# THE POTENTIAL OF AGROFORESTRY FOR UTILISATION AS A SIGNIFICANT DEVELOPMENT FORCE IN RURAL KWAZULU/NATAL: THE CASE OF KWABIYELA

BY

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# ABSTRACT


**The Potential of Agroforestry for Utilisation as a Significant Development Force in Rural KwaZulu: The Case of KwaBiyela.**

Agroforestry (the incorporation of woody perennials into crop production and animal husbandry systems) is placed within the rural development context at the local and national scales, and its potential role in attaining sustainable rural development evaluated. It is suggested as an appropriate response to social, economic and ecological problems in the study area (located in KwaBiyela, a northern part of the former 'homeland' of KwaZulu), with potential applications for South Africa in general.

A diagnostic survey of 90 households applying a questionnaire of open-ended design, and conducted within the Diagnosis and Design framework of the International Council for Research in Agroforestry, has established that problems exist in all farm production subsystems (cash, savings/investment, food production, energy, shelter, and raw materials) in the study area. The findings include an overwhelmingly positive response towards agroforestry. Recommendations for agroforestry implementation are formulated based on the results of the diagnostic survey, taking into consideration information relating to the functioning of the local society and economy. Importantly, these recommendations consist of agroforestry components which are flexible, can be combined in a number of ways as extensions of current farming practices, and pay particular attention to the utilisation of locally available resources, familiar to the people of the study area, to solve local problems. In this way, the adoptability and survivability of recommended practices is enhanced. In conclusion, the requirements for the development of agroforestry in South Africa are discussed in the light of the structural transition currently under way in the country.

The emphasis throughout the thesis is on indigenous knowledge and farmer experimentation, supporting the iterative Diagnosis and Design process by promoting stronger feedback loops between farmers, non-governmental organisations, the government, and the private sector. Agroforestry is viewed as a potential catalyst technology for initiating a process of sustainable rural development in the emerging nation of South Africa.

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# INTRODUCTION

## 1.1 Aims and Objectives

Increasing demographic pressures, poverty, food shortages, soil erosion and deforestation are some of the problems occurring in South Africa's former 'homelands'. Recognising the interrelationships between these problems as manifestations of the interaction of political, social, environmental and economic factors is the first step in their elimination.

Tackling the much-publicised subject of sustainable rural development, this thesis addresses the above problems while simultaneously identifying opportunities for improvement and change. Agroforestry is proposed as a primary agent of change, provided that it is given institutional and financial support, and introduced in a manner adoptable by the local population. Fundamental to achieving this adoptability is the recognition and identification of local farming initiatives to act as building blocks for rural development interventions. The task that has been set, therefore, is to discover the potential of agroforestry as a practice to solve rural problems and facilitate a process of sustainable rural development.



To fulfil this task, a number of objectives were set. These objectives can be listed as follows:

1) To investigate sustainable development theory.
2) To place agroforestry within this context.
3) To obtain an understanding of the functioning of the study area's society and economy.
4) To identify local land management problems and their causes.
5) To discover local initiatives regarding the solution of those problems.

6) To identify the present pattern of tree utilisation.
7) To assess local people's perceptions of and attitudes towards agroforestry.
8) To integrate local and external knowledge in formulating possible agroforestry interventions aimed at addressing local needs within an experimental and iterative design framework.
9) To assess agroforestry's potential in meeting development needs in South Africa and discuss the prerequisites for agroforestry development in the country.

The geographical focus falls on KwaZulu, the former Zulu 'homeland' (now incorporated into KwaZulu/Natal). Hochschild (1991) describes 'South Africa's most populous homeland' as 'some two dozen bits of territory, strewn across Natal's white-owned farmland like an archipelago', and continues to state that 'less than 20 percent of KwaZulu is arable, but its density of cattle and population is many times that of the surrounding white-owned land' (p70). Although the former 'homelands' have been incorporated into the nine regions of the 'New South Africa' under the new constitution (Kwazulu being incorporated into Kwazulu/Natal), change will not be instantaneous. Local problems (e.g. poverty, land degradation, resource depletion) will remain for some time to come; and require urgent attention. The above describes an execrable situation, predisposing the researcher to act as the proverbial 'prophet of doom'. In an attempt to offer positive solutions, an effort is made here to seek out opportunities for improving the situation in one part of northern KwaZulu/Natal, namely KwaBiyela, situated between Melmoth, Eshowe and Empangeni (see Figure 1.3). It is hoped that the recommendations made will be extrapolable to comparable regions of southern Africa.

The sequence of five chapters comprising the thesis represents a progression from the general to the farm-specific scale, accompanied by a shift from the theoretical to the practical aspects of sustainable rural development. The remainder of this introductory chapter serves two purposes: firstly, to introduce the reader to agroforestry as a concept, practice, and field of investigation; and secondly to provide a description of the study area. Chapter Two places the thesis in its theoretical context by considering the ideology and objectives of sustainable rural development and the potential of agroforestry in achieving these objectives (e.g. sustainable livelihoods). The research methodology detailed in Chapter Three marks the transition from theory to practice with a description of the diagnostic survey tools and procedure employed in the fieldwork on which this thesis is based. Diagnostic survey results are discussed in the chapter which follows, laying the foundations for Chapter Five which makes recommendations regarding agroforestry and general development in the study area, while emphasising the practical application of sustainable development theory. The thesis concludes with a discussion on agroforestry development in South Africa.



## 1.2 Agroforestry Definition and Description

Agroforestry is defined in this work as a land management system recognised by the active or passive integration of woody plant species into agricultural and/or pastoral situations. The combination of woody and non-woody components can be simultaneous or sequential, spatial or temporal, and occurs to maximise complementary ecological and/or economic interactions between them*. Put more simply, agroforestry involves the incorporation of trees and/or shrubs into farming environments for the express purpose of increasing farm productivity. Figure 1.1 shows how crops, trees (including all woody perennials) and animal husbandry can be combined within agroforestry systems. Agrisilvicultural (crop and tree), silvopastoral (pasture/animal and tree) and agrosilvopastoral (crop, pasture/animals and tree) systems are depicted, along with examples of each category.

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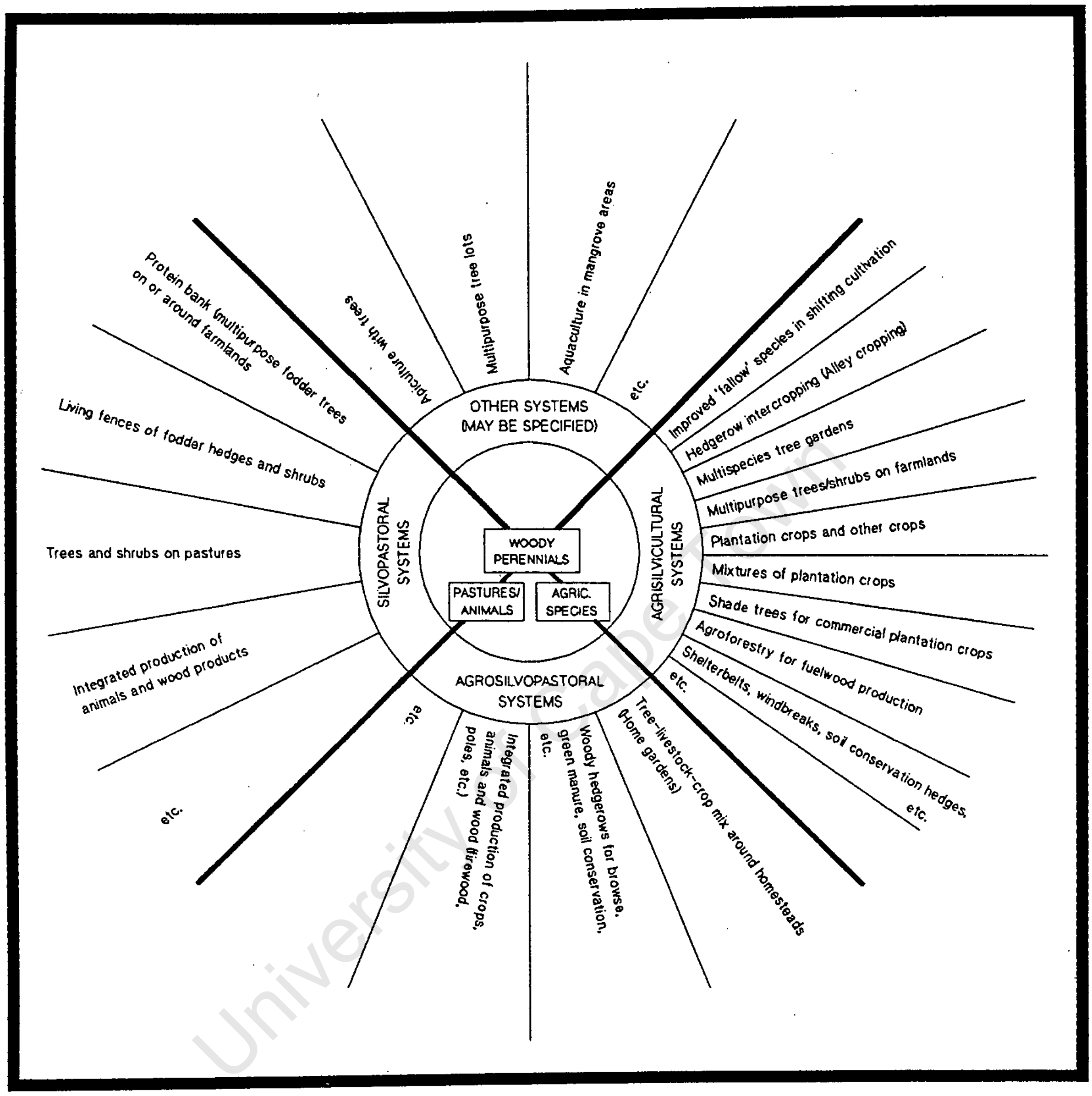
*This definition is based primarily on work by the International Council for Research in Agroforestry appearing in the journal *Agroforestry Systems* vols. 1-15 (1982-1991).

