Improving Agricultural Practices in Mabibi as a means of limiting ecological impacts.

Nqobile P. K. Nyathikazi

Thesis in fulfillment of the Master of Science Degree

Departments of Geography and Agriculture

University of Zululand

October 2005

Abstract

This thesis considers the role of agriculture in a developing rural area adjacent to a nature reserve in northeastern South Africa. The study is framed within the socio-economic conditions of the people of Mabibi, South Africa, a village of 1000 Zulu and Tonga people, most of whom are engaged in subsistence agriculture in nutrient-poor soils and community based use of natural resources. The study actively engages with the community through fieldwork consisting of incremental steps to improve farming practice, with the aim of spatially limiting land disturbance in the wetlands, hence leaving areas for wildlife conservation.

A number of questions are addressed: will improved agricultural practice limit ecological impacts? What will be the main adaptation required to successfully implementing organic farming? Can locally-sourced funding take farming practice to another level?

This thesis examines the cultural protocols used in villages faced with environmental assets conflicting with subsistence livelihoods. Constraints faced by developing rural communities may be alleviated through agricultural improvements in the short term and an economic diversification in the long term.

A $200m^2$ on-farm experimental plot was implemented at Mabibi. In the first planting, Peanuts (arachis hypogaea) and onion (allium cepa) were sown in November 2003 using a block replicates system. Plots were divided into two and again sub-divided into eight. Organic compost was imported from the University of Zululand and incorporated at a rate of 5 kg / $2m^3$ of soil, applied in eight 2 x 2 m blocks. In the other 8 blocks pre-existent soil conditions were maintained (control). Since moving crops from wet to dry lands was the aim, it was difficult to expect positive results without an expensive irrigation system. Mabibi's area, characterized by sub- tropical

climate, is often exposed to dry spells. Annual mean precipitation can be high (1000 mm/year), but usually is concentrated in short periods, which leaves long dry and high temperature spells. Soil temperature in the open field at mid-day were measured and found to be up to 48°C! However with a mulch layer on the surface, this was reduced to 35°C. Given the poor soil and dry weather, vegetables such as onions would have difficulty growing without water stress. Drought and little compost caused the onions to fail. Peanuts responded to a small increase in composted nutrients with a 15% increase in yield, despite drought and pests. In the second planting in April 2004 more compos was added. Compost was incorporated at a rate of 25 kg / 2 m^3 soil and a significant of 54% increase in bean (Phaseolus vulgaris) yield was found, (accounting for standard deviations within the sample). Though sorghum (Sorghum bicolor) fared poorly with low rainfall, it responded positively to compost. The dry weight difference between compost and non-compost samples was 22%. These methods of composting and the outcome of the field experiments were conveyed to the community through workshops and meetings. Some of the local people realise the value of organic farming and seem ready to begin an implementation that will reduce wetland impacts. The community also has an increased awareness that conserving the wetlands will maintain a higher water table and cleaner water, and will thus keep them healthy and strong.

Preface

World trends are paving the way for increased use of organic farming and South Africa is part of the process. South Africa's Province of KwaZulu Natal is in the northeastern side of South Africa, lying adjacent to the humidifying effects of warm ocean currents that sustain coral reefs and a rich dune forest vegetation. Mabibi is a rural village within a coastal nature reserve near the Mozambique border. It has been settled by local Tonga and Zulu people for the past 200 years.

An isolated coastal community of about 1000 people is faced with different constraints such as poor quality soil, few niches for marine resources, illiteracy, a limited cash economy, little infrastructure, etc. Humans are part of biodiversity meaning their survival depends upon a mutually supportive relationship with the rest of the natural world. Loss of biodiversity and climate change are signals that indicate the need to develop and implement livelihoods that encourage the sustainable use of resources, whilst simultaneously benefiting people. Sustainable development seeks ways of reversing the impacts of damaging activities that make life more difficult for People. The aim of this research is to secure a sustainable use of natural farm practices within Mabibi village that help limit ecological impacts. This approach emphasises the intrinsic role of tribal authorities, local people and tourist operators in managing and utilising the natural environment in a sustainable way.

Chapter one covers the introduction and background to the thesis research. Chapter two provides a literature review whilst chapter three outlines the methods and data analysis. Chapter four provides the fieldwork results for the 1st implementation phase, the 2nd implementation phase and the statistical analysis thereof. Chapter five concludes the work and provides recommendations.

The thesis intends to demonstrate the added economic and social benefits of projects, products and initiatives that rely upon sustainable use of natural resources.

Acknowledgements

I would like to thank UNESCO for financial support to engage in this practical study. A special thanks to Prof. Mark Jury with his time, patience, understanding and support. To my Agricultural supervisors Prof. P Scogings and my co-supervisor Mr. A Wilson and Mr. A Mthembu (Department of Geography), I appreciate your assistance. I thank the staff of the Geography and Environmental Science Department of the University of Zululand for providing a 'home'. To the Mabibi people, my assistant Mr. Nhlozi thanks for your dedicated efforts. Thanks to Ms. Elena Bulfoni (University of Udine, Italy) for joining me at Mabibi for this project and to Mr. Mthalane (Agriculture Department) for ensuring that the 2nd implementation was a success.

Lastly but not least to the true God, Jehovah thanks for listening to my prayers, I 'm still seeking wisdom, insight and I believe my dream will come true. Lastly to my Family and my best friends – my special gratitude.

Dedication

To my parents Simon Golide and Thokozile Catherine Nyathikazi, my five Sisters Thandazo, Nonozi, Cebsile, Lindi and Sebe, my two Brothers Mathemba, Timothy and my late brother Mduduzi. I have learned through hardship of different experiences and walked through darkness to the light. Now I know those were the challenges to take me this far. This is dedicated to you.

If you have a vision, enlighten it and walk through it

Contents

Chapter 1
Introduction and background

Chapter 2
Literature Review

Chapter 3

Materials and Methods

Chapter 4
Discussion of Results

Chapter 5
Discussion and Conclusion

List of Figures

List of Tables

Chapter 1

Introduction and Background

1.1 Introduction

Mabibi is found in the northeastern part of South Africa (fig *1.1*). It consists of a coastal rural community that is vulnerable to poverty due to the limited agricultural potential of the land. A community garden has been introduced by the tribal authorities to develop a higher standard of living. Due to the lack of a water distribution network, poor soil and limited application of modern farming practice, its continuing low productivity means that people tend to crop in the wetlands surrounding the village and near Lake Sibaya. According to the Department of Environmental Affairs and tourism, South African Government farming on a wetland is detrimental to the ecology that supports flora, fauna as well as tourism in the vicinity (Moore, 2003). Wetlands provide effective, free treatment for many types of water-pollution. Natural filtration, sedimentation and other processes help clear the water of many pollutants (Hammer, 1992). The need to improve productivity so as to sustain the livelihood of this remote community and its future generations is the aim of this study.

Mabibi is located on the tropical northeast coast of South Africa lies within a government-proclaimed nature reserve. The people are poor and underdeveloped (Govender, 1999) yet the landscape is attractive for eco-tourism due to its scenery and biodiversity. The coastal plains are characterised by high sand dunes covered by dense forests edged by coral reefs interspersed by inland lakes surrounded by grasslands (Jury, 2003). Mabibi's soils are classified as deep Grey sands of Fernwood form or as yellowish redistributed sand with red dune cordon of the Berea form and blown sand (MacVicar, 1986). Mabibi lacks basic amenities such as health services, roads, electricity, shops, and markets and has little eco-tourism development. This research considers sustainable options to improve crop productivity in the community gardens.

1.2 Statement of the problem

Subsistence activities in the area of Mabibi within the greater St Lucia Wetland Park are potentially harmful to the biodiversity and eco-tourism as people farm in wetlands, cut down large trees and hunt wild animals. Despite the transition to democracy and subsequent promise of development, the R800 billion South African economy has not managed to reach many rural areas. Researchers have identified that unemployment, poverty and low poor agricultural production affect the lives of local people (Jury et al 2003).

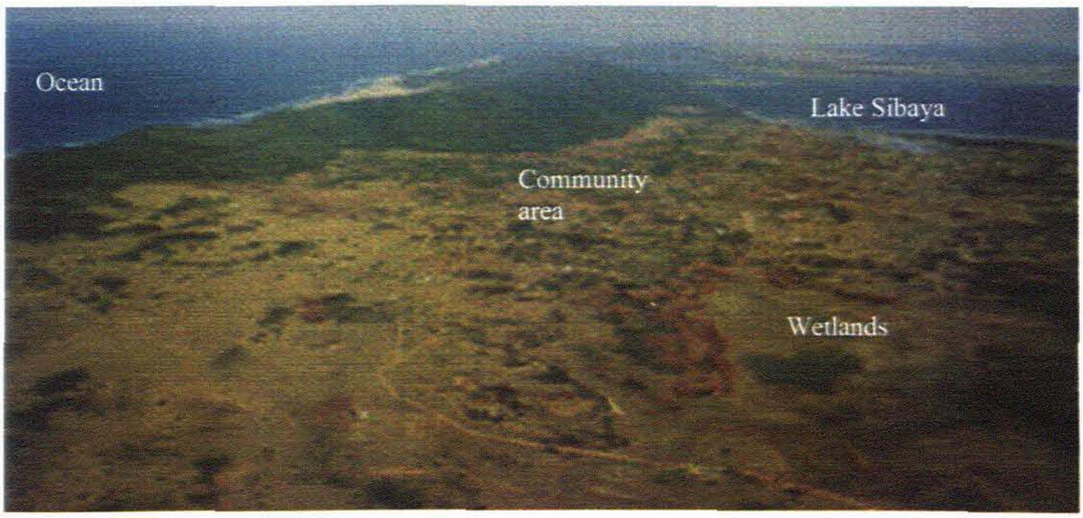


Figure 1.1 Aerial view looking South of Mabibi community area, Jury et al, (2003).

The local community is not making progress. The soil is sandy, poor in nutrients (lack of nitrogen, phosphorus and potassium) and does not retain water, productivity is expected to be low. The people of Mabibi plant crops around their dwellings, and tend to migrate their crops in the hopes of finding 'better' soils, clearing ever more increasing tracts of land (figure 5.1). So it is necessary to consolidate agricultural activities in the community garden. But first they need to be convinced that working in a small area applying organic methods actually works and can be easily sustained. To reduce impact on the land, an intensive agriculture demonstration plot was established in the community garden. With the success of a demonstration plot, local farmers would be attracted to this new method of cultivation.

1.3 Aims and Objectives of the study

A number of studies have preceded this one. Firstly a detailed socio-economic analysis of the Mabibi people was done by Mr. A T Mthembu of the Geography Dept, University of Zululand as part of a wider UNESCO project on sustainable development. He found that in Mabibi there was high level of unemployment. It was found that, out of 289 adult people in 58 households, only 97 people are working. About 26% of the households did not have household members who were employed. Large proportions of the people, who are working (68%), were employed in the surrounding areas of Mabibi such as Manzengwenya, Mbazwana, Manguzi, Mseleni and Jozini. The dominant socioeconomic activity for the households in Mabibi is subsistence agriculture, which is practiced by all the households. The main crops grown in the area include mealies, groundnuts, sweet potatoes and vegetables (Mthembu, 2001). The preparation of fields for planting is labour intensive, the fields are then tilled either by hand hoe or plough. One factor influencing the amount of labour required in cultivation is the technique of production e.g. hoe cultivation is more labour intensive than plough cultivation. Mechanical (tractor) cultivation results in a dramatic reduction in labour-hours/hectare. With tractor ploughing it is unnecessary to clear fields of between-season grass growth prior to ploughing. However it is necessary to plough the soil twice (Derman and Poultney, 1983).

The vegetables were grown in the swamp gardens wild animals and other problems associated with poor soil, insects and lack of agricultural equipment's were the problems encountered by Mabibi people in their agricultural activities (Mthembu, 2001). Secondly Ms E Bulfoni of the University of Udine as part of the same project accomplished a detailed study of current agricultural status and practices. She found that there were several factors that serve to undermine productivity and the realisation of the full agricultural potential of local farmers. These factors include general constraints that impair productivity in the majority of agrarian societies as well as constraints specific to the Mabibi area. Some of the general constraints are the labour off-take due to a high rate of migrant labour; the labour intensive non-mechanised technology; the lack of an efficient marketing infrastructure and the lack of capital required to subsidize entrepreneurial activities on a significant scale. Confined to an area of low agricultural potential and in the absence of irrigation, a form of shifting horticulture has developed on the alluvial soils of the village. Crops are planted on the banks of the lake and pans, to the detriment of the ecological habitat (Bulfoni, 2003).

Lack of water and poor soil induces people to plant in wetlands (Figure 1.2), which in turn cause poor water quality that results in diarrhea etc.

Figure 1.2: Cultivated wetland near Mabibi School.

Given this strong foundation of passive research, it was felt necessary to actively engage with the Mabibi community, to help uplift their agricultural practices, whilst at the same time improving chances for wildlife habitat conservation. So the main objective of this MSc project was:

- To implement a demonstration plot that will improve agricultural practice in the Mabibi community garden.

Sub-objective:

- To train local people in sustainable organic farming, using locally available resources.
- To confine agricultural activity in Mabibi to conserve natural ecological functioning (e.g. wetland bio-diversity, etc).
- To do a comparative analysis of the agricultural production in compost and pre-existent soils.

1.4 Hypothesis

The people of Mabibi practice subsistence agriculture to supply part of their food requirements. In most rural communities there is a tradition whereby indigenous crop cultivars are passed on from one generation to another. But in Mabibi, there are many challenges such as the poor soil and lack of resources, which require technical intervention to enhance the livelihood of the village whilst conserving the natural resources. In addition Mabibi lies within a proclaimed nature reserve where conservation is a priority. The main hypothesis is that organic farming practice in the dry land will improve yields and an indirect benefit will be to consolidate subsistence activities to promote biodiversity in the wider landscape. For this, the community needs technical advice on low-cost organic farming to be able to utilize their resources in an optimal way.

1.5 Background

Multi-disciplinary research has been conducted that seeks a balance between environmental and agricultural development. Without ecology there is no life and for the rural poor, agriculture needs to be improved. Many different assessments have been done on human, biological and physical dimensions (Jury et al 2003). To bring these together requires that rural communities learn to uplift themselves through land use skills that contribute to sustainable livelihoods. For the Mabibi community to have sustainable crop production they need to work with locally available resources. So organic farming is promoted since it is low cost and can be managed locally. Preservation of the natural landscape and ecological habitat is a useful long-term goal for the Mabibi community, as it can take part in tourism development. This can create jobs for some people, but there is also a short-term need to impart better farm skills to improve yields for subsistence crops. With food security comes the option of preservation of sensitive habitats such as wetlands that might otherwise go dry if exploited. Here in the Mabibi community, water from Lake Sibaya is plentiful, so the reason to save the wetlands is for their zoological *habitat and touristic appeal. The new Thonga Beach Lodge (Figure 1.3) will ensure a* pay-off to the community in that regard.

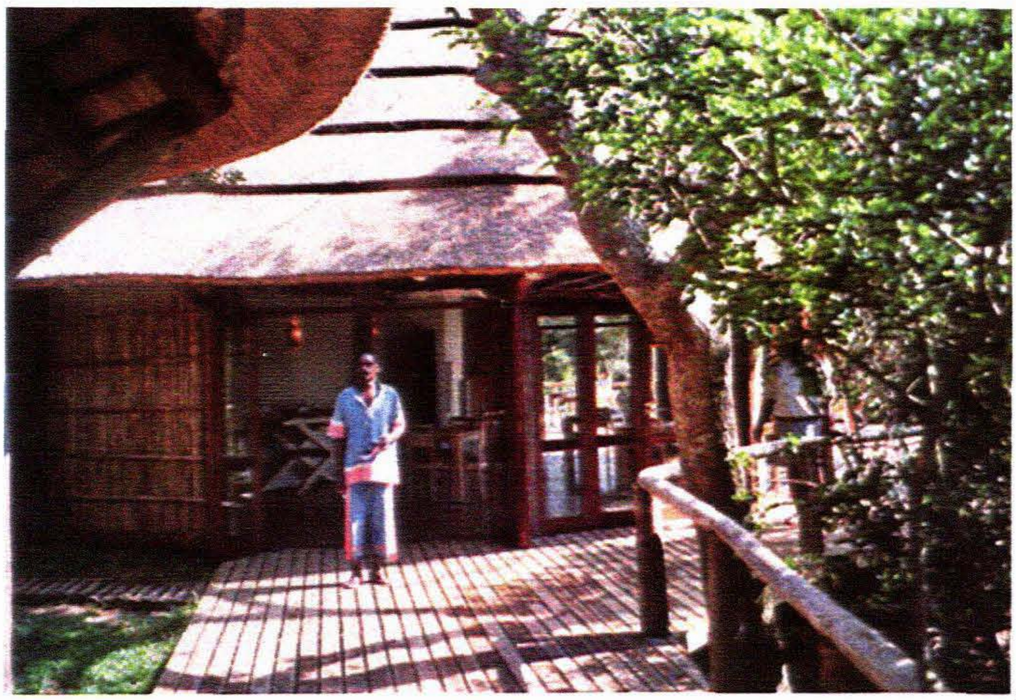


Figure 1.3: New Thonga Lodge on Mabibi beach

In 1996 the South African government decided that tourism should be the primary land use for the Maputaland coastal plains because of its scenic wetlands, coastal forests and its poor soil nutrients. This resulted in potential conflicts between conservation services, developers and local communities on how best to use the natural resources. With plans to promote tourism and related activities in the area, there needs to be available information and studies on the ecosystem functioning; as well as the potential impacts development will have on the biodiversity of the Maputaland region and on the life of its pastoral communities. The target is to find a complementary relationship between new sustainable agricultural practices that respect the environment and enable indigenous people's subsistence, and tourist activities linked to the nature reserve. Confining agricultural activity would benefit the ecosystem, whilst increased production would help the local inhabitants gain a sense of well being and prosperity (Jury, et al. 2003).

