattle grazing in KLF plantations, case study communities want crop production. The need for crop production in these communities is due to high unemployment rate observed in the study communities and poor living conditions experienced; thus some of these communities have poor housing infrastructure, lack proper roads, electricity and toilets. Furthermore, the main income source and the level of income observed in the study communities is not enough to sustain household sizes. Change in focus in KLF could assist the communities to develop their own villages.

The change in focus in KLF will be a challenge as there is a lot of forces that will impact agroforestry development. Forces such as land claims, lack of agroforestry policy, start-up capital, agriculture competition, supply and demand, tribal authorities control, ownership scope, climate change, pest control, land use change, skills level in communities and equipment to be used will impact on agroforestry development. All these forces need to be addressed and before implementation of agroforestry to avoid failure of the project.

The need for interventions is stressed as the resources available for food production (including land, water, and credit) are becoming scarce and costly. From the study there is potential for implementation of agroforestry in the case study communities, though with some challenges. Agroforestry practice that is recommended for implementation is agrisilviculture and product development.

Agrisilviculture could be implemented in the KLF open land where communities could be allowed to use land for crop production. This will enable communities to increase food security in their households while reducing the weeds that grows in the open land. Communities that have land but does not make use of it could be assisted with seeds and extraction of water from forests where possible so they can utilise land for crop production.

Recommendations

Recommendations for the study can be summarised as:

1. The optimal agroforestry system to implement is agrisilviculture (for example gardens). This can be implemented through small scale projects in the case study communities wherein different crops are planted. Non-working women in the communities can volunteer for these projects. Products obtained from gardens will reduce pressure exerted on forests as communities will be obtaining food sources in the proximity of their area. Degraded land can also be rehabilitated through crop production as there will be minimal erosion taking place in the communities.
2. A further study to evaluate the impact that implementation of agroforestry will have on the company should consider benefit cost analysis, risks, conflict of interest between KLF and communities, and land and land use management issues. Implementation of agroforestry system above will require:

- Support

  Financial and material support is required for implementation of the project.

- Suitability assessment

  Suitability assessment is an important aspect that influences productivity, sustainability and adoptability. Field experiments are required using different scientific methods to analyse suitability of agroforestry practices in different communities. This will help in identification of crops and or trees that could be adoptable under conditions in the area.

- Training and advice

  Training is required to equip communities with necessary skills for management of agroforestry practices. This could be short courses and or workshops among volunteers in the community interested in agroforestry projects.

- Project management

  Active involvement of local people in the development of agroforestry project can make a great difference between the success and failure of the project. It is therefore crucial to have community delegated leaders in managing and running of the projects. Managing of specific duties by local people enables them to feel part of the project and it encourages them to work hard.

- Evaluation

  Agroforestry activities can be evaluated once a month or each year as well as in every meeting or visit involving groups or participants in the project. This enables for accessing project progress (production shortfalls, problem generating aspects and the solutions thereof) through community reviewing and discussing their own work, relationship among themselves and the changes they can make in future to make it better.

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Appendices

A: Agroforestry systems practiced by KLF plantations

As mentioned in section 4.11, there are currently agroforestry practices going on within some of the KLF plantations. One such a project is the agrisilvicultural and silvopastural systems employed by Mr Tambani and Mr Tshiamabaro at Entabeni plantation

Mr Albert Tambani - Agrisilviculture

Mr Albert Tambani (Figure 29) from Lwamondo in Belemu village is one of the people that are sustaining their livelihoods through agroforestry. He started working in 2004 when he obtained a 6 ha piece of land within the Entabeni plantation delineated area. The land was previously used for planting *Pinus* species.

Figure 29: Mr Tambani holding Mustard, one of his products.

When he started, he was working alone and since 2011 three young men joined him. These men passed matric but could not further their studies due to financial problems. The agreement he has with the three young men is that they assist him and he sponsor their tertiary studies. Currently one of these men has completed his studies in being a plumber and the other two are in the process of getting their relevant qualifications as a plumber and an electrician.

Mr Tambani's crops are fertilised using inorganic and organic fertilisers however most of the fertilisers that he uses is organic fertilisers from cows, chicken and pigs. During maize harvesting time, those with cows supply him with cow manure and they in turn received the corn stalks (Figure 30) for cow feed. Pine bark is also used as fertilisers. It is applied to control moisture loss in the soil.