**Figure 1.1** Categorisation of Agroforestry Systems Based on the Nature of Components




(source: Nair 1985)

The study of this approach to land use is an interdisciplinary applied science concentrating on complementary resource sharing between system components (including people), and incorporates the fields of forestry, agronomy, ecology, economics and sociology. The applied aspect of agroforestry makes it particularly important to correctly integrate all disciplinary inputs in order to achieve an accurate portrayal of the factors involved in a given situation. This is essential if local problems are to be addressed in a practical and realistic manner. In support of this process, and if agroforestry implementation is to succeed, 'education and research programs must be closely associated with extension programs to assure that the former continue to address real-world issues and needs' (Lassoie 1990:127). Feedback between all the actors in the field of agroforestry is, therefore, essential if theory and practice are to form a complementary relationship, and be successfully applied to real-life situations. Kerkhof (1990) shows the importance of dealing with an actual situation as opposed to one that is assumed to exist, and warns that incorrect assumptions have guaranteed the demise of many agroforestry interventions. In response to Kerkhof's (1990) warning, this thesis endeavours to reveal the actual situation of resource-poor farmers in the study area and utilise these results to suggest directions for improvement.

Agroforestry as a practice is centuries old, but the scientific study of it and its incorporation into land development programmes has occurred only very recently. It is '"an old art", but a "new science"' (MacDicken and Lanticon 1990:57). The establishment of the International Council for Research in Agroforestry (ICRAF) in 1977 marked the beginning of the institutionalisation of agroforestry (Steppler 1990), and this, combined with the Eighth World Forestry Congress in 1978 (with the theme of 'Forests for People'), stimulated international recognition of the concept (Von Maydell 1985).



The traditional utilisation of woody plant species by farmers is only now being investigated to combine knowledge from around the world for widespread application through adaptation and consolidation. It is hoped that this thesis can make a contribution in this regard. Examples of traditional agroforestry practices in Africa include: savanna grazing, farmed parklands, tree crops and shade trees, forested fallow, planted farm trees, home gardens, farm woodlots, forest plantation farming, fodder trees and alley cropping (Cook and Grut 1989). Rocheleau, Weber and Field-Juma (1988) detail a number of agroforestry practices occurring in dryland Africa, adding to the list the functions of structural conservation (e.g. erosion control systems), living fences, and windbreaks, among others. These practices are present today and form the basis for much agroforestry research. Von Maydell (1987) summarises traditional dryland African silvopastoral, agrosilvopastoral and agrisilvicultural agroforestry systems by itemising their shared characteristics: system components were multi-purpose, fulfilling different roles to ensure self-sufficiency and sustainability; the system was adapted to local environmental conditions; it utilised local natural and human resources; and was demand orientated. Importantly, however, he draws attention to the fact that these systems were not adapted to changing social, political and technical conditions and so remained frozen in time.

Trees and shrubs are being evaluated by researchers (in consultation with farmers) for possible multiple uses such as food and fuelwood production, soil improvement, erosion prevention, windbreaks, living fences, and shade provision; while tree/crop combinations are receiving quantitative analysis by scientists and farmers. Rural people's knowledge of farming practices in different environments is invaluable here and represents an essential source of information for the design of new agroforestry systems and the improvement of existing systems (Chambers 1983). The utilisation of indigenous knowledge in central to this thesis. A feedback relationship exists between past and present with this exchange of information contributing to future improvements in agroforestry system design and implementation.

Without the consideration of all factors influencing a farming community (i.e. political, social, environmental and economic factors), the adoptability (a prerequisite for success) of any proposed new or improved system of land management is unlikely. 'A technically possible biological design that makes no sense in terms of socio-economics, is no more useful than a desired or imagined socio-economic design that is biologically impossible'

(Bentley 1985:528). To this end the chapters which follow will examine the political, social, economic and ecological factors influencing the study area population.

The ideal agroforestry system would take into account political, socio-economic, ecological and ergonomic (i.e. matching energy inputs with social and economic formations (Mueller-Darss 1982)) factors to make it compatible with the target population and the environment they occupy. This would enhance adoptability and sustainability whilst simultaneously maximising productivity per unit area through optimum utilisation of available resources. The different components of such a system (e.g. people, resources) need to be integrated in such a manner as to ensure a complementary relationship. It is for this reason that systems designed by researchers cannot be successfully imposed on local people (even if local people co-operate). The farmers themselves must play a major role in the design and implementation of agroforestry initiatives and should fulfil a facilitative function if the agroforestry system is to succeed.

Agroforestry as a science therefore aims to combine traditional knowledge with new technologies and developments in plant research to help meet the needs of a growing population while at the same time maintaining and improving the environment for future generations. In support of this activity, the methodology employed in this thesis will seek to identify traditional knowledge as it relates to on-farm tree planting and utilisation; using this information as the basis for agroforestry component suggestions. It is this attribute of multidisciplinary networking that endows agroforestry research with its future orientated approach, utilising all the information at its disposal to devise systems for sustained agricultural development.

**Table 1.1** Advantages and Disadvantages of Agroforestry

| ADVANTAGES | DISADVANTAGES |
|---|---|
| **Biological** | |
| *better use of ecological space; captures more solar energy | *competition for light between trees and other plants may lower crop yields |
| *temperature extremes reduced | *competition for space between trees and other plants may handicap both |
| *more biomass returns to the soil | *trees compete for nutrients, store them in branches and stems, and so make them inaccessible to crops |
| *recycling of nutrients is more efficient | *loss of nutrients when wood, fruit, seeds, etc. are harvested and 'exported' from the area |
| *trees improve soil structure by producing stable aggregates and by avoiding hard 'pans' | *trees keep part of the rainfall in their crowns; stemflow can adversely redistribute rainfall |
| *fewer weeds because less light reaches the ground and there is the possible suppressive effect of leaf litter mulch | *greater diversity of fauna owing to a larger number of ecological niches; some will be crop pests |
| *leaf mulch reduces water evaporation from the soil, adds organic matter and reduces tillage needs | |
| *most leguminous trees fix nitrogen by the action of specialized bacteria in the plant roots | |
| *erosion is prevented up to a point by the binding effect of tree roots | |
| *greater diversity of fauna owing to a larger number of ecological niches; some will be predators of harmful insects or rodents | |
| **Economic and Social** | |
| *direct economic benefits in the form of firewood, posts, poles, timber, friut, fodder, etc. (although not all at once) | *yields of crops per unit area may be lower than for monocultures |
| *where commercial markets exist, trees constitute 'standing capital' to pay for emergencies | *even though the combined value of trees and agricultural crops is higher, it may take several years for the trees to acquire economic value |
| *crop diversity reduces the risks of irregular rainfall, pest outbreaks, market fluctuations, uncertain supply of external inputs | *likely to be more labour-intensive than growing either trees or agricultural crops separately |
| *greater benefits from crops may offset investments required to establish trees | *time-lag from planting to economic benefits of trees may be longer than people can afford by comparison with other cash crops |
| *trees usually reduce weeding costs | |
| *greater flexibility to spread work loads during the year | |



(source: Budowski 1984)

It must be borne in mind that agroforestry is not always an appropriate land-use system (see Table 1.1 for a summary of the advantages and disadvantages of agroforestry). Potential agroforestry adopters must be willing to establish agroforestry components on an experimental basis and participate in an agroforestry development programme. Moreover, component species, layout, management procedures and system functioning must be tailored by them to suit their particular needs and context. The influence of ecological context is highlighted by Underwood (1991) who attributes the success of agroforestry in equatorial regions (as opposed to regions such as that occupied by the study area of this thesis) to this factor: 'Under such favourable environments, the struggle to plant trees into the existing arable and pastoral systems (a challenge faced in the study area) is replaced by the relatively straightforward practice of growing crops between trees' (p107). In the face of such adversity, it is the function of researchers, extension agents and other interested parties to support and build upon local initiatives, and with the help of local people, address local needs.