1.6 Relevance of the research

The study intends to improve the living standard of Mabibi people. If the demonstration plot is successful, then local people may adopt organic farming that is low in cost but labour intensive. This will help conservation efforts and reduce land-use conflict. Policy makers could then adopt these techniques for local communities bordering other nature reserves to meet the diverse needs of the local people and small scale farmers, whilst enabling the transition to a tourism-based economy. The method if successful may be used in the rural development strategy and may in a long-term help to inhibit the migration of local people to cities, thereby retaining cultural integrity.

1.7 Motivation

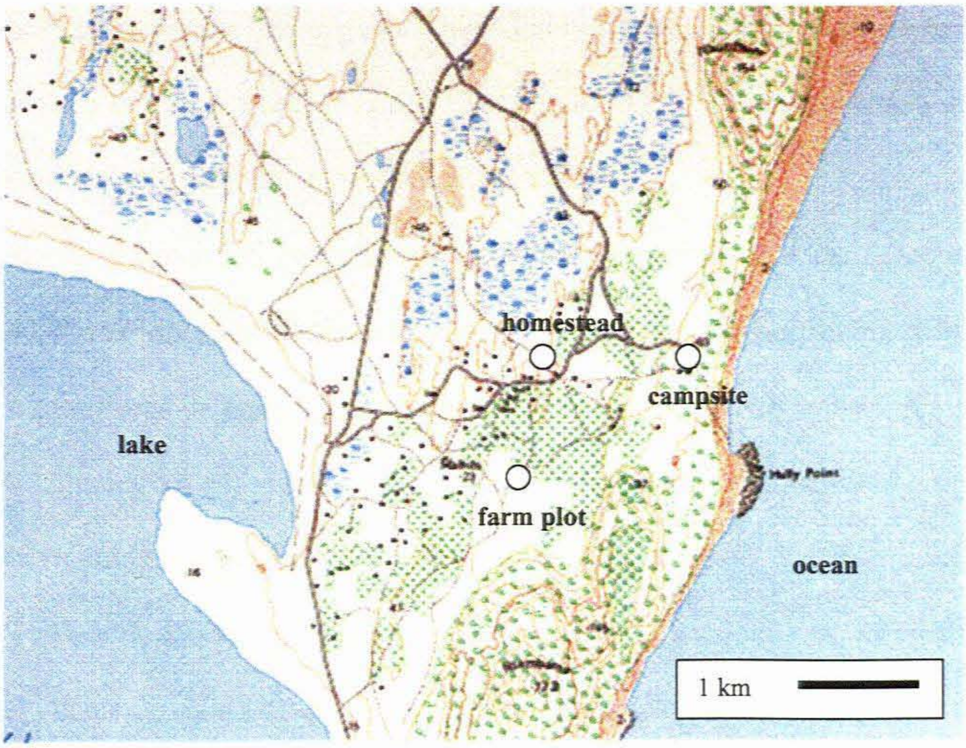


Figure 1.4: Map of Mabibi area, showing the locations of research activities.

Mabibi (Figure 1.4) is an attractive village due to its scenery and biodiversity that brings about 10 000 tourists every year. In our regular surveys, it was found that the landscape supports a variety of small to medium sized wildlife in co-existence with a rural community that has been practising subsistence activities for many years prior to the area gaining National Park (nature reserve) and UNESCO World Heritage status. However the local people may undervalue their environmental assets, being somewhat lacking in western skills and perceptions. Their primitive outlook has a cultural appeal of its own, but the people remain dependent on the land and its outputs. This creates conflict since land used for monoculture crops has a lower biodiversity, compounded by the low carrying capacity from nutrient-poor soils and high evaporative losses. For local people to improve agricultural practice they need to have some training and demonstration activities. So this kind of study is highly recommended for places like Mabibi where people can work a limited land using effective methods, whilst at the same time receiving income the service sector suiting their environment. The implementation of this project depends on locally enriching the soil, as follows:

- Surface structure becomes more stable and less prone to crusting and erosion.
- Water infiltration increases and runoff decreases when soil structure improves.
- Soil organic matter holds 10 to 1000 times more water and nutrients than the same amount of soil minerals. Water percolates easily with minimal leaching if organic farming is well planned and implemented.
- Beneficial soil organisms such as Earthworm, centipede or millipede become more numerous and active with diverse crop rotations and higher organic matter levels.

In 2004 the new Thonga Beach Lodge was built in Mabibi. Employing 25 people, it doubles income in the community from tourism revenue. However, ¾ of households remain dependent on agriculture and other subsistence activities. With the help of improved organic farming practice, the Mabibi people may be able to double their yields and thereby divert more effort to tourism support services (making and selling of crafts, etc). The following chapters outline how the project unfolded, starting with a detailed literature review, methods, results and conclusions.

Chapter 2

Literature Review

2.1 Introduction

This chapter reviews organic farming practices in the context of rural development using international and local literature. The attention is given to the role in which agriculture can play to uplift the standard of isolated communities. Particular attention is given to locally source composting and sustainable farming techniques in harsh sub-tropical climates that help supplement geologically poor soils for domestic production. Studies that outline methods to shift farming from wetland to dry land are considered.

2.2 Improving soil for cropping

Many farm projects in a variety of rural locations have documented the best way to produce high yields. "Soil needs to be well structured so as to accept water and rainfall without crusting, eroding or slipping. It should hold moisture and have acidity in an acceptable range (6 – 7 pH). The CEC (Cation Exchange Capacity) should be above 5 mm eq. / 100 g, especially for vegetable farming (Williams et al, 1991). In the more porous, well-drained tropical soils organic matter will improve both nutrient-holding ability (CEC) and moisture-holding capacity, while in the heavier soils organic matter will improve drainage and soil stability through soil structure. These are the main reasons for the emphasis placed on a regular application of organic matter to most tropical soils used for vegetable production (Williams et al, 1991). These are also the main reasons the use of organic matter will only be considered at Mabibi to improve its poor.

2.3 Soils

It is a growth medium providing plants with support, nutrients, and water from a dynamic, three-phase system. The dynamics of soil-water relations results from chemical and physical interactions of free water and the soil in which it resides. A true interaction exists, for when the soil and water are in contact with each other, the properties of both change. The edaphic functions of soil may be subdivided into the collection, storage, and release of water for plant use (Teare et al, 1983).

Soil is a water reservoir, it accepts, stores, and release water in a continuous cycle and so is often likened to a reservoir. However, not all soils perform these three functions in a manner considered optimum for plant growth. Drought or waterlogged conditions stress plant growth and are likely to occur in most soils for at least short periods of time. Most of the time, however, water relations in soils used for crop production range between field capacity and the wilting point (Teare et al, 1983).

Staines, (1990) says this about soil "The maintenance of a fertile soil should be the prime consideration of anyone lucky enough to be a custodian of land, be they either owner or tenant. This major resource, on which many a nation's prosperity has been built, has vast influence on your own profitability. It is a fragile ecosystem of its own which can be easily damaged but can be improved. It needs to be carefully understood and treated with respect (Staines, 1990).

A good soil makes life easier, a poor soil makes the struggle so much harder. It can be improved, but there is no quick route. What constitutes an optimal soil? According Staines (1990) soil is an 'upper layer of earth in which plants grow, consisting of disintegrated rock usually with an admixture of organic remains.' For all practical purposes, soil is a medium into which plant roots foray searching for the nutrients to sustain the growth of the plant. It also enables the plant to support itself to gain maximum benefit from the available light. So the soil needs to be compact enough to support the plant, yet porous enough to allow the roots to foray easily to obtain the foods the plant requires. It is a hard compromise to achieve, and the level of difficulty depends on the main constituents of the soil. These are sand, silt and clay. A fourth constituent that can have a major effect on the structure is organic matter. It is the varying properties of sand, silt and clay, which determine the classification of the soil (Staines, 1990).

Tropical soils have received much research attention. Ffolliott et al. (1995) says, "Of primary importance for soils in the dry lands are the water-holding capacity and ability to supply nutrients. Soil depth largely governs the amount of water that can be held in a soil profile." However, the depth of soils in dry lands often is limited by a hard layer, restricting water-holding capacities. These "hardpans", consisting of various materials depending upon the actions of climate and vegetation on parent rock, can be more or less continuous and occur between 5 and 60 cm below the surface (Ffolliot et al, 1995).

Soils are characterised by the leaching of nutrients and intensive weathering of minerals. Natural soil fertility, therefore, is low. Because there is little accumulation of organic litter in dry land environments, organic matter content of the soils is low. This limited organic matter is lost quickly when soils are cultivated for agricultural crop production (Ffolliot et al, 1995). Such losses are reported by the farmers of Mabibi.

2.4 Soil Structure

A good soil structure will allow air to enter the soil easily and excess moisture to drain freely from it. It also allows air to permeate the soil, as without air plant roots cannot live. With a good "crumb", good tillage will be easy and the soil is less likely to be damaged. To obtain a good crumb structure the grain size range should be 0.5 to 5 mm. The soil's ability to form a good crumb structure depends on the amounts of two constituents, namely, clay and humus, or organic matter. It is here that the greatest opportunity to improve the soil lies – through the addition of compost or other organic matter. But why is this so? It will improve a sandy soil by helping to bind the particles to stabilise the soil and make it more retentive. The addition of organic matter will therefore help the structure of a sandy soil such as found at Mabibi to become more porous, and provide conditions for plant growth (Staines, 1990).

2.5 Cover Crop Management

Hofmann, (2002) says, "The soil, like water, air and energy, is one of our most important resources. A serious endangerment of ecological soil vitality, caused by the effects of pollution and high external input management systems, can be confirmed at a global level. The development and application of ecologically appropriate soil and land management systems represents an urgent challenge and is imperative because it allows the long term maintenance of ecological soil functions. Organic practice aims at increasing a location's natural soil fertility (Hofmann, 2002). Soil fertility is induced by a positive combination of soil organisms, soil condition, humus supply, soil structure, water conservation and plant growth and its stabilisation (Hofmann, 2002). Wilkinson et al (2002) has documented progress in specifications for compost used for vegetable production in the sandy soils of Western Australia. Results of field trials throughout Australia and reports in the international literature suggest that use of unstable or immature compost is of limited value. In some circumstances it has the potential to reduce crop yield due to chemical residues released into the root zone of plants (allelopathy), (Wilkinson et al, 2002). Improvement of soil structure and water conservation by permanent root spreading. Nutrient supply for soil organisms (earthworms, microorganisms) as a basis for high biological activity and for the availability of soil nutrients is done in order to enable the blossoming of green manuring plants (Hofmann, 2002). Natural processes of cycling water and organic matter are maintained; dead leaves and twigs are left to decompose, keeping a continual litter layer and humus through which nutrients are recycled. Compost, fishpond mud and green manures are commonly used on cropland. These forms of recycling are sufficient to maintain soil fertility without the use of chemical fertilisers. Villagers regulate or modify the functioning and dynamics of each plant and animal within the system (Michon et al. 1983).

Regarding the composition of the mixture, it should be kept in mind that:

- The mixture should consist of different nitrogen fixing plants like (legumes), herbs, flowers and grasses.
- The selection of green cover plants should include slow and fast germinating seeds as well as medium and high growing plants (annuals, biennials and perennials).
- At least half of the plants should be deeply rooting so as to break clods to promote aeration and free flow of water.

- The mixture is linked to the time of agricultural use and location.
- The amount of seeding should be at the lower level so that local wild herbs can germinate and grow together with the green cover (Hofmann, 2002).
- Compost is the best form of organic matter and living fertilizer to be added to the soil. Composting attempts to recreate the conditions that would occur in an undisturbed ecosystem. Mature compost quickly comes into balance with the soil, whereas raw organic matter and especially manures can cause a period of major disruption to the soil workings. Well-decomposed compost is a slow-release source of nutrients, stocked with all the nutrients plant need (Hofmann, 2002). This makes compost the suitable natural fertilizers to be used in the soils of Mabibi since it is cheap and available in the community.

2.6 Organic Farming

Organic farming has become topical in recent years as it is perceived to provide an alternative to the agrochemical control of pests and diseases as well as regulating genetic engineering of food products. It approaches food production and processing in a responsible fashion, providing benefits in terms of environmental protection, conservation and non-renewable resources, improved food quality, reduction of output of surplus product due to reorientation of agriculture to areas of market demand (Kaiser et al, 2001). The transition from conventional to organic farming systems is subject to several different constraints including physical, financial, and social influences. The aim of conversion is to:

-Improve soil fertility for annual crops by establishing a rotation of legumes so those crops may be produced without synthetic nitrogen fertilizer or large amounts of manure.

-Change the management of the system to maintain animal and plant health with limited inputs acceptable to organic production standards.

-Work towards establishing a balanced ecosystem and maintaining species diversity to benefit the environment and agricultural production (Kaiser et al, 2001). A practical organic farm demonstration will be implemented at Mabibi to help them to engage in organic farming which in turn will uplift their agricultural practices at the same time improving chance for wildlife habitat as Mabibi is a village in a nature reserve.

2.6.1 Soil fertility and Biodiversity in Organic Farming

Mader et al (2002) says "An understanding of agroecosystems is key to determining effective farming systems". In a 21-year study of agronomic and ecological performance of biodynamic, bioorganic and conventional farming systems in Central Europe - crop yields were only 20% lower in organic systems, although input of fertilizer and energy was reduced by 34 to 53% and pesticide input by 97%. Enhanced soil fertility and higher biodiversity found in organic plots may render these systems less dependent on external inputs (Mader et al, 2002).

Intensive agriculture has increased crop yields but also posed severe environmental problems. Sustainable agriculture would ideally produce good crop yields with minimal impact on ecological factors such as soil fertility. A fertile soil provides essential nutrients for crop plant growth, supports a diverse and active biotic community, exhibits a typical soil structure, and allows for undisturbed decomposition (Mader et al, 2002).

Organic farming systems are one alternative to conventional agriculture. In some European countries up to 8% of the agricultural area is managed organically according to European Union regulations. But how sustainable is this production method really? The limited number of long-term trials shows some benefits for the environment. In the organic systems, the energy used to produce a crop was 20 to 56% and the corresponding land area was 36 to 53% lower (Mader et al, 2002). Soil stability was 10 to 60% higher in the organic plots than in the conventional plots. These differences reflect the situation as observed in the field, where organic plots had greater soil stability. There was a positive correlation between aggregate stability and microbial biomass ($r=0.68$, $p<0.05$), and between aggregate stability and earthworm biomass ($r=0.45, p<0.05$).

Soil pH was slightly higher in the organic systems. Soluble fractions of phosphorus and potassium were lower in the organic soils than in the conventional soils, whereas calcium and magnesium were higher. Soil microorganisms govern the numerous nutrients cycling reactions in soils. Soil microbial biomass increased in the organic fields. In soils of the organic systems, dehydrogenates, protease, and phosphatase activities were higher than in the conventional systems, indicating a higher overall microbial activity and a higher capacity to cleave protein and organic phosphorus. Phosphorus flux through the microbial biomass. Evidently, nutrients in the organic systems are less dissolved in the soil solution, and microbial transformation processes may contribute to the plants' phosphorus supply. (Mader et al, 2002). Biomass and abundance of earthworms were higher by a factor of

1.3 to 3.2 in the organic plots as compared with conventional. The density of many soil-enhancing insects was almost twice that of the conventional plots. (Mader et al, 2002)

In much of Africa such as KwaZulu Natal, small-scale production systems involve a mixture of both crops and livestock (Mclntyre et al., 1992; Powell &Williams, 1995, Mkhabela, 2002). A major threat to the sustainability of small-scale crop production systems is a decline in soil fertility associated with falling levels of organic matter and soil nutrients (Snapp, 1998; Smaling and Braun, 1996; Steiner, 1991) in Mkhabela, 2002. Although mineral fertilizers have played a major role in maintaining and increasing soil fertility in most areas of the world (FAO, 1992; Smaling, 1993) in Mkhabela, 2002, a range of factors mitigate against the widespread use of mineral fertilizers by small-scale farmers (Gerner & Harris, 1993; Smaling & Braun, 1996) in Mkhabela, 2002.