Figure 30: Corn stalks used for cows' feed after mealies harvesting.

The water he uses for watering his plants is from Lupangamadzi and Dzindi rivers. He uses pipes to extract water directly rivers/stream and it is stored in a tank in the field. From the tank a dripping system is used for watering the crops.

Mr Tambani produces quite a number of products, of which some are illustrated in Figure 31.

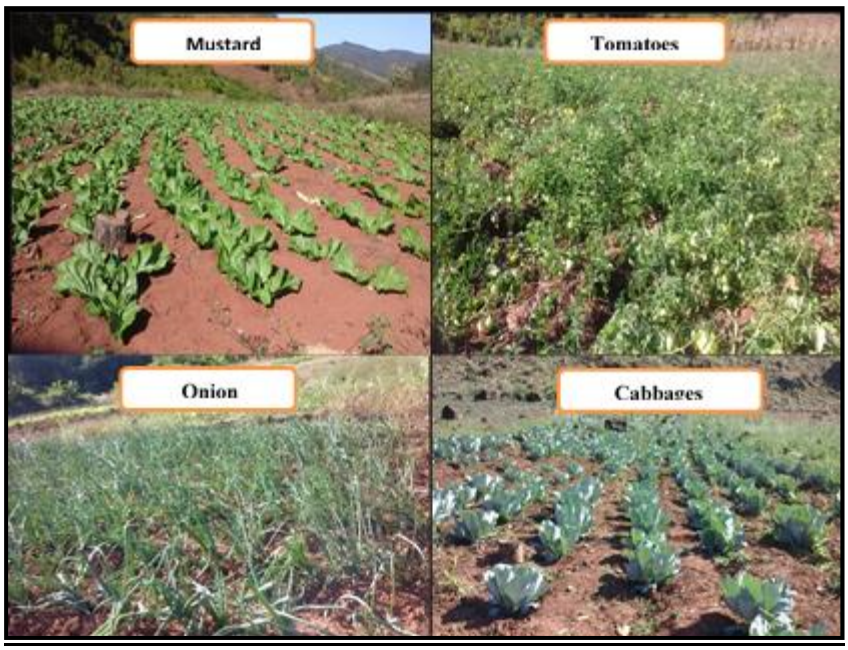

Figure 31: Mr Tambani's products.

Table 8 present the quantity produced and the income thereof of his products. It should be noted that some of his products are seasonal and therefore can only be obtained during specific season and that the figures given below are of 2014. His products are currently being sold to local people and shops such as Spar in Tshakhuma.

Table 8: Income generated by Mr Tambani

Product	**Quantity**	**Selling price**	**Income**
Onion	5 000	R1 each	**R 5 000**
Spinach	1 000 bundles	R5/bundle	**R 5 000**
Mustard	1 000 bundles	R5/bundle	**R 5 000**
Cabbage	1 0000	R5 each	**R 5 000**
Sweet potato	100 crates	R80/crate	**R 8 000**
Tomatoes	250 crates	R80/crate	**R 20 000**
Beet root	1 000 bundles	R5 /bundle	**R 5 000**
Butternut	1 000 of 10 Kg	R25 /10 Kg	**R 25 000**
Green pepper	150 crates	R100/crate	**R 15 000**
Green beans	100 crates	R100/crate	**R 10 000**
Annual income			**R 103 000**

Mr T.A Tshiambaro-Silvopasture

Mr Tshiambaro from Tshakhuma in Mulangaphunda village also known as Diambele. He owns cows and sheep that graze within the KLF plantations (Figure 32). His livestock started grazing in the KLF plantation in 2011. In order for one to have cows grazing in the KLF plantations, he/she has to obtain permission from the company and has to pay R3 per cow per year. The cows are only allowed to graze in matured plantation to avoid damage of young trees. A cowherd is also required to ensure that livestock does not move towards compartments with young species.

Figure 32: Cows grazing in KLF plantation.

The livestock is mainly for sale and sometime for dowry especially when they have a large number of people. Table 9 illustrate the number of cows and sheep he owns and the average selling price for each matured livestock unit. The actual selling price depends on the size of the cows and the gender. The livestock are sold depending on the demand.