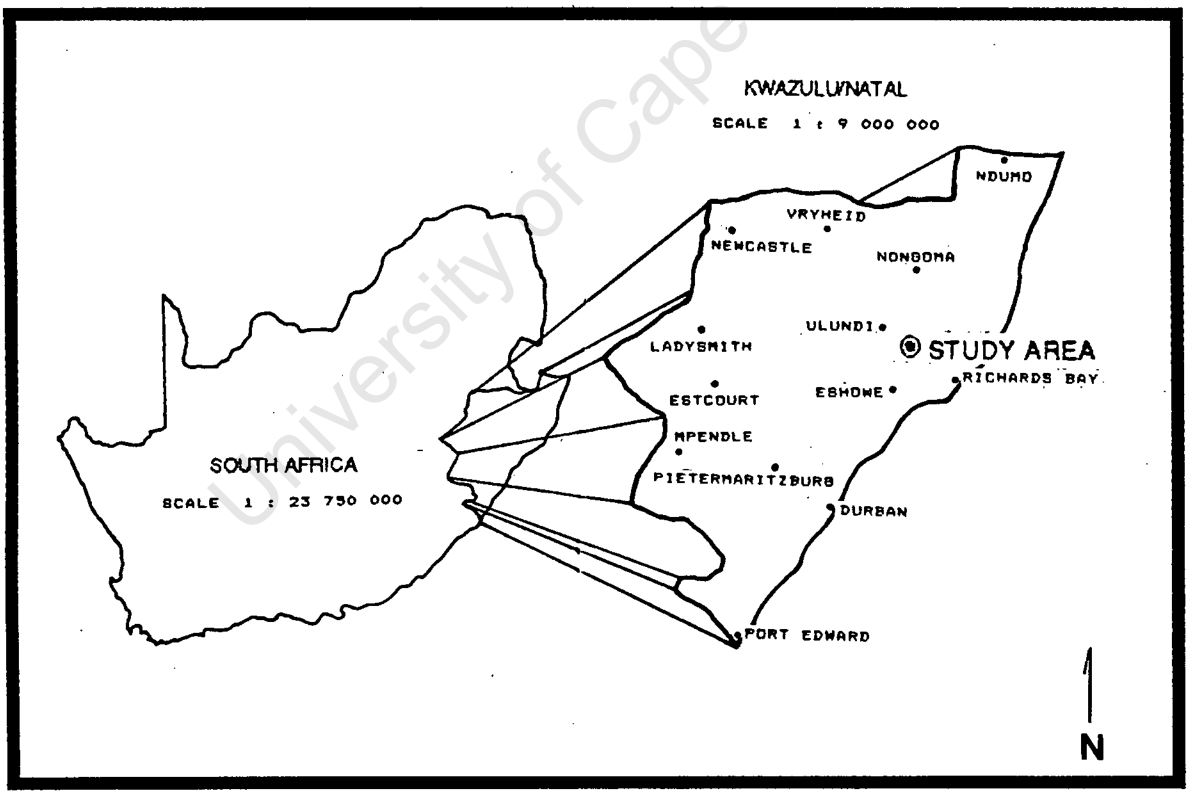
Agroforestry is most appropriate where a number of requirements need to be met simultaneously (e.g. food production, soil improvement and conservation, fuelwood supply). The integrated systemic nature of agroforestry practice (i.e. simultaneous contributions to cash, food production, energy, shelter, and raw material farm production subsystems (Raintree 1987)) and its links with social, economic and ecological development distinguish it from other forms of land use. But to achieve all of these objectives, agroforestry must be included as part of a development network supported by political, social and economic linkages at all levels of society. Therefore, if the above prerequisites are met, agroforestry has a greater potential to achieve its objectives of increased productivity, sustainability and adaptability (Lundgren 1982). Under these conditions it should be the preferred system of land management, relative to, for example, monocropping.

## 1.3 The Study Area

This section provides a summary of the context of the study area as well as some of the problems experienced by its population. The primary source for this information is the Data Report on Resources and Socio-Economic Circumstances of the Biyela Multi-Facet Rural Development Project, conducted by Loxton, Venn and Associates (1985) for the Institute of Natural Resources, University of Natal. Study area boundaries are based on those used in the Loxton, Venn and Associates survey.

### *1.3.1 Location and Jurisdiction*

**Figure 1.2** Study Area Location



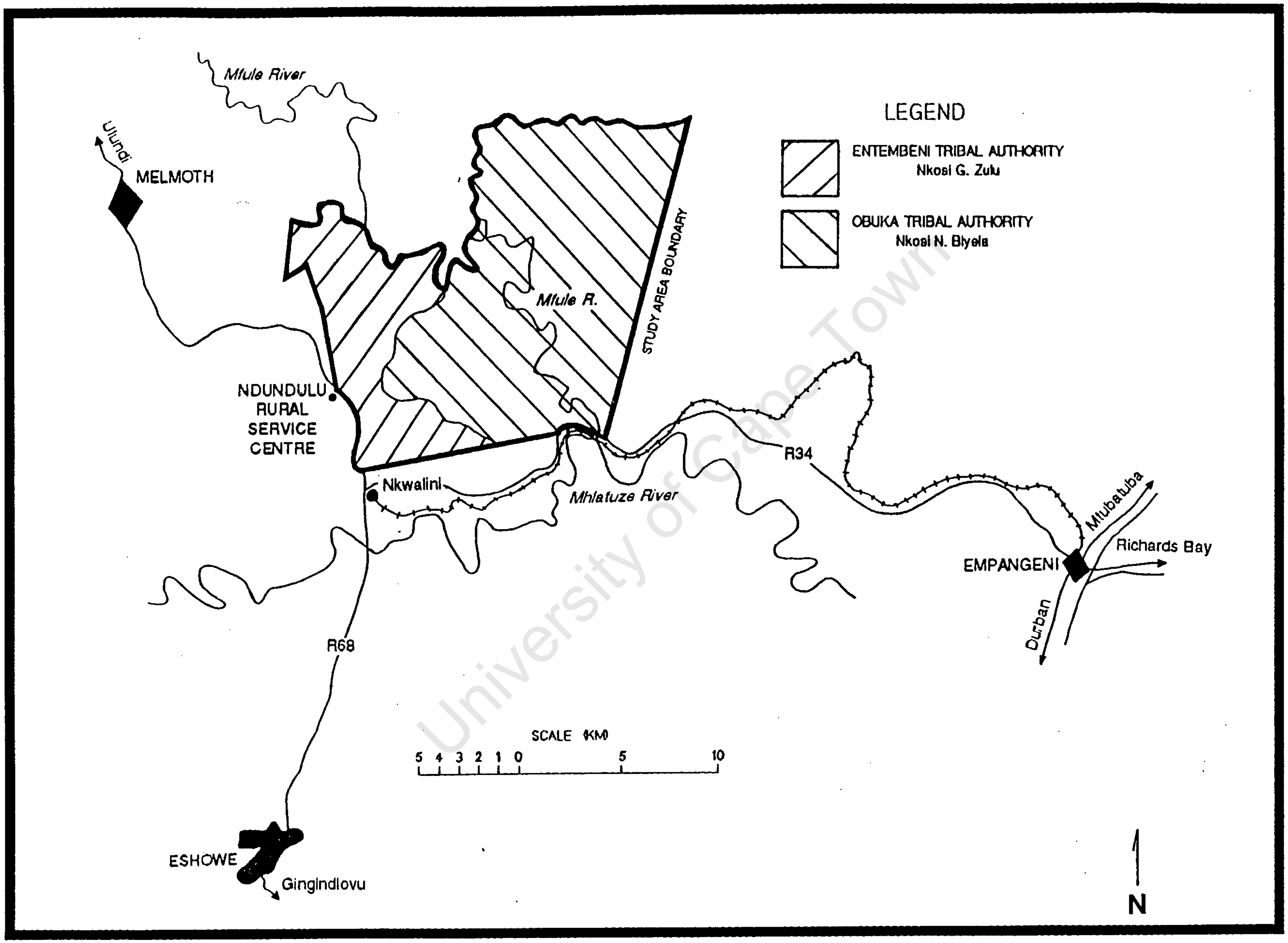





Figure 1.3 Study Area Location Relative to Major Towns, Showing Tribal Authority Areas.