The high cost of these inorganic fertilizers is a factor mitigating against their use by small-scale farmers given their limited financial resources. Use of inorganic fertilizers will not be a good idea in places like Mabibi as it is costing. Mabibi is underdeveloped and have poor soils. Fertilizer has also been shown to produce variable crop yield responses under small-scale conditions, which makes the technology risky and difficult to use by farmers in this sector (Smaling, 1993; Van Noordwijk et al., 1994) in Mkhabela, (2002). Consequently, the amount of inorganic fertilizer used by the small-scale farming sector in South Africa, for example, is generally small and significantly below the levels recommended for the agro-ecological regions of the country (FSSA, 1997) as cited by Mkhabela, (2002). As a result, manure will continue to play a vital role in the maintenance of soil fertility in tropical Africa (Bationo & Mokwunye, 1991; Yoganathan & Van Averbeke, 1996; Materechera et al., 1998) in Mkhabela, (2002).

2.6.2 Organic Manure's, Composts, Green Manure's and Crop Residues

Organic farming projects tend to focus on improving the soil's water-retention capacity within the root zone, increasing aeration of the rooting medium, lowering bulk density, and increasing of the CEC for nutrients such as nitrogen and phosphorus. Organic manures must be of the right composition, however, and must contain a high ratio of nitrogen to carbon; otherwise they may temporarily immobilise plant nutrients and reduce the growth of the crop (Williams et al, 1991). When organic manure is applied to the soil, microorganisms use the nitrogen contained in the material for their own growth. With organic substances that have a low nitrogen content (a high carbon to nitrogen or C/N ratio) such as rice straw or maize stalk, the microorganisms will withdraw from the soil the nitrogen they require to break down the material, and thus cause a temporary shortage of this essential nutrient (Williams et al, 1991).

2.6.2.1 Organic matter

It can play a major role in conserving water for crops in poor sandy soils. According to Teare et al 1983, organic matter in its living, dead or decayed humus form strongly influences the infiltration process. A living vegetative cover insulates the fragile soil surface from the impact energy of raindrops, preserving aggregate stability. Crop residue can be managed to maximize its stay on the soil surface and so protect the surface layer from pudding and crusting. Roots and incorporated residues are converted into humus.

Soils high in humus content exhibit high infiltration rates because of the favourable aggregate stability and porosity conditions that result (Teare et al, 1983). Organic gardening requires a long-term outlook with respect to soil preparation. In fact, the key to successful organic gardening is to feed the soil with organic matter, which feeds the plant, rather than to feed the plant with inorganic fertilizer as in conventional production. An ideal soil would have equal parts of sand (0.02 to 2.0 mm grain diameter), silt (0.002 to 0.02 mm) and clay (0 to 0.002 mm), and contain about 5 percent organic matter. Most mineral soils in Georgia (USA) have less than 2 percent organic matter and are rarely ideal. However, with work, most soils can be improved and made productive. Because it takes a long-term outlook to build a good soil, don't be disappointed if results are less than ideal the first year or two, (Boyhan, 1999).

Organic matter in soil is important for two reasons. First, as it breaks down, it releases nutrients that crops can readily utilize, and secondly it improves the water and nutrient holding capacity of the soil. The amount of organic matter to add varies with the chosen material, the type of soil, and weather conditions. On sandy soils in tropical and subtropical regions, as much as 10 kg / 1 m^3 may be required to gain a benefit from the addition of organic matter. It is recommended that organic matter be tested for nutrient content so that application rates can be adjusted accordingly. In all cases, fresh material should be composted to kill harmful pathogens and weeds. Any crop grown on land with the intent of turning it into the soil is called a green manure. Generally, legumes and various grasses are grown as green manure. Turning under a crop can provide a number of benefits, including increasing organic matter of the soil, decreasing certain disease problems, and increasing the nutrient level in the soil. After the green manure is turned under, it decomposes and adds nutrients and organic matter to the soil. When used as a green manure, grasses and small grains can decrease the incidence of nematode targetes, a weed is said to have nematicide properties. Nematodes are microscopic worms that feed on certain plant roots, weakening the plants. Using various legume crops such as soyabean or centrosema pubescens may increase the amount of nitrogen in the soil (Boyhan, et al, 1999).

2.6.2.2 Value of organic matter in the garden

Most organic matter improves the soil structure, which in turn improves its fertility by making the plant foods it contains more available, as well as making it easier for roots to grow through the soil. Some materials supply plant foods. Being of living origin, they can contain the major elements (nitrogen, phosphates and potash) and the minor and trace elements essential for plant growth. Nutrient analyses can be variable but may not necessarily be a good measure of the outcome. The availability of nutrients can vary from weeks to years, depending on how long it takes the soil life to decompose the material. Organic matter can help to keep soil pest and disease problems under control. Soil pests like rats and moles are a problem in Mabibi so application of organic matter will be of crucial. Bulky organic materials can also be used to control weeds, as mulch to keep the soil moist and as an ingredient in growing media (Beazley, 1995).

2.6.2.3 Composition of Manures

Several organic by-products are also used as manures, especially by horticulturists, including guano (bird and bat droppings), dried blood, fish waste, cottonseed waste and other similar organic concentrates. A sample should be analysed to ascertain the nutrient content before use to determine the rate of application. From the practical point of view manures are seldom used directly but are mixed with straw and other bedding material. Farmyard manure, principally from cattle, is made up of livestock solid and liquid waste *materials and this is applied by people of Mabibi only in their home garden but only few* people have cows. By the use of straw as bedding the nutrients contained in animal droppings and urine are preserved in the pen (Williams et al, 1991).

2.6.2.4 Compost

Fresh manure (that is, without straw or rice husk and other absorptive material) is not suitable for direct use because, apart from the difficulty of handling, it may cause burning of plants. Such materials should be mixed with straw and composted before use, after which it can be used. The nutrient contribution of compost can be increased by the addition of nitrogen, phosphorus and potash fertiliser at the time of preparation.

Compost - how it happens

Some bacteria that break down organic materials function only where there is air or oxygen (aerobic). Others survive only in an airless environment (anaerobic). Both kinds will produce compost, but most gardeners prefer aerobic bacteria because they work much faster. Many complaints about compost "not working" or taking too long can be traced to the type of bacterial action taking place (find article in Countryside & Small Stock Journal, 1995). Some important needs in composting include grinding or shredding, moisture control, and turning. Turning compost is one of the better-known requirements of the process, but why is it so important? To provide air to the aerobic bacteria, so they can keep on working. Without turning - which usually means transferring the material from one pile or bin to another - a heavy wet mat forms. Aerobic bacteria can not live in this environment and the slower-acting anaerobic take over. Proper moisture is also an important factor in composting. A waterlogged heap will *smother the air loving bacteria- although a pile that's too dry is not an ideal environment* either. Aerobic bacteria convert the carbon in organic materials into carbon dioxide, which passes into the air (article in Countryside & Small Stock Journal, 1995). According to Lampkin (2002), objectives of composting are as follows:

- Suppression of unpleasant odours
- Improvement of hygienic conditions
- Reduction of the germination capacity of weeds
- Maintenance and improvement of manurial value
- Increase of the biological activity of soils
- Positive influence on plant quality
- Minimum loss of nutrients during application
- Minimum additional investment expenditures (Lampkin, 2002).

The energy and nutrient balance of the material is indicated by the carbon to nitrogen ratio (C: N). The ideal ratio lies between 25 and 35: 1. The moisture is also very important, as it is essential for the decomposition process. The ideal moisture content is 55-70 %. This can be tested by taking a hand sample from about 2 cm depth of the pile, squeeze it. If water trickles out, the pile is too wet (Lampkin, 2002).

A "hot" compost (or active) pile requires careful management. It works best when a lot of material is added at once. You need to mix the right balance of materials that are carbon-rich and nitrogen-rich and turn the piles often to give the organisms enough oxygen. This system kills weed seeds and pathogens, is richer in nutrients, because it matures more quickly, therefore there is less leaching of nutrients (Lampkin, 2002). Such ideas will be adopted in Mabibi compost demonstration training.

2.6.2.5 Mulching

Mulching improves agro-ecological potential. It typically conserves the soil, improves the soil ecology, stabilizes and enhances crop yield and provides various environmental services. It is a complex basket of interrelated practices including necessary practices so as to ensure the production and retention of sufficient mulch and complementary practices in order to be able to grow a crop or maintain yield levels (Erenstein, 2003).
Crop residue mulching can offer significant savings implied by reduced tillage and the potential to alleviate binding constraints for crop growth and farm productivity (e.g. water conservation, timeliness of land preparation and crop establishment). Its economic potential depends on the opportunity costs of retaining the mulch and the opportunity cost of complementary changes (e.g. alternative weed, pest and disease management practices). Mulching can improve soil fertility and weed management. Mulching only tends to be viable when property rights over residual crop biomass are observed and tenure is secure. Further success in the development and dissemination of mulching for smallholder requires targeting areas with specific economic opportunities for mulching and an integrated approach with a practical orientation, farmer participation, community involvement, flexibility and a long-term perspective (Erenstein, 2003). Most importantly here: mulching reduces heat stress around the time of planting, ensuring much lower soil

temperatures, and thereby reducing evaporative losses. It will be shown later that mulching reduces surface temperatures by up to 10 degrees Celsius.

2.7 Improvement in Agricultural Crop Production

Failure to maintain effective soil conservation practices has resulted in a decline of soil productivity, accelerated soil erosion, nutrient runoff losses and a decrease in soil organic matter content. An approach to reversing the decline of soil resources is the development of cropping systems that use cover crops and plant residues, practices that more producers are turning to each year (Edwards, 1995). "Soil crop production systems that use manures from confined animal operations, newsprint, yard waste and other organic byproducts in an environmentally safe manner have potential for broad based benefits". Poultry and egg producers, dairy operations, cattle feedlots and swine producers may discover valuable nutrient resources for agriculture. Farmers may benefit from the use of the by-products to improve soil quality and crop yields, and thus improve potential for a more sustainable agriculture (Edward, 1995). Productivity of agricultural land in dryland regions is inherently low and the risk of failure is high. This situation is due not only to low and unreliable rainfall but also to the effects of wind and water erosion and low soil fertility (Ffolliot, 1995).

Wind erosion is a serious problem in most of the dryland regions of the world. Destruction of vegetative cover exposes soil to the desiccative effects of hot, dry wind, resulting in dust storms, formation of sand dunes, and other forms of severe wind erosion. Wind is not only responsible for the transport of soil particles and loss of soil nutrients, but through its desiccating effect, wind often reduces growth and development of food crops and livestock production. Wind assumes a larger role in irrigated agriculture than it does in rainfed agriculture. By increasing evaporation, wind facilitates the upward movement of salts and their subsequent concentration in the rooting zones of agricultural crops. The particles of sand and dust carried by wind can be deposited in irrigation channels and drainage ditches, increasing maintenance costs of irrigation. Such damages can be diminished by the establishment of windbreaks (Ffolliot et al, 1995).

Erosion by water also is an important phenomenon in most of the dryland regions. This type of erosion is the result of the soil to erosion, high rainfall intensities, and frequent destruction of the vegetative cover. When these conditions occur, considerable amounts of soil are washed down from upland catchment areas. Roads are damaged, lowlands are flooded, and streams and pans are filled with muddy water. Some of this sediment-laden water accumulates in reservoirs or is transported to lakes or the ocean. The loss of water through runoff and the ensuing soil erosion can be controlled by adopting preventive soil conservation measures. The role of trees and shrubs in an overall strategy for the management of vegetation can reduce siltation of reservoirs, affect stream flow, and reduce flash floods and soil erosion (Ffolliot, et al, 1995)

Agricultural crop production in dryland regions frequently is hindered by poor soil fertility. However, the importance of soil fertility often is overlooked, as water is considered the principal constraint. Whereas a conventional and relatively expensive method to improve soil fertility commonly consists of repeated application of mineral fertilizers, this problem also can be solved through systematic use of soil- improving, salt tolerant species of trees and shrubs (Ffolliot et al, 1995).

Bratt, (2002) says "Farmers are beginning to experience a new awareness about nutrient use and see manure as a resource instead of waste product". Most activities and choices involved in agricultural production methods influence the nutrient balance. Additionally, agricultural activities are carried out by many individuals making their own decisions that have an impact on water resources. Agricultural development is a gradual process, dependent on context and strongly influenced by traditions and cultural heritage, where convictions can be hard to change. Agricultural production is a system-based activity with a history collectively created through communication and co-operation (Holling et al, 1997) in Bratt, (2002). To a great extent agricultural production has been changed and developed by actions carried out by individuals with the expressed intention of achieving improved production (Bratt, 2002).

Sustainable farming seeks to make the best use of nature's goods and services without significant damage to the environment. It does this by integrating natural processes such as nutrient cycling, nitrogen fixation, soil regeneration and natural enemies of pests into food production processes. It also minimises the use of non-renewable inputs that damage the environment or harm the health of farmers and consumers. It makes the use of the knowledge and skills of farmers, improving their self-reliance, and it seeks to make productive use of people's collective capacities to work together to solve common management problems, such as pests, irrigation, and credit management (Pretty et al, 2003). Sustainable agriculture is multifunctional within landscapes and economies: it jointly produces food and other goods for farm families and markets, but it also contributes to a range of public goods, such as clean water, biodiversity, carbon sequestration in soils, groundwater recharge, and flood protection. Because sustainable agriculture also seeks to make the best use of its specific environment, technologies and practices must be locally adapted (Pretty et al, 2003).

The increase in atmospheric temperatures brought on by heat-trapping gases such as carbon dioxide, methane and ozone certainly means more extreme weather conditions that can influence crop production (Johnson et al, 2003). But global warming also creates opportunities in the farming sector- using crops for carbon sequestration and the use of organic material and waste (Johnson, 2003). Rice, cited by Johnson & Jim, (2003) said "Agriculture could help solve the carbon dioxide problem". Crops and other plants remove CO2 from the atmosphere and convert it into organic carbon. After harvest, the organic carbon in residues and roots is deposited in the soil, where portions can remain for long periods. This can help with soil fertility, erosion, wildlife, habitat and water quality, (Johnson et al, 2003) and the idea can be very useful in places like Mabibi.

2.8 Agricultural practices in Eastern Maputaland

This literature review has thus far-highlighted information on agricultural practices in environments similar to Mabibi. In this section, more locally specific literature is reviewed. Taylor, (1988) says, "Agricultural strategies utilized in Maputaland are low in productivity but aim to minimize risk. The area is marginal for agriculture as soils are sandy and rainfall unreliable. Insects and plant diseases accentuate the problem. Infrastructure is lacking in the area. Traditional agricultural systems predominate. Farming in the area is generally of a subsistence nature and can be divided into gardening, swamp farming and field cropping. Mabibi is located on the coastal part of

Maputaland so Taylor's study would help us to understand the existing constraint in Mabibi. The eastern portion of Maputaland is nearly tropical in climate with an erratic rainfall occurring mainly during the summer months (Acocks 1975, Phillips, 1973) as cited by Taylor, 1988.

- the typical coastal belt forest
- the Zululand palm veld
- the dune forest

2.8.1 Rainfall

Annual rainfall varies from 1200 mm at the coast to between 800 mm and 900 mm approximately 30-km inland. However, these figures are misleading, as the distribution of this rainfall is erratic, with heavy rainfall occurring over short periods of time. The effective rainfall and distribution thereof, taken in combination with the soil types, makes this region marginal for agriculture (Taylor, 1988). Efficiency in the management of the small amount of water that can be made available for irrigation must lie at the heart of the irrigation strategies in areas where water is a scarce resource. It is also crucial indicator of the environment sustainability of small-scale irrigation, (Yohannes, 2004). Sustainability can only be achieved if projects to improve small-scale irrigation are based on the identification of appropriate types of intervention suitable for each local aspiration (Yohannes, 2004). Growing a crop without irrigation is possible, but your success is enhanced with irrigation. Several different methods of irrigation can be used, with overhead and trickle irrigation as the most common. Trickle irrigation is the most water-use efficient because water is delivered directly to plant roots with a low volume soaker hose, drip tape, or emitters. The disadvantage of trickle irrigation is cost of installation and maintenance (Boyhan, et al, 1999), especially in the low technology environment of Africa. In the case of Mabibi Lake Sibaya can deliver sustainable solutions to the adverse effects of drought and environmental degradation but there is a need to mobilise financial and technical resources, newly generated as part of the profits from the eco-tourism lodge accruing to the community.