Table 9: Number of livestock Mr Tshiambaro has grazing in KLF plantation

Livestock	Quantity	Average selling price
Cattle	65	R5 000 each
Sheep	40	R800 each

Challenges faced

There are several challenges that those with cows grazing in plantations face. Some of these challenges include:

- Control of diseases: Different people have cows grazing in the plantations and some of them do not take care of their livestock leading to cows getting diseases such as “lumpy skin”.
- Weed killer: Chemicals that are applied in plantations to kill weeds are poisonous to cows. Moreover using these chemicals kills the grass that livestock feeds on.
- Poaching: People who go to the forest for hunting usually set traps in the forest land and sometimes livestock get stolen. Fire can also be induced which in turn damage grazing area.

B: Questionnaire

A: Demographic information

Survey no:.....

Date.....

District .....

Area/Village.....

Gender .....

Age.....

Household size .....

Education level:

Secondary	
Tertiary	
Illiterate	

Occupation.....

Income source, mark all that applies:

Agriculture	
Business	
Labour	
Grant	

Other specify:

_____

_____

_____

_____

_____

_____

Level of income per month:

<1000	
1000-5000	
5000-10000	
>10000	

Household property:

House	
Transport mode	
Livestock	
Farm/piece of land	

Other specify:

_____

_____

_____

_____

Farmland

Who owns the land? _____

Size in hectares: _____

Purpose of farming

Sale	
Home consumption	

Which method of cultivation is used?

Method of cultivation	
Tractor ploughs	
Hand-hoeing	
Ox-drawn ploughs	

Which methods of soil fertility improvement do you use to improve farm production? Mark all that applies.

Method for soil fertility improvement	
Inorganic fertiliser	
Manure (compost, animal)	
Improved fallows	
Biomass transfer	

Other specify:

_____

_____

_____

_____

Which products do you cultivate? Estimate how much is earned from sales

Products	**Quantity**	**Income**

Where do you sell the products? Mark all that applies

Locally	
Urban market	
Foreign market	
None (household consumption)	

Which challenges do you mostly face?

_____

_____

_____

_____

Livestock

Do you keep livestock? **YES/NO**

Which livestock do you have? And what is the number of livestock you have.

Livestock	Quantity
Cattle	
Goats	
Sheep	
Other specify:	

What is the reason for keeping livestock? Mark all that applies.

Sale	
Home consumption	
Manure	
Social roles (dowry, ceremonies)	

Other specify:

_____

_____

_____

_____

How often do you sell livestock? Estimate how much is earned from livestock sales.

		No livestock sold	Income from livestock sales
Daily			
Weekly			
Monthly			
Annually			
Never			
Other specify:			

_____

_____

_____

B: Ecosystem services and the environment

Ecosystem services usage

Indicate all ES that are used by your household, and those you would expect to gain from forests but not available.

ES	ES extracted	Expect to gain from forests
Timber		
Fire wood		
Medicinal plants		
Food sources (e.g. crops, mushrooms, fruits etc.)		
Water sources (e.g. river)		
Crafting materials		
Construction material		
Forage areas		

ES quantification

ES	Distance to and from (hrs)	Quantity collected (Kg)	How often	Cost (Rand)	Income generated (Rand)
Timber					
Fire wood					
Medicinal plants					
Crafting materials					
Construction materials					
Forage areas					
Food sources					
Mushrooms					
Fruits					
Vegetables					
Honey					
Insects					

What do you think are the limitations for accessing or using ecosystem services?

_____

_____

_____

Impact of extracting ecosystem service in the forest

Indicate if the following are stable, increasing and or decreasing in the community.

	Stable	Increasing	Decreasing
Environmental degradation			
Crop production			
Fruit production			
Sufficiency in forest products			
Time spent in collecting forest products			
Local food security			

What do you think is the reason for the change?

_____

_____

_____

_____

C. Enterprise and income generation

Which benefits has your household obtained from timber and non-timber products processing?

None	
Job opportunities	
Income generation	
Packaged product	
Long lasting product (preservation)	
Other specify:	

What activities of forest-based products processing have been conducted in your area?

None	
Carpentry	
Handicraft production	
Treatment of medicine plants	
Primary processing of food	
Other specify:	

According to your opinion, how can we increase opportunity for poor households to participate in income generation activities at your locality?

Train the poor on techniques for non-timber products treatment and processing	
Assist in development of techniques for non-timber products treatment and processing	
Develop product markets	
Assist in product selling	
Other specify:	

Which of the businesses based on natural products and farming would you like to start and which of those already exist?

Business	**Would like to start**	**Already exist**