The study area (falling between the co-ordinates: 28°31'S and 28°43'S latitude, and 31°29'E and 31°42'E longitude) lies within KwaZulu Area No. 2 (as designated by the Government of South Africa) (now incorporated into KwaZulu/Natal) (Figure 1.2), and occupies approximately 20 000 hectares of land under the jurisdiction of the Entembeni and Obuka Tribal Authorities of the Biyela Tribe (KwaBiyela). It forms a major part of the current Biyela Project Area of the Institute of Natural Resources (INR), and is located within the Enseleni Magesterial District (Figure 1.3). The Entembeni Tribal Authority area (western section of study area) is headed by Chief G. Zulu. Chief N. Biyela heads the larger, but less populous Obuka Tribal Authority portion of the study area (eastern section) (see Figure 1.3). Each Chief is represented by a number of Indunas (nine in Entembeni and twelve in Obuka) (Loxton, Venn and Associates 1985). Land is allocated under the tribal tenure system.

### *1.3.2 Population*

Since the study area boundaries are arbitrary (encompassing the portion of the Loxton, Venn and Associates survey area under the Entembeni and Obuka Tribal Authorities to the east of the R34) - it is bounded by rivers to the north and south, commercial farms in the east, and a combination of commercial farms and a main road in the west - and do not correspond with magisterial district boundaries, it is impossible to arrive at an exact population number using census data. Population census data are, however, useful in providing a rough idea of the number of people resident in the study area, as well as determining the population growth rate. The 1980 census data (Central Statistical Services 1980) show the total resident population of the Enseleni and Ngwelezana sub-districts of the Nseleni Magesterial district, an area slightly larger than the study area, as 13 439. By the 1991 Census (Central Statistical Services 1990), the number had grown to 17 857. Combining the census data with distributional information (INR Annual Report 1992), it becomes apparent that the number of people resident in the study area grows at an average of 2.9 percent per annum (calculated over the eleven years from 1980-1991), and is becoming increasingly nodalised, particularly around the Ndundulu Rural Service Centre (due to the clinic, agricultural and other services available). The study area falls within the core region of the Zulu Nation, where the major political influence is the Inkatha Freedom Party (IFP) (Forsyth and Mare 1992). Branches of the IFP and IFP Youth Brigade are located throughout the region (Loxton, Venn and Associates 1985), but as far as is known, not within the study area itself.

### *1.3.3 Land Use*

The settlement pattern in the study area is generally dispersed, with concentrations near transport routes and service facilities (e.g. clinics, Ndundulu Rural Service Centre), and some clustering of farms held by members of the same family. Farms (defined as that part of the land held under tribal tenure on which the homestead is situated) are generally below one hectare in size and laid out with the homestead (area occupied by dwellings, other buildings and the kraal) upslope and near one boundary, with cultivated fields usually located immediately adjacent to the homestead. Only part of a land holding (all the land allocated to the head of the household under tribal tenure) is cultivated, the remainder being utilised as community grazing land (Loxton, Venn and Associates 1985). Wherever possible, crop fields are located on level or gently sloping land (the level valley floors of the Makasaneni area form the most productive vegetable gardens in the study area), but due to the heavily dissected nature of the local topography, many farms are located on the steep slopes of escarpments adjacent to plateaux, cultivation and grazing occurring on steep slopes.

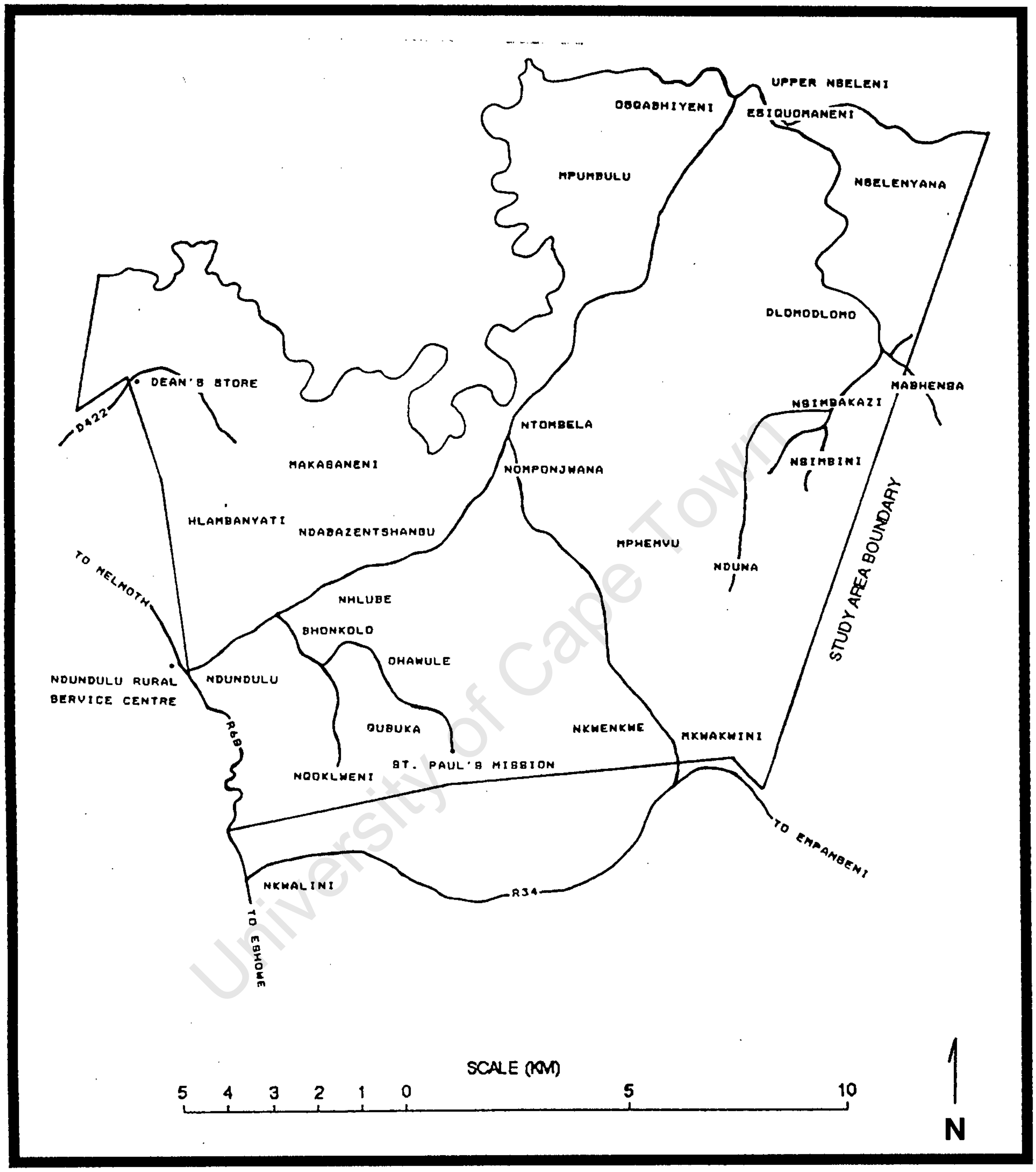


Major forms of land use are dryland cropping and livestock production. The dominant crop is maize and the dominant livestock type is cattle, a source of wealth in traditional Zulu culture. Gum (*Eucalyptus grandis*) and wattle (*Acacia mearnsii*) plantations on steep slopes are recommended as a form of land use in the Loxton, Venn and Associates (1985) report. This recommendation is supported by the INR, and plantations have been established on such slopes with the co-operation of companies such as Mondi Paper.

### *1.3.4 Infrastructure and Services*

There are no tarred roads within the study area, but gravel roads enter it at junctions along the surrounding tarred roads connecting Melmoth, Empangeni and Nkwalini (R34), and Eshowe (R68). One primary gravel road leaves the R34 south-east of the Ndundulu Rural Service Centre, enters the study area behind a bus/taxi stop, and runs in a north-easterly direction from Ndundulu, across the Mfule River to Esiquomaneni. Branches along the route provide access to Nqoklweni and St. Paul's Mission in the south-west; Nkwenkwe and Mkakwini in the south-east; the Mpumbulu Uplands and Upper Nseleni in the north; and the Nselenyana Uplands, Nsimbini and Nduna in the east and south-east. A gravel road from Mtimona enters the eastern section of the study area via Luwamba, at Mabhensa, and joins the road to Nduna between Nselenyana and Nsimbini. The north-western section of the study area is accessed from the D422 which leaves the Melmoth road and enters at Dean's Store. A number of sand tracks lead off from the gravel roads, allowing access to isolated areas, but most homesteads are only accessible on foot. Although the main route through the study area, from Ndundulu to Esiquomaneni, is maintained, the surface is uneven and heavily rutted in places. All other routes are in poor condition with heavy rutting and potholing. Figure 1.4 shows the main routes through the study area.