2.8.2 Relative humidity and temperature

The high humidity levels and temperature provide a favourable environment for many insects and plant diseases. The area is frost-free, with hot wet summers and mild winters with some rain throughout the year. Although plant growth is slower in the winter months, growth occurs all year round where moisture conditions are favourable (Taylor, 1988).

2.8.3 Infrastructure

Subsistence agriculture is the norm in eastern Maputaland. Where yields are in excess of subsistence needs, the surplus is sold within the area. Maputaland suffers from inadequate roads. No markets available other than informal ones where vegetables, foodstuffs and locally brewed palm wine are sold. Until recently there was no source of agricultural inputs other than some vegetable seeds and two insecticides, sold at local shops (Jury et al 2003). There is a lack of potable water. Water utilized for domestic consumption is usually obtained from rivers and pans. However, it may be contaminated by human and animal waste. The health of the rural population is adequate with assistance from a wellequipped clinic. But hospital treatment is not immediately available, so emphasis is on curative rather than preventative medicine. Infectious diseases account for a large proportion of morbidity in the area (Taylor, 1988).

2.8.4 Crops planted in eastern Maputaland

The crops planted are divided into staple agronomic: maize, sorghum, millets, cowpeas, jugo beans, groundnut, rice, pigeon pea, cassava, sweet potatoes, taro and sugar-cane, and horticultural crops: vegetables like cabbage, spinach, onions, pumpkins and fruits: bananas, citrus, mango, pawpaw, avocado, guava and granadilla (Jury et al 2003).

2.8.5 Cropping Systems

Agricultural systems can be divided into:

- Household gardening
- Wetland or swamp forest cropping
- Dryland cropping

Traditionally, only dryland cropping and farming were practised, but wetland gardening is increasing in popularity. This is one reason why the UNESCO project sought to provide an organic farming demonstration plot at Mabibi.

<u>Other naturally occurring problems and strategies employed by farmers</u>

Farmers in Maputaland have numerous problems with common pests such as birds, monkeys and moles. In addition local animals such as duikers, wild pigs, hippopotamuses and even the occasional elephant are also problems. In the past, children were available to scare away birds and monkeys. Now many attend school. It is for this reason that many people no longer grow sorghum and millet. Birds, drought, or weevils in the post-harvest stage have destroyed seed reserves. In the case of maize, women and children when they are available sit in the field to scare monkeys away. Cobs when picked are hung above the cooking fire so that the smoke that blackens the cob can protect the seed from weevil attack. At critical times, fires are lit in and around fields during the nights, in order to scare away hippopotamuses. This may necessitate building a second dwelling where fields are far from the homestead. Tins are also struck together from the safety of the dwelling, in the hope that noise might frighten away the animals. Alternatively, deep trenches are dug to keep out hippos. The swampy soils, which are high in organic matter, have a much higher water-holding capacity, are richer in nutrients but still relatively infertile (Taylor, 1988).

Agricultural performance and the potential for agricultural development should be assessed within the context of the interrelationship between different spheres of economic exchange associated with rural life in South Africa. Of particular concern here is the dynamic between individual aspiration and group (family, lineage, community) responsibility that develops out of short- and long-term economic strategies, and the social expression associated with different ways of making a living (Derman et al, 1987).

2.9 Ecological setting and human complement in Mabibi

Most of the Mabibi village inhabitants reside in the vicinity of the Sibaya Lake and the pans, which are seasonally filled by floodwaters (figure 1.4). As was mentioned in a report written by Smedley and Ribeiro-Torres (1979) on Tongaland, it is extremely difficult to establish the exact identity of the indigenous people. It is, however, known that they constitute a considerable mixture of Tonga, Swazi and Zulu, with the Tonga group having its origins from southern Mozambique and Zulu/Swazi from the southward migration of the Tekela Nguni from central Africa. Official statistics classify over 90% of over 200 000 people in the Ingwavuma/Ubombo districts as Zulu (Smedley and Ribeiro-Torres, 1980).

2.9.1 Aspects of the local human ecology

The high density of indigenous settlement in the proximity of the pans and the lake itself suggests a human link with the wetlands. The utilisation of the wetland resources reveals the dependence of the people on the flood regime of the waters. They rely on the pans and lake as their water source. People depend on the alluvial deposits left between the pans and lake when the floods subside for the cultivation of a major portion of their food crop. Fish caught and trapped in the lake and in the pan form a significant part of the diet, food economy and social activities of the village inhabitants. A variety of wild fruits thrive in the vicinity of the wetlands. The wetland grasses and bush provide grazing for livestock. Moreover, building materials for homesteads construction and for other purposes are available in the numerous species of reeds, grasses and trees found in the wetlands.

This wetland ecosystem is dependent on the fluctuations of flow derived from seepage, the water table and level of Lake Sibaya. Some Mabibi inhabitants practice a system of horticulture by means of which they cultivate a portion of their food crop on the low-lying ground near the lake and between the pans. The crops grow well there since the soil contains alluvial deposits from previous floods. The pastures are also in the vicinity of the pans and lake. Conservation officials would like the fields moved to higher ground to protect the integrity of the wetland as a habitat for wild animals that are attractive to tourists.

2.9.2 Allocation of land

Land is allocated to the chief's subjects through the subchief. The induna or subchief allocates tracts of land for homestead sites, garden sites and for pasturage. On request by a member of his district for land the induna measures out a garden or a homestead site by using various landmarks to demarcate the area. The person who has been allocated the land then has usary rights over that land and the land cannot be taken away whilst it is occupied or cultivated by that person except for criminal offences. Farmers who intend extending their field apply to the induna for an extension. An extension of garden area or even homestead area where some land is cultivated is granted on condition that the land is well utilised.

2.9.3 Crops

The people practise a system of horticulture that involves both hoe and plough. From about September "with the onset of the star constellation Isilimela" (Pleiades); until November the main summer food crops are planted. These crops are maize (umbila), groundnuts (amantongomane) and pumpkins (amathanga). These crops are harvested from about the end of December through until April depending on when the crops are planted. After harvesting, the fields are left fallow for a month or so until the winter crops are planted from April. The main winter crops grown are beans (ubhontshisi), cowbeans or jugo beans (izindlubu) and cowpeas (imbumbe). Groundnuts are cultivated also in this period. Sweet potatoes (obhatata), which play a significant part in the people's diet, are grown throughout the year, as is cassava (umdumbula). Generally only vegetables are grown on the wetlands, whereas the other plants are grown in fields in the homestead vicinity. At times of good rains a surplus of food is produced. However, there is a limited market for their products within Mabibi and marketing in Mbazwana is subject to transport limitations.

2.9.4 Domestic labour and crops

The homestead is the single most important socio-economic unit of the village and therefore the most important unit of production. Resources such as land for cultivation are allocated on a homestead basis; and as such labour, in terms of horticulture, is deployed on a homestead basis. The household head deploys his wives and children and any other relatives staying in his homestead that make up an extended family unit, over different agricultural activities. He allocates labour tasks in accordance with a social division of labour according to sex and age. Women, for example, are involved in most of the domestic activities such as cooking and the fetching of water for household use as well as in the wider agricultural sphere by being delegated to weeding, planting and cleaning. The agricultural cycle consists of peak periods of planting and harvesting when the demand for labour is high and sometime exceeds the supply that can be provided by a family unit. At this peak labour demand periods most able-bodied people are engaged in agricultural activity. The labour demand decreases, however, after planting or harvesting and the maintenance work such as weeding is done mostly by the women and younger men whilst the older men supervise.

2.9.5 Income and Subsistence

An account of the activities that constitute the means of subsistence are provided from Bulfoni (2003). Over and above the subsistence economy, a cash economy has emerged in response to the new socio-economic demands felt by people of the Mabibi village. Cash needs are felt to meet these new socio-economic demands that have permeated into the rural situation from cities as a result of labour migrants. Radios, furniture, crockery, cutlery and the like have become symbols of status. Education has also become important and prestigious. Cash is however required in order to send children to school, and it is needed for the purchase of radios, bicycles and furniture.

Hence, the emergence of a rural cash economy to meet cash needs whereas previously cash was obtained primarily by labour migration to towns and cities. In order to meet cash needs, many families have extended the subsistence effort into a cash effort as well. Labour migration is a means of coping with subsistence and cash needs. Crop damage results in people having to purchase staple foodstuffs such as maize meal and samp at remote markets. In order to buy these staple food commodities people rely on cash sent home by migrants. Additionally some cash income for many households comes from the pension of the oldest family member.

2.9.6 Constraints on Production

There are several factors that serve to undermine productivity and the realisation of the full agricultural potential of local farmers. These factors include general constraints that impair productivity in the majority of agrarian societies as well as constraints specific to the Mabibi area. Some of the general constraints are the labour off-take due to a high rate of migrant labour; the labour intensive non-mechanised technology; the lack of an efficient marketing infrastructure and the lack of capital required to subsidise entrepreneurial activities on a significant scale.

Having chosen to live in an area of low agricultural potential and in the absence of irrigation, a form of shifting horticulture has developed on the alluvial soils of the village. Crops are planted on the banks of the lake and pans, to the detriment of the ecological habitat.

2.9.7 Farming skills

Farmers cultivate their fields without the benefits of professional advice or, with the exception of the plough, Western farming technology. Although there are no statistics relating to productivity, an evaluation of existing farming practice suggests that yields could be significantly improved with a more efficient service infrastructure to facilitate appropriate farming methods and a labour-saving technology. The preparation of fields for planting is labour intensive, eg. 50-75 labour-days/hectares (Derman and Poultney, 1983). The fields are then tilled either by hand hoe or plough.

One factor influencing the amount of labour required in cultivation is the technique of production, e.g. hoe cultivation is more labour intensive than plough cultivation.

Mechanical (tractor) cultivation results in a dramatic reduction in labour-hours/hectare. With tractor ploughing it is unnecessary to clear fields of between-season grass growth prior to ploughing. However it is necessary to plough the soil twice. If a tractor is used in both ploughing sessions then fields can be prepared in 3 hours/hectare (sandy loam) (Derman and Poultney, 1983). Unfortunately farmers do not have ready access to tractor hire. The use of tractor is the exception rather than the rule: only a few homesteads have enough money to hire a tractor once or twice per year (ploughing two hectares twice a year with a tractor cost about R 800, about 15% of mean annual income).

Weeding is done by hand hoe, the labour involvement in this task for maize being 39 labour days/hectare. Maize fields are weeded after approximately 1 month and 2 months'growth (Derman and Poultney, 1983). It is the amount of time and labour associated with ploughing and weeding that puts the harvest at risk. Not all fields can be prepared and cultivated to obtain the maximum benefit from the rainy season.

It is frequent for families to cultivate both a field on the wetlands and a field in close proximity to the household. Someone has also fields far from the household. The distance between fields precludes working both daily. Also, since the harvest is transported either by sled or on the heads of women, the distance between fields and household takes on added significance.

A further factor influencing crop yields is the quality of the seed planted. The introduction of appropriated seed would have an obvious effect on yields. It should be noted that local farmers are receptive to new crops and farming advice.

Besides, households, having no irrigation supply, are dependent upon rainfall for crops. This limits the time of year when crops can be grown and therefore overall annual production. Often yields are very low because the soil does not retain moisture. During the interviews with the community members it has also found that farmers in Mabibi have numerous problems with the local wildlife.

2.9.8 Agricultural Production

Agricultural practices in Mabibi village reflect the adaptation by man to survival in an area marginal for agricultural production. Practices have evolved over time and are geared towards this end in that systems aim to minimise risk. Such systems are inherently low in productivity. The average yield for households producing maize is 350-400 kg (5 bags), which is still 40 % less than the "estimated 9 bags required for household subsistence" (Vandeverre et al.). Unfavorable soil conditions can reduce the average production to 100-150 kg/ha. Many of those engaged in agriculture are deficit farmers, in the sense that they do not produce enough for their household food requirements.

2.9.9 Crops planted

The crops planted in Mabibi village may be divided into staple field and horticultural crops comprising both annual and perennials.

Field crops	Horticultural crops	
	Vegetables	Fruits
Maize	Onions	
Peanuts	Tomatoes	Banana
Sweet potatoes	Cabbages	Mangoes
Millets	Spinach	Pawpaw
Beans	Pumpkins	Avocado
Sugar cane	Melons	Guava
Cassava	Carrots	Oranges
Yam	Chilli	

Table 2.1: gives staple field and horticultural crops.

The information obtained from interviews with members of the local community carried out by Bulfoni (2003) give the following details:

CROPS	% OF HOUSEHOLDS ENGAGED
Maize	98
Peanuts	93
Sweet potatoes	47
Onion	29
Tomatoes	28
Cabbage	26
Spinach	22
Yam	14
Pumpkin	14
Green pepper	9
Beans	9
Sugar cane	9
Banana	7
Millet	5
Carrot	5
Pawpaw	3
Avocado	3
Mangoes	3
Cassava	2

Table 2.2: Gives the list of the most consumed crops in Mabibi.

2.9.10 Cropping systems

Agriculture in Mabibi has remained free of modernisation and the traditional agricultural systems are predominant. Farmers plant with the rains. An area is initially prepared and planted. Should weather conditions appear favourable a further area will be prepared and planted. Since neither organic nor inorganic fertilisers are used in cropping, a field rotation is practised. The most common rotation is alternating maize and peanuts: maize in September and December that is harvested in January and May. Peanuts are planted in the winter. This rotation realises the benefit of planting peanut (legume) to enrich the poor soil. Intercropping is a widespread agricultural practice in Mabibi; it consists in cultivating plants (usually vegetable crops) of different species at the same time on the same plot. This practice is an efficient use of space since it yields a variety of products for the homestead's livelihood.

The swampy soils next to the lake and pans, which have more organic matter, have a much higher water-holding capacity, but still relatively infertile. Since in the wetter periods the soils are waterlogged, drainage is necessary. Farmers sometime incorporate organic matter (cattle manure) only into soil used for vegetable crops. This serves to increase fertility and water-holding capacity, but the quantity of available cattle manure in Mabibi is very low owing to the small number of cattle.

Mabibi's farmers use the 'slash and burn' practice for preparing plots for sowing and also for weeding. High nutrient losses occur through volatilisation of C and N during the burning process, leading to a reduction in the quantity of these elements in the surface soil layers.

2.9.11 Soil evolution in traditional agricultural systems

The evolution of cultivated soil has been studied in two quite different situations which are representative of itinerant agriculture after the tillage of forests or savannah, compared with soils allowed to 'rest' and obtain the benefits of fallow periods. "The tendency is for the land to deteriorate after a few years of cultivation. Its capacity to render is maintained for 3-6 years. After this period the soil productivity degenerates. This is initially perceived in a deterioration of the physical state of the ground and in an increase of salinity, and, subsequently, a fall in soil fertility" (Piéri, 1989). Specific studies have been conducted on the subject of the length of the set-aside period and on the regeneration of the land: according to these studies a period of more than ten years set-aside is necessary for the degraded land fertility in the area of the humid savannah to regenerate.

"The conclusion is clear: brief periods of natural fallow have no effect on the regeneration of the land that has degenerated due to crops" (Piéri, 1989).

In conclusion, it is seen that the traditional crop systems adopted by the farmers in Mabibi are not necessarily sustainable, and harm productivity of the land, even at moderate crop intensity (only a few years of continual crops, followed by many years of set-aside). This means that in such conditions, the available space for crops for the local farmers must be three times the size of the cultivated space. In view of such experimental results, the grasslands used by the Mabibi farmers for 1-5 years need to be 'rested' for longer periods. The practice of burning the grass at the end of the period of set-aside does not improve the soil productivity. It has been proved that it draws nitrogen and carbon out of the system that would otherwise act as compost.

2.10 Agricultural sustainability

Tilman et al, (2002) define sustainable agriculture as practices that meet current and future societal needs for food and fibre for ecosystem services and for healthy lives, and that do so by maximizing the net benefit to society when all costs and benefits of the practices are considered. If society is to maximize the net benefits of agriculture, there must be a fuller accounting of both the costs and the benefits of alternative agricultural practices, and such an accounting must become the basis of policy, ethics and action. Intensive land use means that there is an impact on nature and the environment. Sustainable land use and care for the products of a region or, in industrial terminology, quality control requires a benchmark against which impacts can be measured and monitored. A diverse picture can be given of the human impact on the landscapes of Europe, but agriculture, urbanization, transport and tourism have a major influence on the quality of the land, its structure, its products and its ecology. It is important to gain insight into the human impact on the landscape, not only at the farm level, but also on the level of the wider landscape. That can provide a basis for landscape planning as well as for international programmes for land management and quality control (Jongman, 2002). Additionally, the development of sustainable agriculture must accompany advances in the sustainability of energy use, manufacturing, transportation and other economic sectors that also have significant environmental impacts and people of Mabibi are looking forward to such kind of developments

2.11 Ecosystem services

Society receives many benefits, called ecosystem services, from natural or managed ecosystems. Ecosystems provide food, fibre, fuel and materials for shelter. Additionally they provide a range of benefits that are difficult to quantify and have rarely been priced. Forest and grassland ecosystem can create or regenerate fertile soils, degrade plant litter and animal wastes, and purify water and this regenerative process is essential for subsistence slash and burn farming systems. Shifting cultivation also called swidden agriculture has been and still is practised to manage soil fertility. Shifting cultivation involves an alternation between crops and long-term forest fallow. In a typical sequence, forest is cut and burnt to clear the land and provide wood ash as 'fertiliser' or 'lime' for the soil. Crop yields are typically high for the first few years but then fall on account of declining soil fertility or invasion of noxious weeds or pests. The fields are then abandoned and the farmer clears another piece of forest. The abandoned field is left to fallow for several years or decades and thus has a chance to rebuild fertility before the farmer returns to it to start the process again. (Reijntjes, et al. 1992). Shifting cultivation is often characterized by a season-to-season progression of different crops, which differ, in soil nutrient requirement and susceptibility to weeds and pests. Shifting cultivation practices throughout the world vary immensely, but there are basically two types of systems:

-Partial systems, which evolve out of predominantly economic interests of the producers, e.g., in some kind of cash crops, resettlements and squatter agriculture.

-Integral systems, which stem from a more traditional, year-round, community-wide and largely self-contained way of life. Agricultural practices that degrade soil quality contribute to eutrophication of aquatic habitats and may necessitate the expense of increase fertilisation, irrigation and energy to maintain productivity on degraded soils (Tilman et al, 2002).

2.12 Maintaining and restoring soil fertility

Soil tillage speeds decomposition of soil organic matter and the release of mineral nutrient. The effects of land degradation on productivity can sometimes be compensated for by increased fertilization, irrigation and disease control, which increase production costs (Tilman et al, 2002). Crop rotation, reduced tillage, cover crops, fallow periods, manuring can help maintain and restore soil fertility in Mabibi.

2.13 Environment and development economics

It is well known to observers of agricultural development that the structure of agriculture is changing rapidly both in the developed and the developing countries. These changes are being caused by demand- side effects, such as changes in income and population migration, technological change, and the limited availability of land, water and other factors of production and places like Mabibi and other places in parts of Maputaland are experiencing such kinds of changes. These changes are not only affecting how business is traditionally conducted on the farm, but the very core of the agriculture-environment relationship (Chakravorty, 2001).

As the economist article suggests, modern agricultural practices are one of the major contributors to the degradation of the natural resource base (e.g. soils &water) upon which the future productivity of our planet depends. However, in a world that is rapidly becoming urbanized, agriculture is also valued as a source of open spaces, clean air and water, and as a traditional way of life (Chakravorty, 2001).

2.14 Transforming traditional agriculture

The task of transforming traditional agriculture is not simply a question of land reform or price policy. The transformation of traditional agriculture is also dependent on new inputs. The policy issue is to attract an adequate share of investment resources. The task is not exclusively a question of the supply of capital (Khan and Sobhan, 1990).

The low productivity of farm labour is due more to an absence of specific factor inputs, such as research and education, than to a shortage of reproducible capital as such. The most practical and economical approach to achieving a sizeable increase in agricultural productivity lies in enhancing the efficiency of the existing agricultural economy through improvements in the quality of inputs, and by the application of advances in knowledge and modern technology on a broad front (Khan and Sobhan, 1990). The way to transform traditional agriculture into a relatively cheap source of growth is by investment to produce a supply of new agricultural inputs that will be profitable for farmers to adopt (Khan and Sobhan, 1990). A farm project has been introduced in Mabibi with the hope of transforming traditional agriculture that can be easier for Mabibi farmers to adopt.

2.15 Technology and efficiency

Sen, (1975) reported that 'technique' is an individually acquired and socially secured way of doing something; 'science' is a way of understanding how to apply technology to improve. The gap between understanding how something would work and making it actually work can be quite a substantial one, and some of the major problems of technological advance in developing countries seem to arise from difficulties in the translation of science into technology (Sen, 1975). The application of `intermediate technology' (for intake by poor countries) can result in a number of problems - economic, social, and organizational (Sen, 1975). In mabibi a number of studies have been done. Firstly a detailed socio-economic analysis of the Mabibi people by A T Mthembu of the Geography Department, University of Zululand and secondly a detailed study of Agricultural status and practices by Ms E Bulfoni of the University of Udine, etc preceded this one. This study will be first practical study to be implemented in Mabibi and According to the author's point of view, people seem to be very delighted to be involved in a practical study as it would be a reward for them to acquire new technical farming skills.

2.16 Conclusion

This chapter has reviewed a wide range of peripheral issues that show the kind of improvements that can be brought to traditional farming to increase yield, e.g. adding compost to dry land soils. With such improvements Mabibi local people might withdraw from cultivation of wetlands. The next chapter discusses the materials and methods.

Chapter 3

Materials and Methods

3.1 Introduction

The *study contains qualitative and quantitative elements in a practical context.* Before the farm project commenced, the tribal authority was contacted for permission. The local chief or Induna held a meeting with people of the Mabibi informing them about the project. The author and project supervisors attended a few meetings together with the community people introduced by the Induna. The response was positive. Collaboration with the community and other organizations (like Nature Conservation etc) working in the area was done to sustain the project, as part of the work (planting and harvesting) was conducted on-site by the author and some part was carried out by a local assistant when the author was off-site.

3.2 Procedure

A randomised plot design was implemented, to test crop growth before and after a specified treatment, within a 10 m by 20 m fenced garden. Two different crops (Onions& Peanuts) were planted in November 2003. Peanuts were sown at 36 seeds/plot (or 90 000-seeds/ha density). Onions were sown in seed trays and, after 2-3 weeks, transplanted in half (100m^2) of the crop enclosure, and peanuts in the other half (100m^2). The two plots were divided into small 16 sub-plots measuring 2 m x 2 m in size, leaving 0.5 m spacing "as a guard row" for management and irrigation of the sub-plots. Onions were irrigated before transplantation. Irrigation was limited for both crops once in the open fields.

Two treatments were used: compost and no compost (control). The sub-plots were randomly allocated, which resulted in eight replicates of the two treatments in each half of the field. Randomisation was accomplished by drawing numbers from a box. Sub-plots were labeled no compost (NC) and compost (C). The sub-plots were further named using (odd and even) numbers. A similar method was done for each crop. The structure of the randomised plot design is shown in Table 3.1 a and b.

7C	12NC	3C	13C
4NC	1C	2NC	9C
11C	10NC	8NC	6NC
5C	15C	16NC	14NC

Table 3.1a: Experimental design table for onion, where C = Compost and NC = No Compost

13NC	1NC	12C	8C
4C	2C	3NC	15NC
9NC	10C	14C	16C
7NC	5NC	6C	11NC

Table 3.1b: Experimental design table for peanuts, where C = Compost and NC = No Compost.

The methods used in planting, cultivation practices (spacing, planting depth etc) were the standard used for commercial production. The methods used in applying compost were given to the author as advice by one of the co-supervisors. Irrigation was applied according to the available water. The spacing for onion was 30 cm x 15 cm (Tindall, 1983) and for groundnuts 50-90 cm x 15-30 cm (Tindall, 1983). Pegs were made for identification of sub-plots, treatment and crop. 5 kg of (dry) compost was incorporated into each (C) 2 m x 2 m sub-plot to a depth of 0.5 m, e.g. a total volume of $2m^3$. Based on soil density measurements (shown later in table 4.4) the sub-plot soil mass is 3000 kg. Therefore the rate of compost application was 0.16% (low). After two days, planting commenced using hoes to open holes. Irrigation was done using a watering can. 50 L of water was equally divided amongst all sub-plots and sprinkled three times per week. For more information on the first and second implementation methodology refer to the diary in appendix 2.

Second Implementation Methodology

The same methodology was applied during the second implementation in April 2004 except that the amount of compost was significantly increased, the season was winter so less hand watering was needed, and different crops were used. Two days prior to planting, 25 kg of dry compost was incorporated into the (C) sub-plots (each $2m^3$). The rate of application was thus 0.83%, a 5-fold increase over the 1st treatment. A spacing of 35 cm x 10 cm was used for sorghum and 50 cm x 35 cm (Tindall, 1983) was used for beans. Photos of some crop stages were taken to document the process (see appendix).

3.3 Harvesting

Peanuts were harvested from the field pulling whole plants with nuts and placed in plastic bags for analysis. The different bags (labeled according to sub-plots and treatment) were taken together with soil samples for both compost and no compost to the University of

Zululand, Agricultural laboratory for further analysis. Both fresh weight and oven-dried weight were determined as the weighing scale was used. The total biomass was measured (see tables 4.2a, 4.5a, and 4.6a). Other considerations were made with the laboratory-analysed results. These indicated only slight increases in yield from the composted sub-*plots during the first implementation phase. For each control and experiment soil* (mixed with compost), the soil was collected 10 or more places in each sampling area in a zigzag fashion so as to make a representative sample. The soil was mixed thoroughly before filling a sampling carton to be mailed to the lab. Top 2-3 inches of soil was dug and collected. Before the soil was mixed with compost soil samples were taken and after harvesting the mixed soil were collected and sent to the lab for analysis. The soils were analysed for N, P, and K, organic carbon, moisture content and pH for comparison of compost and no compost soil.

7	5*♦ (30)	6♦ (30)	11
9♦ (33)	10♦ (31)	14*♦ (28)	16
4	2*♦ (34)	3*♦(29)	15♦ (30)
13	1	12	8

Table 3.2: gives the structure of groundnut plot and the picture on how the harvest was done.
▒ : Sub-plots without compost;
□ : Sub-plots with compost;
(1÷16): plots numeration;
(*): Sub-plots where soil samples were taken;
(♦): Sub-plots where plants samples were taken;
(n): n plants harvested.

In the second implementation, Sorghum and Beans were planted within a soil of much higher compost content (20 kg). Again large plastic bags were used to collect the harvested crops from the field on a per sub-plot basis with labeling to distinguish NC and

C samples. The weights of oven-dried samples were recorded for Sorghum and Beans for NC and C treatments. The results (crops and soil) were sent to Cedara College of Agriculture in Pietermaritzburg for further independent analysis.

Two statistical questions arise.

-How can the variance between the NC and C samples be tested?

-Did the difference between the means of NC and C groups occur because of differences in the composting procedure, rather than by chance?

A t-test allows comparison of the means of two groups and determination of whether the difference between the two means occurred by chance. The calculations for a t-test require three pieces of information:

-The means for each group

Equation Av=Sum of samples / no of samples

-The standard deviation for each group

Equation SD= Square root of the sum of the differences / sample size minus one

-The number of samples in each group

The size of the standard deviation influences the outcome of the t-test so it is important. The more replicates (samples) involved in a study, the more confident the analysis can be that the differences between groups did not occur by chance.

When calculating the outcome of the t-test (which produces a t-value), it is necessary to check the value in the context of the appropriate degrees of freedom. This process is accomplished with a computerised statistical package that calculates the means and standard deviation of groups, the mean difference, the standard error of the mean difference and a p-value (probability of the mean difference occurring by chance).

3.4 Presentation of data

The data were analysed for crop yields with different treatments measuring freshweight of crops in the first and second implementation. The data are presented as two sections. Improvements in the second implementation regarding compost levels raised expectation of positive results. In addition to the in situ work in Mabibi a (surface temperature) mulching experiment was conducted at the university. Two digital thermometers were used on the soil surface in three different environments (bare soils, mulch soils, tree-shaded soils). Midday temperatures were recorded over the period of 20 days, this has been shown in the following chapter (Results).

3.5 Conclusion

The literature review on the work of Bulfoni (2003), who assisted the second implementation, indicated that agricultural land use at Mabibi in 2003 was unsustainable, as field extensions were eroding valuable habitat for the natural ecosystem. Questionnaire results from Bulfoni (2003) in appendix 4 show that agricultural yields are low. A plan for an integrated development of the area should be made. It has to be emphasised that agriculture should be analysed within the context of a market economy. It is essential therefore to develop viable rural income generating alternatives to urban employment. Here a case is made for stimulating agricultural development as a short-term option, prior to the development of a service sector economy within the World Heritage Site of

Maputaland. Attention should be given to development strategies that both stimulate entrepreneurial activities, and improve the quality of life in rural areas. To minimise the impacts of agriculture on the natural environment it is necessary to provide local farmers with new technology. The establishment of a community market will provide a reliable outlet for services, both amongst the community and as a point of interaction with the tourists. The following chapter gives the results of an implemented project plan but before getting into result it is wise to check the results background.

Chapter 4

Discussion of Results

4.1 Introduction

The chapter provides both the first and second implementation results and their interpretation. Supplementary information is provided in the Mabibi research diary (see appendix, pg 94).

4.2 First Implementation Results

Both soil and crop results are presented starting with the soil result. This result provides one table for soil results (pre-existing Mabibi soil and the improved soil with the use of compost) which is table 4.1. Two tables for groundnuts that show the average, the standard deviation and one with statistical test.

4.3 First Implementation field soil results

In order to start the fieldwork, it was necessary to test the soil for agriculturally significant nutrients and to also determine the impact of incorporating compost. Soil samples were analysed and the results are given in table 4.2 below.

Sample	Organic carbon %	Estimated organic matter %	K	P	P04	%Moisture
A	0.67 %	1.145 %	246.ppm	40 ppm	124ppm	0.37%
B	0.02 %	0.06 %	60ppm	27 ppm	84ppm	1.33%

Table 4.1: Gives comparison of soil result in both treatments, where Sample A is Mabibi soil improved with compost, and Sample B is pre-existence Mabibi soil.

As can be seen from the table, the nutrient content of the soil was improved in terms of K, P and % moisture, however organic matter still dries out rapidly in the normal Mabibi soil in summer.

4.4 Data Analysis for Groundnut with T-test

The harvested groundnuts gave the following results.

Peanuts Results (mass for two different treatments values (dry samples), in g's.				
	Sample no's	Mass	Average	Standard deviation
Compost	6C	54.9	44.95	8.01
	2C	39.4		
	10C	37.6		
	14C	47.9		
No compost	15N	54.1	47.17	6.44
	3N	45.7		
	5N	39		
	9N	49.9		

Table 4.2a: Table giving results for groundnut comparing the two treatments. The mass is referring to the weight of the total biomass per sub-plot e.g. $2m^3$ of soil.

Soil samples were taken from 8 sub-plots because peanuts did not do well. Peanuts were small, but similar to locally grown peanuts in dimension. Not much difference could be noticed between plots with compost or without compost as the concentration of application was too limited. As it can be seen from table 4.2a the averages are not very different because of the limited treatment (5% compost). Peanut grows well between the temperature of 22°C to 30°C; above 33°C or below 18°C the yield is reduced. Drought of 2003 affected both treatments, so significant differences were not obtained.

Groundnuts statistical results

The following table continues from table 4.2a and gives statistical results of groundnuts.

t-Test: Two-Sample Assuming Equal Variances in Peanut results		
	Compost	No compost
	Variable 1	Variable 2
Mean	44.95	47.17
Variance	64.17	41.46
Observations	4	4
Pooled variance	52.82	
Hypothesized Mean Difference	0	
Degrees of freedom	6	
t Stat	-0.43	
P (T<=t) one-tail	0.34	
t Critical one-tail	1.94	
P (T<=t) two-tail	0.68	
t Critical two-tail	2.45	

Table 4.2b: Statistical outcome from results in table 4.3a

As can be seen in table 4.3, there was little significant difference between the two treatments ($t=0.433$; $df=6$; $p>0.05$).

4.5 Considerations

Demonstrating that crops could be moved from wet to dry land was one of the aims of this project. Yet it was difficult to expect positive results without an expensive irrigation system. Mabibi's area, characterised by a sub-tropical climate, is often exposed to long dry spells. Annual mean precipitation can be high (1000 mm/year), but usually is concentrated in short periods, which leaves spells of high-temperatures. Soil temperatures in the open field at mid-day were measured and found to be up to 48°C. However with a mulch layer on the surface, this was reduced to 35°C (Table 4.3). Given the poor soil and dry weather, vegetables such as onions would have difficulty growing without water-stress. Groundnuts also suffered because of drought and pests.

During the first implementation, October-December 2003, the climatic conditions were unfavorable: daytime soil temperatures were often above 40°C and these cause rapid water loss and less crop yield.

For unmulched soil a lot of water was lost. From the above given data you can calculate how much was evaporation increased.