Figure 1.4 Main Routes through the Study Area






The primary means of motorised transport is the bus, with very few residents of the study area owning motor cars or 'bakkies'. Most people travel on foot.

No railway lines, electrical power lines, or fuel stations are located in the study area, but these are present beyond its southern boundary. Three telephone lines, to St. Paul's Mission, Nomponjwana and Upper Nseleni, have been installed. The Ndundulu Post Office is the closest to the study area and there are others at Nkwalini and Ntambanana (Loxton, Venn and Associates 1985).

Luwamba Hospital is situated beyond the eastern boundary of the study area on a junction in the Mtimona-Mabhensa road. It is the only facility of its type in KwaBiyela, but most people make use of clinics located within the study area (e.g. at Nomponjwana and St. Paul's Mission) (Loxton, Venn and Associates 1985).

Schools, of which there are 13, are distributed throughout the study area, but Loxton, Venn and Associates (1985) draw attention to the high rates of absenteeism (due to farming obligations), high pupil/teacher ratio, and low numbers of pupils in the higher standards.

Twelve shops, including 'tearooms', general dealers and bottle stores, are located within the study area (Loxton, Venn and Associates 1985), usually on main routes, and often 'at the end of the road' (e.g. Nduna), at junctions (e.g. Nomponjwana), or concentrations of facilities (e.g. Upper Nseleni bus terminal, market and clinic).

Study area residents do not have piped water supply systems, and rely on rivers, streams, springs, and boreholes (there are currently eleven boreholes in the study area (Roy Dandala, Rural Development Facilitator, INR, pers. comm.)). Many of these water sources have dried up or have become polluted.

The KwaZulu Department of Agriculture and INR Biyela Integrated Rural Development Programme staff provide agricultural extension services to the local population (INR Annual Report 1992).

### *1.3.5 Physiography*

The study area is heavily dissected, consisting of two, sometimes discontinuous, plateaux, between which flows the Mfule River. Altitudes range from 60 to 750 metres above mean sea level (amsl). Escarpments occur on the southern boundaries of the plateaux, while the steep slopes separating the plateaux give way to the gently undulating alluvial terraces of the Mfule River Valley. All the rivers flowing through the study area are tributaries of the Mhlatuze River which flows past the southern survey boundary. The largest river is the Mfule, followed by the Nhlozane, Hlambanyati and Nselenyana. Numerous streams with steep gradients and v-shaped valleys enter the rivers from the surrounding slopes, and waterfalls occur on slope discontinuities (Loxton, Venn and Associates 1985).

Loxton, Venn and Associates (1985) divide the study area into four topographic units: Dissected Plateau Remnants, Steep Mountain and Hill Slopes and Valleys, Escarpments with slopes greater than 45 degrees, and The Biyela Lowlands of the Mfule River valley. The Dissected Plateau Remnants are further divided into seven sections. The Makasaneni Mountain Ridge (at 620-750m amsl), Makasaneni Plateau (at 440-550m amsl with an undulating surface and incised drainages), and St Paul's/Nomponjwana section (at 520m amsl with a steeply rolling to hilly surface and deeply incised drainages, occupying most of the western plateau) form the western plateau remnant. The eastern plateau remnant comprises the Nduna/Nsimbini/Dlomodlomo/Esiquomaneni unit (at 455-555m amsl with steep side slopes), Nsimbakazi upland (at 260-403m amsl and steeply rolling to hilly), Nselenyana upland (at 260-472m amsl and steeply rolling), and the Mpumbulu upland (at 430-510m amsl and deeply incised and steeply hilly). A total of ten physiographic units have, therefore, been identified, and are illustrated in Figure 1.5. Plates 1.1 and 1.2 compare typical upland and lowland topographies.

**Figure 1.5** Physiographic Regions within the Study Area

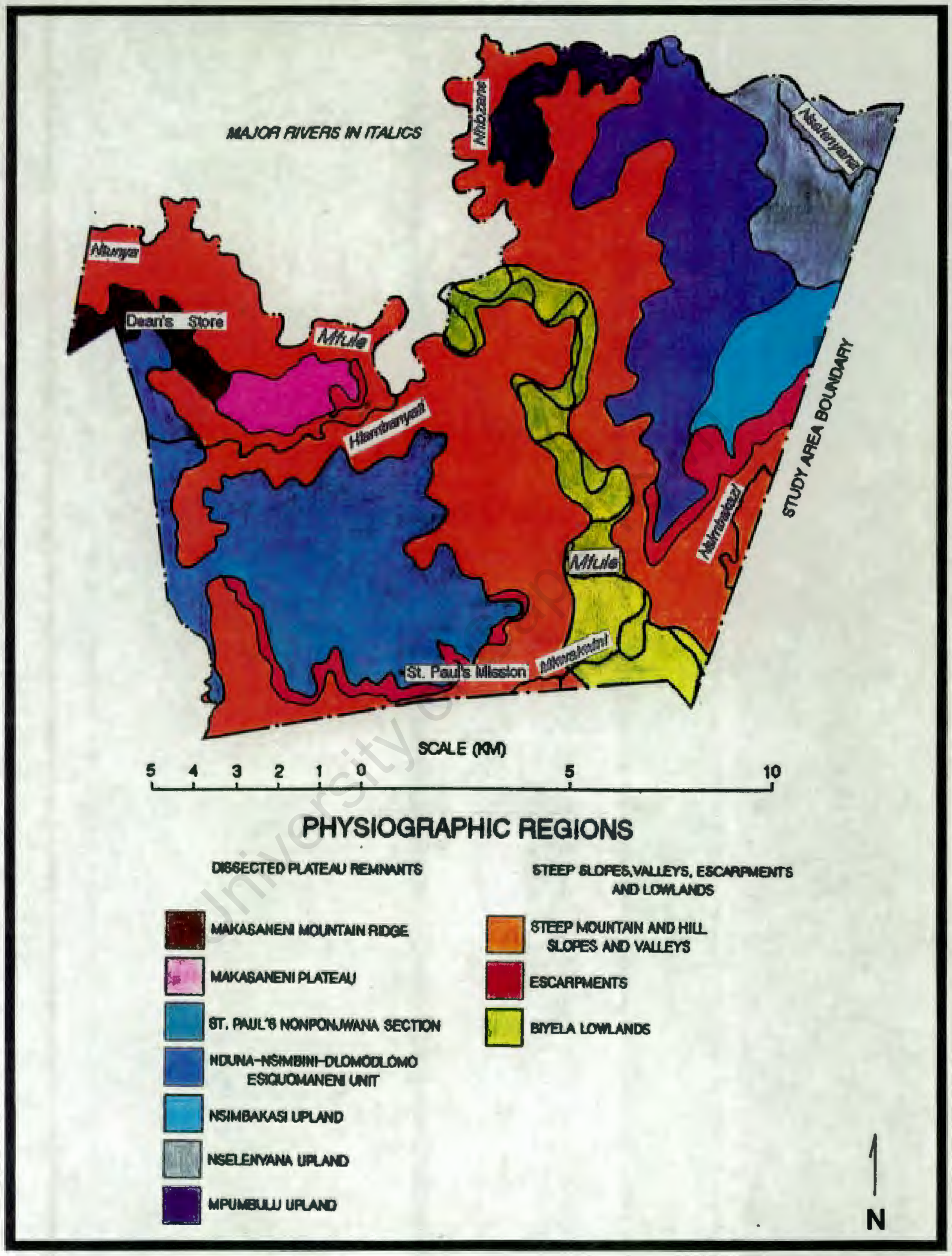


**Plate 1.1** The Biyela Uplands: Looking towards the Makasaneni Plateau from the Makasaneni Mountain Ridge

**Plate 1.2** The Biyela Lowlands: View over Mphemvu on the Banks of the Mfule River

### *1.3.6 Geology, Climate, Soils and Vegetation*

Geological and climatic factors have resulted in a diversity of soil types and vegetation patterns within the study area. 'The solid geology of the area consists of Tugela Complex rocks overlain by sedimentary rocks of the Natal Group and Karoo Sequence...intruded in places by dolerite, usually as sills and/or dykes' (Loxton, Venn and Associates 1985:18). Block faulting, fracturing and tilting are common, and are related to the Natal/Lebombo monocline (Loxton, Venn and Associates 1985). Loxton, Venn and Associates (1985) divide the study area into two regions distinguished on climatic grounds: the Biyela uplands with a mean annual rainfall of 800 to 900mm, and the Biyela lowlands with a mean annual rainfall of 550 to 700mm. Rainfall is unreliable (more so in the lowlands) and unevenly distributed. Rain shadows are common throughout the study area as a result of its dissected topography. The Biyela lowlands, in addition to being drier than the uplands, are also warmer. Average daily summer and winter temperatures are 23.6°C and 16.8°C respectively, as compared to 22.3°C and 16.6°C for the Biyela lowlands (Loxton, Venn and Associates 1985). Maximum daily temperatures in excess of 40°C are common in the Biyela lowlands in summer (Gavin Pote, Field Co-ordinator, INR, pers. comm.; pers. observation). KwaBiyela has recently suffered a debilitating drought and recovery in the face of a host of other problems (e.g. soil erosion, crop failure, lack of nutrient inputs, livestock mortality, and debt) is likely to take a number of years.