E= aT (bR)-cP

Where as ---A, b, c are coefficients

T= Temperature

R= Solar radiation

P= Precipitation

Temperature differences were recorded in various environments. Comparing averages of both bare sandy soil and grass-mulch covered spot and assuming the R difference is 1.33 and P is the same, the evaporation is increased by about 60% for a mean temperature difference of 8°C. It has been worked out this way:

E= aT (bR)-cP

==(1)1.2 (1) 1.33-(1) 0

==1.6/ 100

==60%

The impact of surface mulching was studied after this phase of the project, by comparison of mid-day soil surface temperatures taken for 20 days in January 2004 using an Oregon digital temperature sensor. The idea was to see how tree shading or a mulch layer could be used to shield the soil from direct sunlight, thereby conserving the moisture content of the underlining soil. Results are provided in table 4.3.

Bare or Sandy spot		Grass-mulch covered spot		Tree-shaded spot	
44°C	42°C	36°C	36°C	32°C	33°C
43°C	43°C	37°C	38°C	32°C	32°C
41°C	40°C	36°C	36°C	30°C	31°C
48°C	47°C	34°C	34°C	30°C	30°C
47°C	46°C	34°C	35°C	31°C	31°C
42°C	43°C	35°C	35°C	32°C	32°C
45°C	46°C	34°C	35°C	31°C	32°C
36°C	37°C	30°C	31°C	26°C	26°C
38°C	38°C	32°C	31°C	28°C	29°C
31°C	30°C	29°C	29°C	29°C	29°C
39°C	39°C	33°C	33°C	28°C	29°C
44°C	45°C	37°C	37°C	33°C	32°C
43°C	43°C	36°C	35°C	32°C	33°C
44°C	43°C	35°C	34°C	30°C	30°C
39°C	39°C	33°C	33°C	29°C	30°C
36°C	37°C	31°C	32°C	28°C	29°C
45°C	44°C	37°C	38°C	32°C	32°C
48°C	48°C	35°C	35°C	31°C	32°C
45°C	44°C	33°C	34°C	32°C	31°C
44°C	45°C	34°C	35°C	31°C	30°C
Average					
42.15	**41.95**	**34.05**	**34.30**	**30.35**	**30.65**
STN.DEV.					
4.42	**4.32**	**2.28**	**2.32**	**1.84**	**1.72**

Table 4.3: shows variability of temperature in three different environments, with two replicates based on independent sensors.

Bare soils, consistent with the first implementation, had a mean mid-day temperature of 36°C to 48°C, compared to mulched soils 29°C to 38°C, and tree-shaded soils 26°C to 30°C. This is clearly indicated in the graph below.

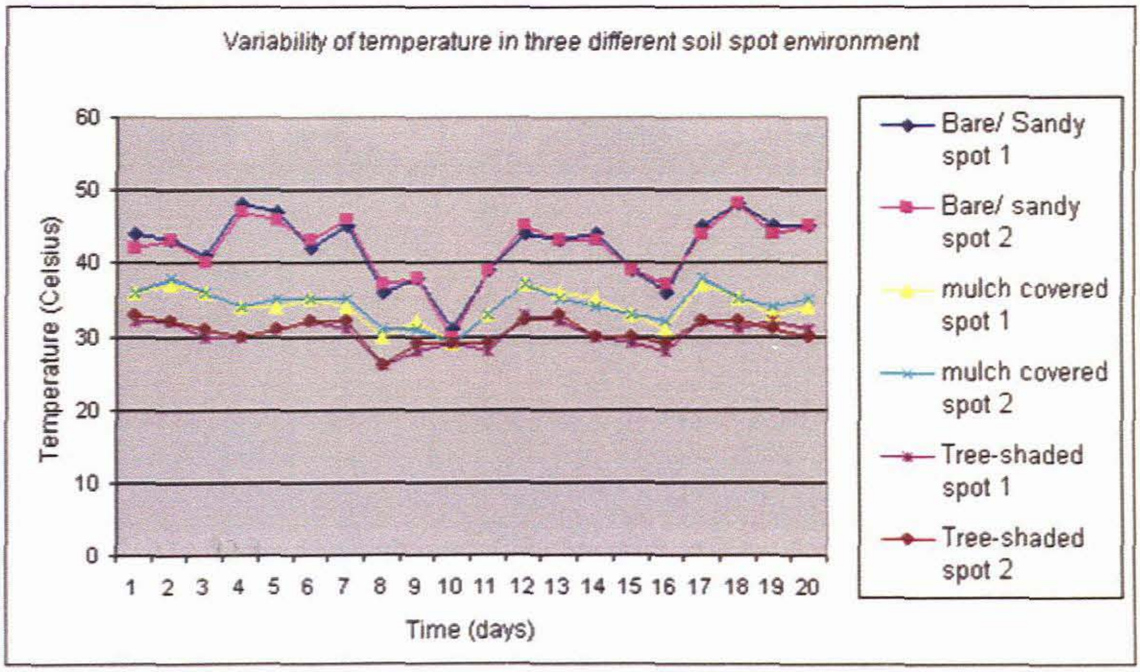


Figure 4.1: Shows the variability of temperature in three different soil spots.

Given a 10°C increase in surface temperature over a 4 hour period during the middle of each day in the early summer planting season, a significant increase in evaporation would result. Thus there is a need for mulching of summer crops, to reduce irrigation needs.

4.6 Fieldwork photos for 1st phase

Before the project commenced, Mabibi farmers were contacted and interviewed about the projects in terms of how they feel, think about it and to see if they see the future in it, figure 4.1 shows the picture of the two farmers together with the researcher talking about the project.

Figure 4.2: The researcher with one of the honour's student from University of Zululand and the two of Mabibi farmers Mr. Nhlozi (second left side) and Mr. Mdletshe (Right side).

For the garden to be safe (from theft and wild animals) it needed to be fenced. That was done during the first implementation. The researcher and the farm assistant Mr. Nhlozi in figure 4.3 established the fencing over the period of one week.

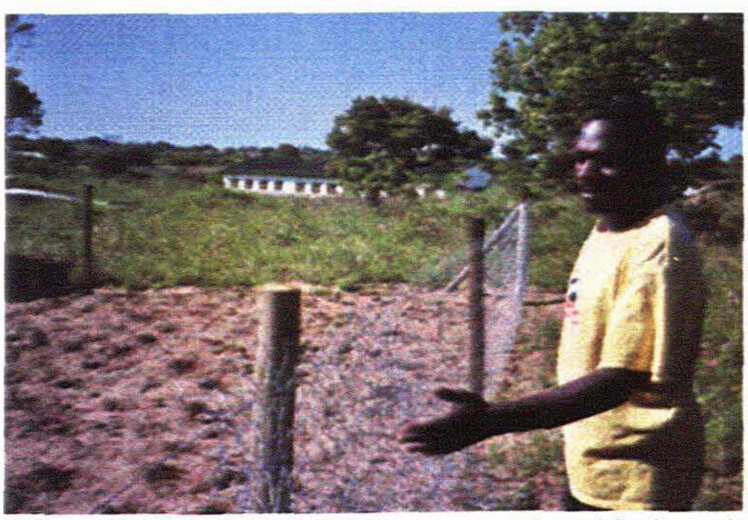


Figure 4.3: Initiation of the project: Mr. Nhlozi in the picture assisting with garden fencing

The co-supervisors from both departments (Agriculture and Geography) were there to assist the researcher, giving advice and good planning of the project (Figure 4.4)

Figure 4.4: Mr. Alec Wilson (Agriculture dept), Mr. Amos Mthembu (Geography Dept) and the researcher sharing ideas.

Crops were planted between mid October and mid November 2003 and harvested by March 2004. Below is the picture of groundnuts ready to be harvested.

Figure 4.5: First implementation, Peanuts in No Compost sub-block.

Another peanuts sub-block below

Figure 4.6: Peanut in compost sub-block

Because it was hot, vegetables like onion were started in the seedling trays and a small nursery was created as shown in the following picture.

Figure 4.7: A complete home made nursery for starting the vegetables, note shade cloth to reduce heat coming direct to the growing seedlings.

Closer look at the peanut sub-blocks

Figure 4.8: Peanut field with Mr. H.Chikoore (MSc student from Zimbabwe) indicating different sub-blocks.

Mabibi women came to lend a helping hand during the harvesting. The community enjoyed being involved in the project.

Figure 4.9: Mabibi community members assisting the harvest.

4.7 Second Implementation Results

The results are presented the same way as in first implementation. Soil results are followed by two tables for sorghum and beans which gives means, standard deviation and statistical results.

4.8 Soil results

Subsequently to the first phase, significantly more compost (25kg) was added in the second implementation in April 2004. The weather was cool so good results were expected.

Sample ID	Density (g/ml)	P (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Ex. acid (cmol/L)	Total cat. (cmol/L)	Acid sat. %	pH (KCl)	Zn (mg/L)	Mn (mg/L)	Cu (mg/L)	Org. carbon %	Clay %
A	1.34	143	483	590	471	0.11	8.17	1	6.36	6.7	26	0.6	-	12
B	1.50	8	20	274	93	0.07	2.24	3	4.89	1.1	8	0.6	-	8
NC	1.48	2	9	271	91	0.04	2.18	2	4.78	0.0	4	0.3	-	7

Table 4.4: Second implementation soil results, where A = Mabibi local made compost, B = Field compost partly imported in the 1^{st} phase, NC = No compost.

As it can be seen from table 4.4, the freshly composted sub-blocks (Soil A) obtained higher nutrient levels and that led to increased crop yields as it will be seen in the following crop results. Soil B: the 'older' composted sample had increased phosphate. Soil NC: the untreated Mabibi fernwood soil was much lower in nutrients. From a practical point of view, the locally made compost was then seen to be useful in terms of crop productivity improvements.

4.9 Sorghum results

The following table (Table 4.5) indicates the differences in different means of both treatments and it can be seen that for compost the yields were high. The mass is referring to the weight of the total biomass per sub-plot e.g. 2m³ of soil in each different crop results.

Sorghum Results (mass for two different treatments values (dry samples), in grams.				
	Sample no's	Mass	Average	Standard deviation
Compost	7C	13.86	20.26	5.75
	3C	21.62		
	13C	15.16		
	1C	19.82		
	9C	17.11		
	11C	17.18		
	5C	27.86		
	15C	29.50		
No compost	12N	7.47	9.95	3.38
	4N	10.84		
	2N	8.67		
	10N	8.27		
	8N	17.28		
	6N	8.28		
	16N	11.79		
	14N	7.00		

Table 4.5a: Sorghum results in g's showing the averages and standard deviation based on the September 2004 harvest.

t-Test paired two sample means for sorghum		
	Compost	No compost
	Variable 1	Variable 2
Mean	20.26	9.95
Variance	33.08	11.43
Observations	8	8
Pearson Correlation		
Hypothesized Mean Difference	0	
df	7	
t Stat	4.28	
P (T<=t) one-tail	0.002	
t Critical one-tail	1.89	
P (T<=t) two-tail	0.004	
t Critical two-tail	2.36	

Table 4.5b: t-Test continued from Table 4.5a

There were significant differences between the two treatments. The dry weight difference between compost and non-compost in terms of standardised departure was 22%.

4.10 Consideration of Results

The *Sorghum bicolor* (variety PAN 8564 - chemically treated seed), provided by the Agriculture Department, was a good choice since it is a bird-proof type. Closely associated with maize production is the grain sorghum crop, used in South Africa since the earliest days of white settlements. Sorghum is rich in vitamin D and proteins, and is best known for its roles as malt and meal in brewing local beer.

4.11 Bean results

Based on the September 2004 harvest results for the bean crop, the following information was generated.

Beans Results (mass for two different treatments values (dry samples), in g's.				
	Sample no's	Mass	Average	St. deviation
Compost	12C	12.25	8.26	2.33
	8C	4.9		
	4C	8.38		
	2C	8.31		
	10C	10.75		
	14C	7.12		
	16C	6.49		
	6C	7.86		
No compost	13N	4.78	3.85	1.67
	1N	4.67		
	3N	0		
	15N	4.14		
	9N	5.23		
	7N	3.48		
	5N	4.93		
	11N	3.93		

Table 4.6a: Average, standard deviation for both treatments (C and NC) in bean results.

The following is the statistical test for bean given in table 4.6b

t-Test paired two sample means for beans		
	Compost	No compost
	Variable 1	Variable 2
Mean	8.26	3.89
Variance	5.43	2.80
Observations	8	8
Pearson Correlation	0.09	
Hypothesized Mean Difference	0	
df	7	
t Stat	4.49	
P (T<=t) one-tail	0.001	
t Critical one-tail	1.89	
P (T<=t) two-tail	0.003	
t Critical two-tail	2.36	

Table 4.6b: Beans statistical results. The significant differences were obtained. The composted sub-blocks improved yields by 54%.

According to tables 4.6a and b and table 4.7a and b, and considering the standardised departure (accounting for variance within the sub-plots), the sorghum yield was increased by 22% and the bean yield by 54% in the composted plots. This was a most satisfying result, as very little effort had been put into the crops since planting, with exception of hand watering three times a week.

4.12 Conclusion

By adopting the use of improved organic farming practice people of Mabibi can gradually increase their yields. The results have shown that 1% compost can double the yield. Compost application increased soil available N. Increased K uptake may be more important for crop yield (see table 4.4) than either N additions or the effect on retained soil water. The beneficial effects of organic composting and mulching on soil physical properties were evidenced by reduced irrigation demand. It was seen that the compost delayed the onset of water stress in sorghum, beans crops because from the control the crops lost the green colour and became yellow. Compost is a low cost local resource suitable for poor rural villages like Mabibi that are still in the process of development. The soil results have shown how locally made compost enhances nutrients and therefore yield.

4.13 Second Implementation on-site photos

The people of Mabibi took care when the researcher was off-site.

Figure 4.10: The ground after the harvest. One can notice the difference between the field and the pre-existing grassland.

The garden was prepared for second implementation to carry out the planting for the second time. It was tilled and measured as shown below.

Figure 4.11: Measuring the garden to sow sorghum.

After the compost was incorporated the sorghum was sown

Figure 4.12: Sowing Sorghum

Figure 4.13: Different sub-blocks (with growing sorghum) and the researcher.

Preparing for beans as it was the second option after the failed cabbage.

Fig 4.14: Starting the preparation for beans in the background

Finishing the preparation of the ground to sow beans.

Figure 4.15: Researcher and assistant Mr. Mthalane (from Agriculture Dept) and Ms E. Bulfoni (MSc Agricultural student from Univ. Udine, Italy) incorporating compost to sow beans in April 2004.

Figure 4.16: The researcher removing competing plants.

Figure 4.17: Closer look of the sub-blocks. The green colour with healthy plants growing up sub-block is for compost and the one with no-compost shows stunted growth (to right).

The people of Mabibi were taught on how to make their own compost to help people increase soil fertility and crop yields. Demonstration with available resources was made (Figure 4.18).

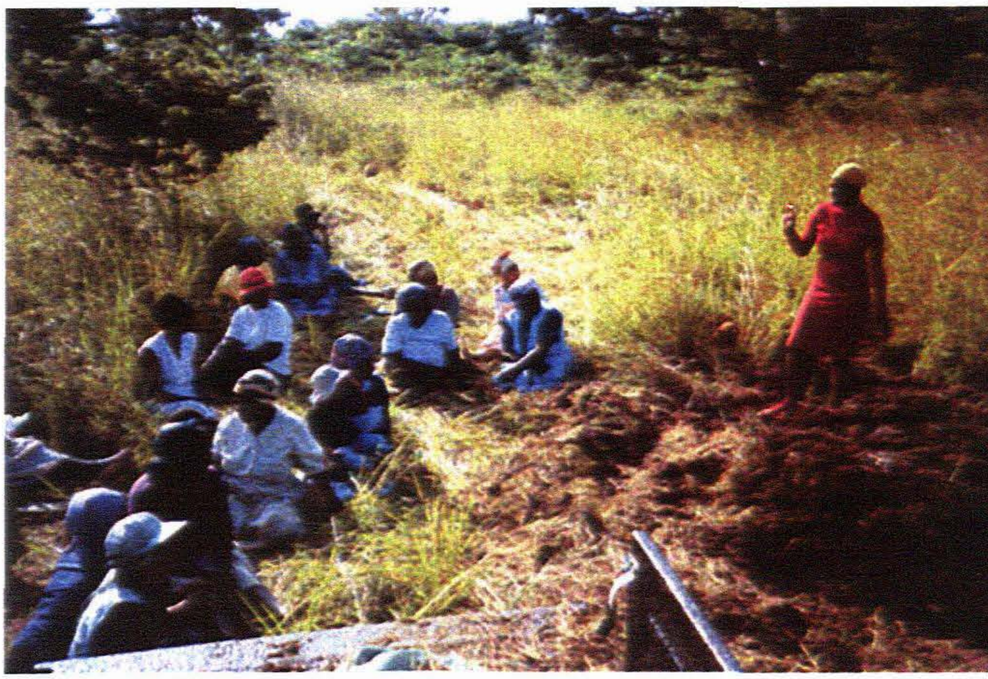


Figure 4.18: Compost demonstration.

Figure 4.19: Two researchers Nqobile and Elena Bulfoni from Italy (University of Rizzi, Udine) with Mabibi group of people attended the compost demonstration.

Chapter 5

Discussion and Conclusion

5.1 Introduction

The UNESCO-sponsored farm sub-project was intended to 'simulate' a local farmer and the hardships faced in farming in sandy soils with limited means. Financial resources were maintained at about R 5000 per year ($1000 in 2005), for the project researcher to engage in on-site activities. Only fencing, compost delivery, seeds, tools/implements and personal supplies were provided to the researcher. No vehicle was available, and the researcher walked long distances to fetch water, tend the field and return to residence in the village. A positive spin-off was direct contact with the villagers that helped avoid perceptions of elitism that often accompany more highly resourced projects.

5.2 Discussion

Farming on 'dry' land (water table is below root level) in summer is quite difficult in southern Africa. The sand heats up during the day (table 4.8) and even with the application of water (50 L thrice per week) to growing plants, high evaporation losses resulted in water-stress and low crop yields in 2003. The application of compost is of little value without adequate rainfall. This was found in the first phase where onions failed and peanuts did poorly. Increased compost (25 kg) and use of the cooler season gave a better result in the second phase. Despite the poor sandy soil and climatic constraints faced in Mabibi the use of compost improved yield. Table 4.4 clearly indicated improvements in different soil samples. Sample NC representing Mabibi pre-existing soil was found to be very poor in nutrients (P, K, Ca, Mg, Zn, Mn, and Cu). The use of imported compost represented in table 4.4 as B played a major role in fertility of the soil and that resulted in an increase of yield. Locally made compost was demonstrated and used and also found to increase Mabibi crop yields (in Table 4.4). A large area of land 20-35 ha, would require an efficient irrigation scheme and the continuous formulation and incorporation of local compost. However the community still needs a market.

5.3 Conclusion

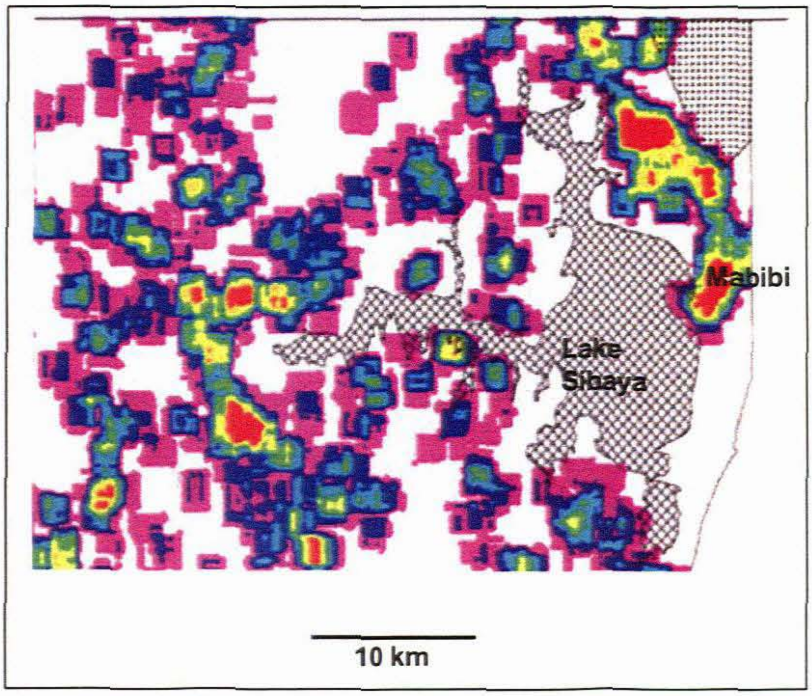
This two-year farm project implemented at Mabibi became part of the community with sequentially held meetings on-site arranged by the author. Some of the local people involved in the project gained new farming skills particularly in soil preparation and compost making. This was a different experience for the community since they claimed that outside researchers often make promises that are unfulfilled. Some said "we want this project to continue because farming plays a major role in our lives". For the author this was a different experience, staying in an unfamiliar isolated place was a tough challenge, but the local people were welcoming. Ultimately, the project proved it possible to significantly increase yields (Table 4.6a) with minimal expense and effort. The results obtained in the experiment indicated that improving dryland practices can encourage local people to withdraw from cultivating wetlands. The increase in labour associated with the collection of organic matter, compost preparation, transport and incorporation of compost into the soils will be necessary. Increasing compost to 1% caused a doubling of yield equivalent to what would be expected for a wetland. Therefore the hypothesis that organic farm in dry land will improve yields was supported in the second experiment.

Following on from this with uptake by the local community, a change in land use could be a realistic expectation.

5.4 Recommendations

This brief land use experiment had a limited scope and duration (two plantings), and was never intended to determine the wider impact of its activities on the community. In any case, 'outside' technological inputs might be expected to have a limited appeal. Changes in agricultural practices have to come from within. With this in mind, the farm plot should be continued under guidance of the local community. They should formulate compost from locally available resources and incorporate this into the entire plot. With each planting, supplementary compost would be added. Then the local farmers could qualitatively compare crop yields inside and outside the fence and also compare with wetlands, whose yields depend on climate. A future issue for study is to compare wetland and dry-land yields in rainy and drought spells, through a continuation of this farm project. Tribal council meetings could be used to report results, and help influence other farmers to engage in organic practices that fix the location of cropping activities. As can be seen in fig 5.1, urbanisation and farming is rapidly transforming the land near Mabibi. It may be possible to uplift the standard of living through installation of a water network and crop irrigation scheme. It is hoped that eco-tourism will increasingly benefit the community and take over as the main source of income thereby saving the ecosystem.

Figure 5.1: Satellite derived changes in land use from 1996 to 2000 (Square shading demarcates areas with increasing human impacts) from Jury et al (2003).



References:

Boyhan G. E, Granberry D, Kelley W.T and McLaurin W, 1999. *Growing Vegetables Organically*, University of Georgia College of Agricultural and Environmental Science and the U.S. Department of Agriculture.

Bratt, Anna, 2002. Management practices to reduce nutrient leakage within a Sweddish catchment. *Journal of Environmental Planning and Management*, 45, 5, 673-717.

Bulfoni E., 2003, Sustainable agriculture in a natural reserve of KwaZulu-Natal, South Africa, *PhD Thesis*, University of Udine, Department of Crop Sciences and Agricultural Engineering. Unpublished.

Centre for Community Organisation, Research & Development (C.O.R.D.),1989. Overcoming apartheid's land legacy in Maputaland (Northern Natal), *Proceedings of S.A.E.R.T.* policy workshop towards a new agrarian democratic order, Wageningen, 12.

Chakravorty U, 2001. Globalization and the Agriculture-environment relationship. *Environment and Development Economics*, 4, October.

Countryside & Small Stock Journal, 1995. Compost: How it happens, 79 issue 1, p40.

Derman P. J, 1981. *"Small-holding farming*: Objectives and issues", Pretoria.

Derman P. J and Poultney C, 1983. *"The social dynamics of smallhold farming in the Siphondweni district of the Makathini Flats".* Human Sciences Research Council, Pretoria.

Derman P. J and Poultney C, 1987. Agricultural reconstruction in a consumer society: *The Mboza village project*, 4, 3, August 1987.

Edwards J. H, 1995. Support for usage of organic byproduct in Agriculture. *BioCycle,* 02765055, 36, Issue 11, p.10.

Erenstein O, 2003. Smallholder conservation farming in the tropics and sub-tropics: A guide to the development and dissemination of mulching with crop residues and cover crops. *Agriculture, Ecosystem and Environment*, 100 issues 1, p. 17-37 (21).

Ffolliot P.F, Brooks K.N, Gregersen H. M and Lundgren A. L, 1995. *DRYLAND FOREST.* Planning and Management. Published in Canada.

Govender Y., 1999, Impact of conservation measures on community development. *Unpublished Honours Thesis*, University of Zululand, KwaDlangezwa.

Govender Y, 2001. "Environmental factors maintaining coastal biodiversity in Maputaland". University of Zululand, South Africa.

Hammer DA, 1992. *Creating freshwater wetlands*. Lewis Publishers

Harris J, 1982. *Rural development. Theories of peasants' economy and Agrarian change*: London. Hutchinson and co. (publisher. LTD).

Johnson and Jim, 2003. Global warming offers benefits to farmers. *Waste News*, 9 issue 13, p12.

Jongman R. H. G, Apr2002. Landscape Planning for Biological Diversity in Europe. *Landscape Research*, 27 issue 2, p187, 9p.

Jury M R. Y, Govender, E. Bulfoni, J, Mitchell, S.Hatesse, S.Guyot, 2003: Conservation and sustainable development on the Maputaland coast of South Africa, Report to UNESCO, *Centre for Environmental Studies, University of Zululand*, 163 pp.

Kaiser C and Sheard A. G, (2001). Guidelines for Organic Fruit and Vegetable Production in the KwaZulu-Natal Region for export to the European Union and the United States. *KZN Agri-Report* N-A-2001-38.

Khan A. R and Sobhan R, (1990). *Trade, Planning and Rural Development:* London. Published by Macmillan press LTD

MacVicar, 1986. "Land types of South Africa N° 2632 Mkuze", Department of Agriculture and Water Affairs, *Report N°6*. Pretoria.

Mader, Paul, Flie bach, Andreas, Dubois, David, Gunst, Lucie, Fried, Padruot, Niggli, Urs, 2002. Soil Fertility and Biodiversity in Organic Farming, *Science*, 0036-8075, May 31, Vol.296, Issue 5573

Mitchell Beazley, 1995. The Royal Horticultural Society's Encyclopedia of Practical Gardening: *Organic Gardening* @ Reed International Books Limited.

Mkhabela T S, 2002. Determinants of manure use by Small-Scale crop farmers in the kwaZulu- Natal province: A Logit Analysis. *Agrekon*, 41, 1, March.

Mthembu, A.T., 2001, Mabibi socio-economic survey. *Paper presented at the Institute* for Research Development and University of Zululand seminar, Richards Bay.

O'Riordan T.1995. *Environmental Science for Management.* Essex, London Scientific and Technical.

Piéri Christian, 1989. *"Fertilité des terres de Savanes"*, CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement).

Poultney C, 1982. *"Man and the Pongolo Floodplain - Part 2: Subsistence and the utilisation of resources by the inhabitants of the Mthikeni/Nsimbi pans region"*. Human Sciences Research Council, Pretoria.

Pretty and Jules, 2003. Agro ecology in Developing Countries. *Environment*; Nov, 45 Issue9, p8.

Reijntjes C, Haverkort B, and Waters-Bayer A, 1992. *Farming for the future: An introduction to low-external input and sustainable agriculture.* London: Macmillan.

Smedley L.N and Riberio-Tories J.L, 1980. *"Man and the Pongolo Floodplain: A preliminary study"*, Pretoria.

Smith E.M and Dr Mary Ann Rose, 2001. *Mulching landscape plants,* by the Ohio State University for the Ohio Florists.

Staines R, 1990. *Market Gardening.* Published by the Crowood Press.

Taylor D, 1998. Development Southern Africa: Agricultural practices in *Eastern Maputaland.* Nov, 5, 4.

Teare I. D. and Peet M. M, 1983. *Crop-water relations*. Published by John Wiley Sons, Inc.

Tilman, David, Cassman, Kenneth G, Matson, Pamela A, Naylor, Rosamond, Polasky and Stephen. 2002. Agricultural Sustainability and Intensive Production Practices. *Nature*, 8/8, 418 issue 6898, p671.

Tindall H.D, 1983. *Vegetables in the Tropics*. Macmillan International College edition.

Tinley K.L, 1985. "Coastal dunes of South Africa", *South African National Scientific Programmes Report Number 109*. Pretoria.

Vandeverre Apsey Robinson & Associates Architects, 1989. "Ubombo-Ingwavuma structure plan". Durban.

Wilkinson K, Paulin R, Tee E, O'Malley P, 2002 Grappling with compost quality down under. *Biocycle*, Sep, 43 issue9, p 56.

Williams C.N, Uzo J. O, Peregrine W.T.H., 1991. *Vegetable Production in the Tropics*. Published by British Library Cataloguing in Publication Data.

Yohannes A, 2004. Problems of the solution: Intervention into small-scale irrigation for drought proofing in the Mekele plateau of Northern Ethiopia. *Geographical Journal*, Sep, 170 Issue 3, p226.

Internet References

Lampkin N and Hoffman U, 2002. Organic Agricultural Association of SA, Good Soil Management, Newsletter pg. 5&6
http://www.oaasa.co.za/downloads/march2002-newsletter.pdf

Moore N, 2003. Saving Wetlands saves people.
http://www.environment.gov.za/newsmedia/articles/2003

Warman D S, 1999. Community Gardens: A tool for Community Building. http://www.cityfarmer.org/waterlooCG.html

Appendix 1

Definition of key terms (Terminologies)

Community garden: is an ongoing, year-round project that enables local people to supplement their food supply.

Mulching: is a layer of peat moss, compost, animal manure or similar material uniformly spread on the surface of the soil around and under plants. Smith E, Rose M.A, 2001.

Organic mulch: are derived from plant material, leaves, bark, etc that decompose in time and enrich the soil. Smith E, Rose M. A, 2001.

Organic farming: uses natural materials and methods, and avoids practices that employ synthetic chemicals or fertilizers that may be expensive or detrimental to health or environment. Williams C. N et al, 1991

Sustainable development: is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This means transferring the opportunity of sustainable livelihoods to the poor, through capacity building in science and management, and in correct resource use.

Rural development: is a strategy designed to improve the socio-economic status of rural people. Refers to a distinct intervention in underdeveloped regions beyond agriculture that contribute to development of broader economic activities to alleviate poverty. Harris, J. 1982.

Schedule of activities for Mabibi Research

Activities	Date	Year
Research Proposal	April	2003
First trip to Mabibi Situation analysis (e.g. soils, assistance) Check on available resources Commence diary and photo surveys	26-30 May	
Literature review	June-November	
Second trip to Mabibi Preparation for mulching of soil Check on available resources	27-31 July	
Extended stay in Mabibi Implementation of farming activities Start collection of input data	October to December	
Fourth trip to Mabibi To check how the plot is doing	Mid February	2004
Second implementation to improve on previous year.	March to May	
To check the progress in the field (crop growth).	July	
To harvest crops and check productivity	September	
Finalise analysis and write up of thesis	November	

A 1: Table- giving activities of Mabibi Schedule

Appendix 2

MABIBI DIARY

Initial Development (field visits)

First Trip to Mabibi

The trip was 26-29 May 2003. The aim of the trip was to introduce the farm project and to build a relationship between the researcher and community members. This was most important since the researcher was going to spend two months each year in Mabibi during the two-year project. Furthermore, acceptance by the community of the farming technology depended on good personal relations and a perception by the community of the projects' good intentions. Prior to this study passive ecological and socio-economic snapshot surveys had been conducted by the Environmental Studies Department of the University of Zululand. This sub-project was different since it was more practical, situated on-site and involved direct sustained interactions with local community members. During these brief initial visits meetings were held with the Induna (chief of Mabibi) and the tribal council. Then, the Induna addressed the community about the farm sub-project and it was well supported from Induna's response to the researcher and project leader

On 27 May the researcher met with community members including Mrs P Thwala (Principal of Mabibi primary school), Victor Thwala, husband of the principal (Teacher in the same school), Mr T Nhlozi (a well- known community member), Mr Mdletshe (Induna) and the family, Mr Zikhali and the family, and the Thwala's family. The researcher was taken around and saw existing failed community gardens and the degraded wetlands. The researcher was provided a site to work by the community and the

Chief. The researcher enquired amongst the local people about agriculture practices at Mabibi so as to guide the project. This involved: different local crops planted in drylands and wetlands, consideration of the available resources, water constraints (irrigation), infertility of the soil, how much land was available, farming practices, tools utilized, pest control and market demand. The researcher sought accommodation for two months (beginning of October to December 2003) for the first implementation of the project. The Thwala's offered to provide this. Mr. Nhlozi agreed to assist the researcher in the community and thereby received a small payment from the project.

Trip to Cedara

To get advice from different agronomists and soil scientists, a trip was made to Cedara Agricultural College in June 2003. Another purpose was to search for more information related to the research project since there is also a library.