Soils in the form of deep and moderately deep lithosols occur in the western and eastern uplands respectively, while shallow to moderately deep lithosols occur on the steep mountain slopes. In the lowlands (i.e. the Mfule River valley) moderately deep lithosols occur, alongside river terraces comprised of deep light-textured alluvial and colluvial sands. Throughout the study area, soils are acidic and usually of low inherent fertility. Exceptions include the river terraces, Nseleni and Nsimbakazi uplands, and Nduma-Nsimbini-Dlomodlomo-Esiquomaneni plateau remnant, where moderately fertile soils can be found (although the river terrace soils have a calcium deficiency, and the upland soils mentioned are low in phosphorous) (Loxton, Venn and Associates 1985). The low organic matter content and generally low water-holding capacity of study area soils increases the danger of erosion. Erosion occurs wherever soils have been exposed by overgrazing, cultivation and the passage of livestock.

The natural vegetation of the study area is as diverse as the localised climatic and edaphic factors. Five veld types have been identified and correlated with Acocks (1975) veld types. High-lying, moist areas support Sour/Ngongoni veld, while the warmer dissected uplands and mid-slopes support the sour mixed veld and mixed veld types of the Zululand Thornveld, High Altitude Form. The Lowveld veld types of mixed sweetveld and sweetveld occupy the warm, dry Mfule River valley (Loxton, Venn and Associates 1985). Natural vegetation has been severely impacted by overgrazing, fuelwood collection, and the introduction of alien species (e.g. exotic *Acacia*, *Hakea*, *Psidium*, *Eucalyptus* and *Melia* species).

## 1.4 Conclusion

The problems encountered in the study area (e.g. poor infrastructure and service provision, water and food shortages, overgrazing, and soil erosion) are characteristic of the former 'homelands' of South Africa. They are also recognised worldwide as major challenges to be met for the achievement of sustainable development. The chapters which follow will examine these challenges and attempt to discover how they can be appropriately addressed in the study area.

# CHAPTER TWO
# SUSTAINABLE RURAL DEVELOPMENT AND AGROFORESTRY

This chapter explores the concept of sustainable rural development. Political, institutional, social, environmental and economic issues integral to this concept are discussed and agroforestry's potential contributions to sustainability and development are highlighted.

Given the disciplinary context within which this thesis is written (Environmental and Geographical Science), it is particularly relevant that 'the definition and implementation of sustainable development is a challenge made to order for the discipline of geography because it is at the heart of human-biosphere relationships' (Manning 1990:301). Also, 'geographers have unique comparative advantage in helping to produce solutions; their spatial and regional traditions and their history of work in integration of biophysical and socioeconomic information are germane to this challenge' (Manning 1990:291).

Although the discussion takes place at a general level, reference is made at certain instances to the South African situation, the context in which this study takes place. Much has been written about sustainable rural development and it is not the intention here to provide a comprehensive history of the concept; suffice to say that it appeared in development literature in the 1970s and now dominates this area. Instead, the meaning of the term will be discussed; relevant aspects investigated; and the place of agroforestry within it considered.

## 2.1 Sustainable Rural Development

Sustainable rural development embodies the interdependent concepts of ecological and economic sustainability which operate at different scales (e.g. regional and local ecological processes, economic activity at the national or household level) (Scoones 1988). Sustainability is defined here as the capacity for self-replenishment of systems through efficient and environmentally friendly (future-oriented) resource utilisation. Agroforestry is promoted as a potential facilitator for, and stimulator of, sustainable rural development through its contributions towards the creation of sustainable livelihoods (where labour and capital merge with a renewable resource base in such a way as to maintain an equilibrial input-output cycle).

The place of the concept of sustainability within the current development debate is perhaps best explained by O'Riordan (1989), as 'embracing ethical norms within the Gaianist tradition...taking into account the rights of future generations of all living matter' giving consideration to 'structures and arrangements that ensure that sustainable utilisation actually takes place. Sustainability is, therefore, a reformist notion in the radical tradition of opening up institutions of economic investment and resource development to a far greater sense of Gaian accountability'* (p94). Sustainable rural development is thus primarily concerned with human-environment relations, and the interaction of ecological and economic processes in terms of resource utilisation. As will be argued later, the consideration of the social, political, and institutional contexts within which these processes operate, is critical to the achievement of sustainable rural development.

To address the challenge of achieving sustainable rural development, it is essential to discover why rural development has been charting an unsustainable course. Many factors have combined to make much rural economic activity (including development projects) unsustainable up to the present. These factors apply

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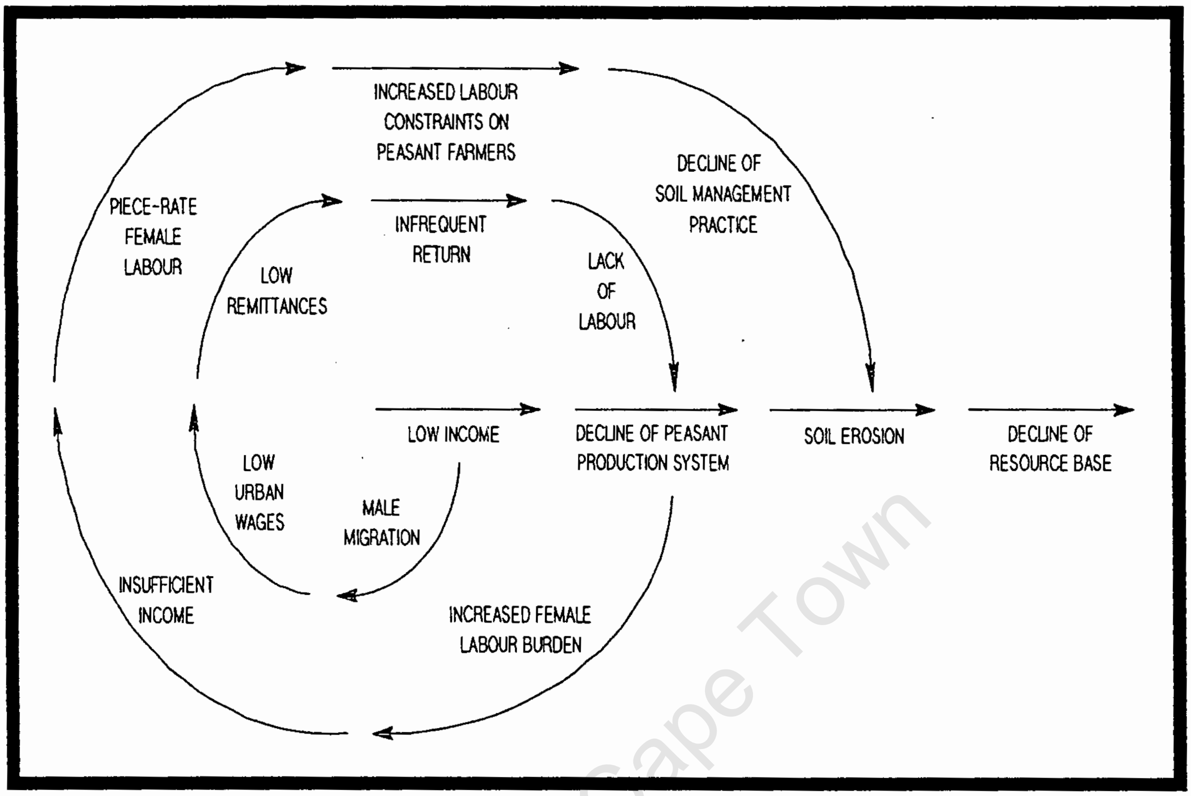
*Gaianism is understood here as the theory of the integration of Earth's biotic and abiotic systems, and the necessity of utilising resources on a sustainable basis to ensure the continuation of life on the planet.

in rural areas worldwide, but the emphasis here is on developing countries, given that the project area is located in a section of KwaZulu, one of South Africa's former 'homelands' on the socio-economic and environmental periphery of the country.