The researcher was accompanied by the project leader. A number of interviews were conducted. One lecturer (Debbie H.) came up with the idea of making trenches for composting, since the soil was sandy. This would prevent erosion and help retain water and nutrients in the soil. James A., the horticulturist suggested the use of lime for soil acidity. Peter V. the agricultural engineer gave few tips on irrigation, but these seemed too expensive for the Mabibi project. Nobuntu M., a farm technician working on small-scale farmer's community projects discussed constraints faced by the farmers and gave advice on small farming projects. These ideas helped the researcher to better plan the project, to ensure its success.

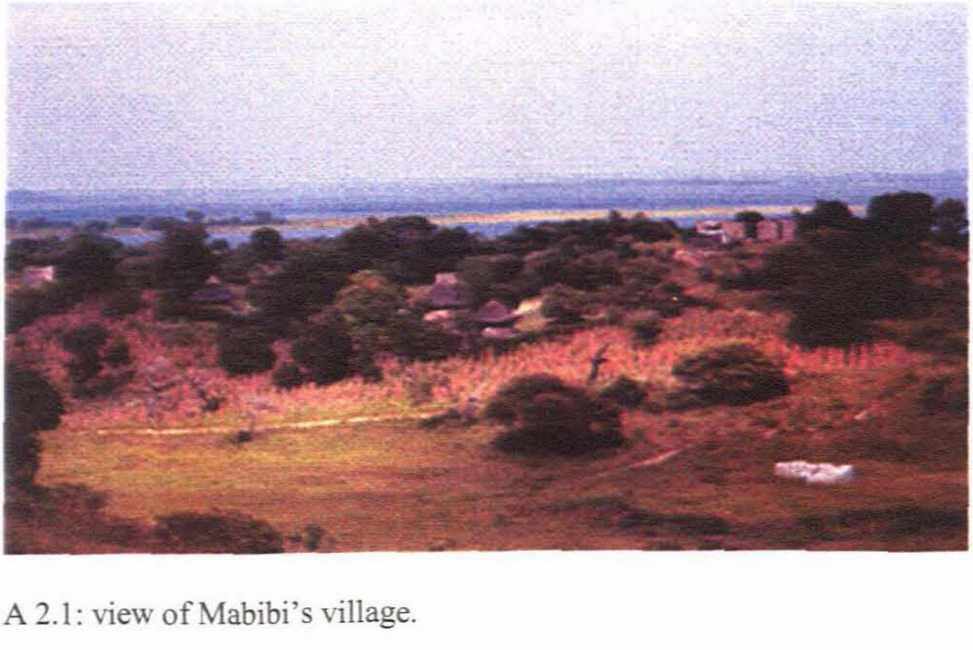
Second Trip to Mabibi

A second trip was made to Mabibi on the 28th of July 2003. The author was accompanied by a soil scientist in the department of Agriculture, A. Wilson and A. Mthembu from the Geography Department (University of Zululand). The main aim was to identify the site and gain permission for its use. The trip was successful.

First Implementation: Diary

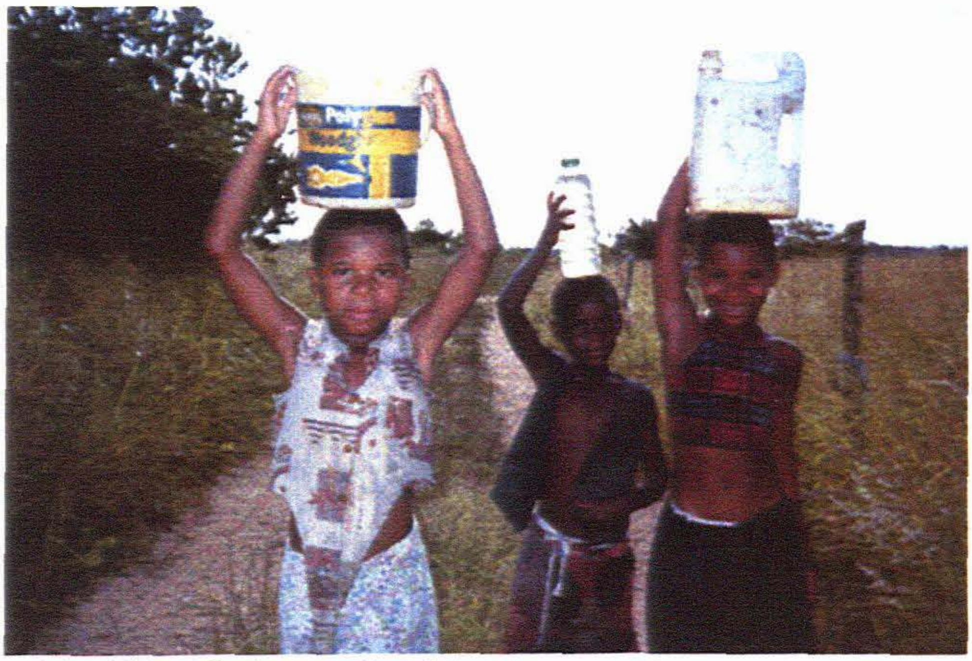
Living in a Mabibi homestead

Mabibi's people are traditional in their outlook and culture and have been little affected by the processes of westernisation and modernisation. Living in Mabibi, the feeling is that nothing happens: no electricity, no potable water, no public transport, no markets, no public telephones. It is so quiet. Civilisation is reduced to a school, a camp site (where running water is available) and a small health clinic.



A 2.1: view of Mabibi's village.

In Mabibi there is no water borne sewage system, the existing houses being serviced by outdoor pit latrines. People collect water from the lake or pans, carrying it in bottles on their heads or in 25 litre containers in wheelbarrows. There are a few wells, but the majority are exhausted. Transport is a private truck, which travels from Mabibi to Mbazwana a few times a week. It sometimes conveys more than 15 people with their food and luggage, which makes an uncomfortable journey that takes over one hour. Women work at home and in the fields, while men fish to the Ocean (the lake can be a problem with crocodiles and hippos) or migrate to towns to work for cash.



A 2.2: children fetch water from lake or pans.

People in Mabibi live a life quite well integrated with the primitive environment. However the youngest do not want to remain in the village. The extreme isolation is strongly felt; they are not interested in farming because they do not see enough profit.

Although development is slow, over and above the subsistence economy, a cash economy is emerging in response to the new socio-economic demands felt by the people of Mabibi village. Cash is needed to meet these demands that have permeated into the rural situation from cities as a result of labour migrants. Radios, furniture, crockery, cutlery, etc. have become symbols of status. Education has also become important and prestigious.

Report on 1st Phase Fieldwork at Mabibi

The first fieldwork started in October 2003 consisting of two experimental cultivations: one of peanuts, another of onions. The aim was to test the possibility of growing those crops on dry lands rather than in the wet lands and to understand whether the use of compost could improve yields. Two 10 m x 10 m fields were prepared and divided into 16 (2 m x 2 m) sub-plots. Randomly, compost was added in half of the plots as discussed in Chapter 3. Peanuts and onions were sown and irrigated as outlined earlier. Irrigation was limited for both crops once in the open fields and this posed a problem due to many hot dry spells.

In mid-March 2004, it was time to harvest. The onions had largely failed because of the drought (rainfall was < 70% of normal in the preceding summer) and the field was prepared for the next cultivation. Peanuts were harvested, reaping the whole bush and its nuts and soil samples for laboratory analyses. Samples were taken from 8 sub-plots. Peanuts were small, but similar to locally grown peanuts in dimension. Not much difference could be noticed between plots with or without compost. This was because the concentration had been too limited.

A 2.3: onion and peanut crops being harvested in 2004.

With a budget of only R 10 000, a few months on-site, and the part-time assistance of a local man with hoes and rakes in a previously uncultivated field, it was challenging to take on this cultivation on a scientifically valid basis. Considering the compost quantity utilised for crops, it emerged that too little had been incorporated. A greater amount would be needed in future. The fencing system turned out to be economical and effective, and the author and Mr Nhlozi's commitment to the work remained high. With this background, a 2nd phase was conducted.

Second Implementation Results: Diary

For this second phase of the Mabibi farm plot an increase in compost and a change in seasons and crops were considered. The author was joined for one month by E. Bulfoni, a Master's graduate from Italy. We left the University with cabbage and sorghum seeds, food and equipment to stay in Mr Nhlozi's homestead in Mabibi village. The first three days were spent at the campsite with Mr Mthembu (project co-leader from the Zululand University) and Mr Chikoore (a MSc student studying land-atmosphere interactions as part of his MSc). They assisted the harvesting of peanuts. Thereafter the ladies moved on-site in Mr Nhlozi's homestead.

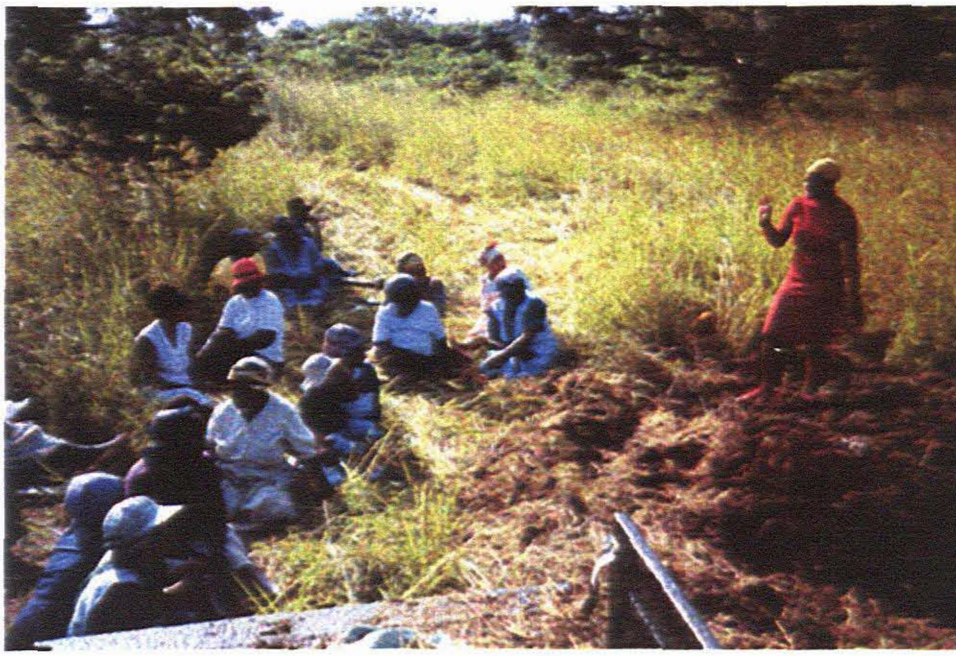
Fieldwork was restricted by the limited labour and equipment available: no irrigation, no vehicle, etc. However without the vehicle we were better able to appreciate the community's situation and were more in touch with its inhabitants. However leaving the village to buy necessities was difficult.

We decided to go back to the University with public transport, to obtain a vehicle to return in Mabibi. The cultivation of sorghum was completed, but cabbage germination was unsuccessful. With Mr Mthalane's (a University technician) collaboration, we obtained bean seeds and sowed them into the farm plot, in place of cabbage. The same sub-plot layout was maintained, but the compost content was increased 5-fold as described in Chapter 3. *Sorghum bicolor* was sown in 6 continuous rows in each sub-block with 40 cm spacing. Cabbage seeds were sown in seed trays to be transplanted later (this crop was substituted by the bean crop). Compost was added in higher quantity and in more extended surfaces.

MAKING COMPOST

A composting demonstration was organised, involving the local people of Mabibi. Straw, plant residues and kitchen waste are a valuable source of organic matter for improving and maintaining the fertility of soil. Making compost with them is a practical alternative to the use of animal manures. Compost is low in nutrients but is a rich source of humus, which has a crucial influence on the retention and release of nutrients, in the formation of good soil structure and the soil's ability to hold water. Any bulky matter of plant origin is more or less suitable for composting. Nitrogen-rich material, in the form of leaves and nitrogen-rich additives such as animal manure, accelerates decomposition. There must be a good balance of material in a heap in order to ensure the movement of air, composting being an aerobic process. Mixing in a proportion of semi-woody material helps this by preventing the heap from becoming compacted. Building the compost heap up in layers aims to mix the type of material added. The heap must not be allowed to become waterlogged, which excludes air and lowers the temperature, and it has to be covered to keep off rain and maintain warmth and internal moisture. Conversely, the heap should not be too dry, as this similarly slows decay; in warm weather it needs to be watered. It must be at least of 1.5 m large x 2 m long x 1.5 m high. Rotting waste generates heat through the activity of micro organisms, and a well-made compost heap can reach around 70°C within three or four weeks. It is most beneficial to turn the heap from time to time, ideally by forking rotting material out of a full bin into an empty one: less rotted material has to be moved from the sides of the bin to the centre of the new load, where it rots faster. This has to be done at least once per full loading and preferably more often. A heap that is carefully loaded and regularly turned can produce usable compost within a month or so.

Everything mentioned above was explained in plain terms in Zulu language to the Mabibi people during our composting demonstration. The people were very happy with this new information.



A 2.4: compost demonstration.

Compost was made from locally available material from the Mabibi area: litter from poultry, peanut harvest residues, dry grasses and soil (there was insufficient time to collect organic matter like kitchen waste, but it was suggested). The compost demonstration proved itself successful, with good participation by the village's women especially.

A 2.5: sorghum field.

As shown above, when we left Mabibi the sorghum was growing rather well (it rained sometime after seeding); the small plants were 20-30 cm high and there were no evident signs of diseases. Beans were just sown. Some differences could be noticed in the plants' dimensions between plots with and without compost, but it was too early to make valid considerations. Subsequently these crops were harvested in September 2004.

One week workshop was held at Mabibi in the beginning of November 2004, the handouts were given to the community members.

A 2.6: Project leaders giving feedback to the Tribal villagers. Sitting in the first rows is the Chief, councillors and community members.

Appendix 3

<u>Questionnaire from Bulfoni (2003)</u>

The sampling was by informed consent, as the project was authorized by the tribal authority and well known to the community.

Questionnaire

Date...

.....

Interviewer..

......

Respondent..

......

Respondent relationship within the household

......

Household head

......

Household coordinates:

....

Household structures (house, kraal, etc)

....

Number of people in the household:

			people working in agricultural activity
males	females	children (0-10)	

Crops

Total farm area (ha)

....

Presently cultivated farm area

....

Crops	Area	Yield/no trees	Amount sold (kg/y)	Notes
Maize				
Peanut				
Sweet potatoes				
Onions				
Tomatoes				
Cabbage				
Spinach				
Yam				
Pumpkin				
Green pepper				
Beans				
Sugar cane				
Banana				
Millet				
Carrot				
Pawpaw				
Avocado				
Mango				
Guava				
Cassava				

Agronomic techniques: Soil preparation, plantation period, cultivation practices, residue burning, fertilisation, irrigation, protection from pest, tillage	
Maize	
Peanut	
Vegetables	

Problems experienced in producing crops

……………………………………………………………………………..

Cattle (number)

……

Use of cow manure in crop-fields

…………………………

Agricultural production bought to market

……………………………………………………..

Food bought on the market or from neighbours

……………………………………...

Household refuses production

………………………………………………

Household transports

……………………………………..

Example of response from (Bulfoni, 2003).

Household no. 2

Respondent: Alexinia Soliwe Zilchali, she is the household head.

Household composition: 11 people - 3 men, 4 women and 4 children. Only 3 people work in agricultural activity. The household's source of cash income comes from the sale of surplus locally and in Mbazwana. This farm, in fact, seemed to work quite successfully. The total farm area is about 4 ha and 2 ha of them are presently cultivated.

Household production:

Crops	Area	Yield/no trees	Amount sold	Notes
Maize	2 ha	800 kg/y	500 R/y (= 2500 ears)	They sell bags of 10 cobs each; 1 bag costs 2 R. Because of the weather, sometime, they produce only for 100 R/y.
Peanut	2 ha	750 kg/y	1500-3000 R/y (= 500 kg/y)	They sell 25 kg for 10 R, therefore 500 kg = 1500 R. If they sell them far from their house, they sell 25 kg for 20 R.
Peanut for seed	0.2 ha			
Sweet potatoes	0.25 ha	375 kg/y	100 R/y (= 250 kg/y)	
Onions	small plot		300 R/y (= 50 kg/y)	3 onions = 5 R; 5 kg = 30 R
Spinach	small plot		100 R/y (= 5 kg/y)	10 R for each tuft (about 0.5 kg)
Carrots				For family own consumption
Mango		1		

They have a kraal with 15 cattle.

They pay neighbours for weeding: 5-6 people once a year (for 500 R/Year).

Food bought on the market: they go in Mbazwana to buy, each month, 50 kg of maize-meal, 10 kg of samp, 5 kg of dry beans, 5 kg of potatoes, 25 kg of sugar, 5 L of oil and meat.