The first group of factors to be considered are related to inappropriate agricultural practice, and include environmental constraints to hybrid exotic crops, manifested primarily in the form of drought (natural, not that caused by human-induced environmental modification), wind damage, and variable soil fertility, particularly when these crops are grown in marginal areas. The dependence of current crops such as maize and wheat hybrids on irrigation is the reason why agriculture consumes more water than any other sector of the economy, worldwide, and the reason for the low productivity experienced in areas without irrigation. The nutrient requirements of these crops (i.e. hybrids) are such that they require continuous artificial inputs such as expensive chemical fertilisers to maintain maximum productivity. Also, monocultures are susceptible to annihilation by pests with the lack of habitat required to harbour natural pest predators, as well as invasion by weeds if mulching is not practised. Labour requirements under such agricultural systems are, therefore, often high. These inputs (i.e. labour, fertilizers, pesticides, herbicides, irrigation) often fall beyond the reach of small-scale resource-poor farmers (the majority of farmers in this country, and mainly women burdened with caring for the farmland and household), making monocropping with hybrids unsustainable (Conway and Barbier (1990) emphasise this relationship between monocultures and rural poverty). The same farmers do not have access to the capital required to purchase food when drought and/or wind destroys potential yields, resulting in serious negative impacts on livelihood sustainability. Research into high-input agricultural systems is therefore inappropriate for the majority of South Africa's farmers.

The second group of factors causing unsustainability relate to land management and resource allocation, and operate in tandem with the above category. They may be divided into two types: actions by the farmer and actions by external agencies. The former are more visible and include overgrazing (especially from overstocking with cattle), soil erosion (e.g. from leaving bare soil to fallow), nutrient depletion (no contribution to soil nutrients), water pollution (e.g. by silt and chemical fertilisers) and deforestation (e.g. for fuelwood), all operating at a local, often farm specific level, and all leading to environmental degradation, resource depletion, and reduced yields. At a regional level, population pressure often forces the farmer onto marginal land and leads to environmental degradation, threatening the sustainability of rural livelihoods. This process occurs throughout the developing world, but is especially prevalent within South Africa's former 'homelands', where expansion opportunities are severely limited. Still using the example of the former 'homelands' of South Africa, actions by external agencies take the form of, for example, land tenure restrictions introduced by community leaders, tradition, and government intervention; lack of financial support by government and financial institutions; and lack of agricultural training and marketing facilities. These often lead to a decreased interest in farming, and hence a migration out of rural areas to seek work in the cities, and the collapse of rural economies. The relationship between these factors in the cycle of poverty and land degradation is illustrated in Figure 2.1.

**Figure 2.1** The Cycle of Poverty and Land Degradation




(adapted from: O'Keefe 1987)

All of the abovementioned factors operate within a political-economic context which influences each of them to a different degree and in a different manner. In this respect, O'Riordan (1989) draws attention to 'the pressures for non-sustainable resource draw and the self-perpetuating imperatives of international capitalism, international aid...and cultural conflict' as 'forces' rendering 'impossible any realistic hope of achieving sustainable utilization in much of the Third World' (p94). The way forward is summarised by Manning (1990), who maintains that 'the achievement of sustainability will only occur through significant modifications to the way we make decisions' (p292). The section which follows deals with these issues.

### *2.1.1 Political and Institutional Issues*

The challenge to future rural development is to deal with the reality of multiple causative links between and within social, environmental and economic spheres, processes of interaction which must be considered within political and institutional frameworks. These frameworks determine human-environment relationships and, therefore, directly influence the sustainability (ecological and economic) of development processes. It is only through a recognition of decision-making processes (i.e. the exercise of power in development policy formation) that rural development problems can be overcome; if these are ignored by development practitioners, no amount of biological and socio-economic research, no matter how comprehensive, will be able to make a difference on the ground. Questioning the depoliticization of the environment, Redclift (1984) maintains that 'so many causes of the environmental crisis are structural, with roots in social institutions and economic relationships, that anything other than a political treatment of the environment lacks credibility.' (p2). As Adams (1990:83) points out: 'all relations between environment and people are political, just as all development is ideological'. Recognising the implications of the power to decide on resource access and utilisation is, therefore, crucial to the avoidance of resource exploitation. If rural development is to benefit the rural resource-poor, they must have a voice in the development process, as they are best equipped (e.g. with knowledge of local resource availability, shortages, and opportunities), not only to identify problems, but to implement solutions and facilitate a process of sustainable rural development. Drawing attention to these issues, the next sub-section will consider the exercise of decision-making power and the approach to development taken in this thesis.

#### *2.1.1.1 Development and the Exercise of Power*

In the past, development has been equated with economic growth (Erskine 1985), but this is only one aspect of this complex concept. It is, in fact, internal growth - growth from within, forming a foundation for prosperity based on simple principles of health, security and asset maximisation, and amounts to helping others to help themselves. It is not an end in itself, but a means to an end. In short, development is a process, not only of economic improvement, but of improvement in social wellbeing. It is as much a mental as a physical state, severely affected by context. People must feel secure within a development framework for it to succeed. They must want this process to occur; it cannot simply be imposed on an unsuspecting populace.

History has shown that the 'top-down' approach (e.g. imposition of externally developed technologies, investment in large scale enterprises) to rural development does not work for the majority of the population (i.e. the rural poor). Economic growth, productivity and the distribution of wealth have all been negatively impacted by this approach - one need only witness the downfall of so-called 'peasant agriculture' in many countries (including South Africa) to be reminded of this. Benefits do not automatically 'trickle down' to the poorest in society, while the 'marketing system transfers resources out of agriculture making investment possible in industry and services' (Pacey and Payne 1985:171). Reinvestment in agriculture often takes the form of government loans to commercial farmers, with small-scale farmers receiving little support. This situation is, however, likely to change in South Africa with the implementation of a policy of redistribution of resources by the new government.

The culture of imposing development ideas on others must be buried if there is to be any progress in development initiatives. The history of South Africa bears testament to this, the imposition of 'betterment planning' in the 'Native Reserves' up until the early 1980s being a case in point. Indeed, as Seneque

(1982) shows, the resistance of local people to this system of land-use classification, relocation and social engineering has been such as to cast suspicion (in some areas of the 'homelands') on all planning processes. The implementation of externally derived rural development programmes, as well as being inappropriate, has in fact become an impossibility in these areas. Worldwide, it is the ideas and aspirations of the people requesting the advantages of development that should feature foremost in any planning process. How can such a process succeed without consultation and understanding between interested parties? Methods may be demonstrated, but must be compatible with the needs of the proposed target group. Agroforestry practice utilises such an approach and the sections which follow will show why it is an effective response to many current rural development problems.

In opposition to the above, Chambers (1983) and Adams (1990) advocate a 'bottom-up' approach to development which has as its starting point the needs and aspirations of the resource-poor. According to Rocheleau, Weber and Field-Juma (1988) this assures that the strategies selected are adapted specifically to each situation, increasing their chances of success. Corresponding to this view, and in reference to the approach of the World Bank to non-governmental and community organisations, with its aim of 'community participation in policy formation' (p38), Fleming (1991) notes the current absence of a mechanism for incorporating decisions reached within communities into national policy systems. Clearly, pathways of communication between non-governmental organisations (NGOs) and government policy-making structures must be opened, and systems set in place to allow NGOs to contribute to policy formation, if the World Bank's view is to be realised. A major obstacle to this, according to Fleming (1991), is the failure of development agencies such as the World Bank to recognise the variety of such organisations and their differing approaches. With the voting-in of a democratic government in South Africa, and the possibility of World Bank and other development agency funding for development projects, the introduction of such pathways of communication in this country is crucial if these projects are to succeed. The needs of the rural resource-poor, and the future opportunities for meeting these needs, are such that failures cannot be tolerated.

The concept of returning power to the poor (Chambers 1983), especially the power to decide, is relevant at this point and forms part of the 'bottom-up' approach to rural development. Attention must be drawn to inequalities in the 'structure and exercise of power at various levels from the point of production to the state itself' (Watts 1989:30) in African agriculture. Rural development may be redefined to include 'enabling poor rural women and men to demand and control more of the benefits of development' (Chambers 1983:140). According to Adams (1990:202), 'green development is not about the way the environment is managed, but about who has the power to decide how it is managed. Its focus is on the capacity of the poor to exist on their own terms'. He supports ecodevelopment, defined by Glaeser and Vyasulu (1984:25) as 'a process which is geared to the satisfaction of basic and essential human needs, starting with the needs of the poorest...in society', which aims at the achievement of social and economic objectives in an ecologically sound manner. O'Riordan (1989) links ecodevelopment with 'basic needs replenishment' as essential for the achievement of sustainable development. He argues that 'basic needs replenishment' requires social reform: a change in the environmental situation of the marginalised poor 'cannot be achieved by natural manipulation, by means of soil conservation or replanting. Reform must be achieved through the transformation of social relationships' (ibid.:95). 'The economic and political framework within which problems are identified is vital to understanding which environmental problems society will recognise' (Bowlby and Mannion 1990:330).

This thesis maintains that the need is for an equilibrial approach, a two-pronged approach which takes into account 'top-down' (i.e. capital intensive, industrial, urban) and 'bottom-up' (i.e. rural, resource-poor) viewpoints and considers how they might be combined. Essential to this combination is the opening of channels of communication between the relevant participants at all levels in the decision-making process.

It has been suggested, therefore, that empowering the resource-poor in the development process is essential to the sustainability of rural development. In fact, the empowerment of the resource-poor forms part of the context of this thesis, drawing on indigenous knowledge and practice to introduce sustainable agricultural technologies (i.e. agroforestry) or improve existing systems, with support from the private and public sectors. Implementing structures capable of combining external and local sources of information in the formation of development policies would do much to stimulate the rural development process. This is particularly true in South Africa where the opportunity now exists, not only to acquire international support for rural development, but also to draw on international development experience and avoid the mistakes made elsewhere.

#### *2.1.1.2 Environment, Development and Sustainability*

The integration of environment and development in the achievement of sustainable development at the local scale thus depends on financial and other support from policy makers. With this in mind, the discussion which follows will look at how the consideration of environmental, development and economic processes have become more integrated at the national policy-making level with a view to supporting a process of sustainable development, particularly in the rural context. To achieve this, the progress of the environment-development debate from the World Conservation Strategy (1980), through the Brundtland Report (1987) to the United Nations Conference on Environment and Development (1993), will be utilised to illustrate the evolution of ideas on development within 'mainstream environmentalism' over the past two decades. Of particular significance will be the recognition of the political, institutional, and economic factors which determine human-environment relations, and the degree to which they are addressed in these three environmentalist landmarks. It will be seen that environmental issues were initially incorporated into the development process using a simple 'top-down' approach. Finally, at UNCED, the resource-poor were recognised as actors in the development process, a factor deemed here to be essential for the introduction of sustainable development processes. The discussion will show that the debates in the spheres of development and environmentalism have now reached common ground on the subject of sustainable rural development, and the findings of UNCED will be applied directly to the South African situation, and hence to the study area. Through this process the links between the international environment-development debate and local development activities will be revealed.

A wide range of views exists on the subject of sustainable development. These do not differ in terms of the ideals sought (e.g. health, prosperity), but rather in the means of achieving these ideals. To illustrate this point and to place the ideology of this thesis into perspective, the environmental debate within development studies and practice will be briefly outlined, as 'environmental problems *are* development problems' (Redclift 1984:46). Development cannot take place without the utilisation of natural resources, and human survival is jeopardised by the exploitation of these self-same resources. The concept of sustainable rural development therefore draws on experience from both development and environmental spheres, as it deals with the relationship between humans (including social and economic structures) and their ecological context. Politics, economics and ecology are therefore closely interlinked within the scope of the development process.

However, many authors support the view that political-economic factors have received surprisingly inadequate consideration in major documents on development and the environment such as the World Conservation Strategy (WCS) (1980) (a document commissioned by the United Nations Environmental Programme and drafted by the International Union for the Conservation of Nature with the aim of highlighting global environmental problems and suggesting possible solutions (Adams 1990)) and the Brundtland Report (1987) (a report from the World Commission on the Environment launched at the Stockholm Conference on the Human Environment in 1972 (Brundtland 1987)), reducing any potential impact that they may have on actual development practice. These documents stand in contrast to the views on environment and development expressed in works by authors such as Adams (1990), Chambers (1983, 1989), Redclift (1984, 1987), Blaikie (1985) and O'Riordan (1989), all of whom convincingly demonstrate the crucial role of politics and economics in determining not only if development is to occur, but the direction of development, and who stands to benefit from that development. The United Nations Conference on the Environment and Development (UNCED) was convened partly in response to the failure of the WCS and Brundtland Report to address, among other things, mechanisms for the alleviation of rural poverty, but has received mixed reviews on its success generally and in this specific regard. The contributions to development debate and practice as well as the shortcomings of the WCS, Brundtland Report, and UNCED will now be briefly discussed.

The goal of the WCS was the 'integration of conservation and development' (IUCN 1980 para. 1.12) with the aim of ensuring human wellbeing, but the suggestions it made assumed the existence of a politically benign context and therefore offered no practical solutions to the problems outlined. The statement that 'conservation and development are mutually dependent' (IUCN 1980 para. 1.10) was the most important contribution of the WCS and this document stands out as a commentary on environmental problems, rather than a guide to their solution. In a critique of the World Conservation Strategy (1980), Adams (1990:51) concludes as follows: 'Like so much of the environmentalism of the 1970s, the WCS was...blind to the twin worlds of policy and political economy. As a result, what it has to say about development is not particularly convincing'. The same criticism is offered for the Brundtland Report of 1987, seen as outlining the problems without suggesting how these may be overcome. Furthermore, as Fincham and Auerbach (1990) show, the Brundtland Report suggests economic growth to raise living standards and cure environmental degradation (i.e. a Western, resource-hungry development path for the Third World). This is totally inappropriate, with the majority of Third World countries finding themselves in debt and a situation of natural resource paucity and depletion. It is, of course, necessary to outline problems, as this provides frameworks within which research may be undertaken. But Adams (1990) makes an important point above: the world's development problems cannot be solved by description alone; a practical plan of action must be formulated and adhered to. Action is the key to future prosperity and it is the political economy that dictates what action is possible and appropriate.

Notwithstanding the necessity for the formulation of a plan of action, the importance of contributions to the sustainable development debate should be measured not only in terms of suggesting methods for achieving sustainable development, but also for their influence in mobilising public opinion towards certain objectives, and hence affecting the direction of policy formulation. It is in this sphere that the Brundtland Report has made an important contribution to the sustainable development debate, and its value in this regard is often underestimated. This is a view shared by Soussan (1992), who begins by stating that the Brundtland Report 'set a broad agenda for change without confronting the many barriers which exist to achieving these goals... [it therefore]... contains a series of fine statements which are impossible to disagree with, but which are too vague to be translated into concrete actions.' He then concludes that 'despite this, the conclusions are bold and ambitious, and have set the direction of the debate on the re-orientation of future development policies' (p26). Also, the Brundtland Report has provided development practitioners with a working definition of sustainable development, endowing the concept with 'public currency' and acceptance: sustainable development is 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (Brundtland 1987:43).

The United Nations Conference on the Environment and Development (UNCED) which culminated in the Earth Summit in June 1992 after two years of negotiations (Lerner 1992), represents an attempt to implement sustainable development on a global scale and address the shortcomings of previous attempts (i.e. the WCS and Brundtland Report). It has, undeniably been a success as far as encouraging international co-operation in solving some of the problems relating to sustainable development is concerned (Lerner 1992), particularly in its recognition of the structural mechanisms which cause unsustainability as expounded by Redclift (1984), Adams (1990), Chambers (1983) and O'Riordan (1989), among others.

Since the Earth Summit, UNCED has received criticism for its handling of the relationship between development and the environment. One such criticism comes from *The Ecologist* (vol.22 no. 4 1992:122): 'Unwilling to question the desirability of economic growth, the market economy or the development process itself, UNCED never had a chance of addressing the real problems of "environment and development"'. It goes on to suggest that 'by...deliberate evasion of the central issues which economic expansion poses for human societies (e.g. free trade, logging, automobiles), UNCED condemned itself to irrelevance even before the first preparatory meeting got underway'. Wynberg (1993) shows that 'UNCED failed to reform economic structures, regulate transnational corporations, tackle the debt crisis and the South's falling terms of trade. Moreover, UNCED largely failed to internalise environmental and social costs and restructure the relevant decision-making processes.' (p254).

In spite of these problems, UNCED does have a number of successes to its credit. These are summarised by Wynberg (1993), and include the signing of a series of intergovernmental agreements which legitimised the interdependence of environment and development, recognised the needs of the resource-poor, and committed countries to take steps in a more sustainable direction. As a result, sustainable development now occupies a place in the international diplomatic arena. Another outcome of the conference was the recognition that the solution of environmental problems lies in addressing the causes of environmental damage rather than the symptoms. The lack of communication between government departments (e.g. environmental and economic) was highlighted, as was the interdependence of developed and developing nations. Media coverage of the conference increased public awareness of the issues, while public participation (through non-governmental organisations) in the negotiation process was facilitated. Of great importance was the establishment of networks and agreements between non-governmental organisations. A significant breakthrough of UNCED which is particularly relevant to the subject of this thesis was the successful integration of environment and development in the sphere of sustainable agriculture and rural development, providing a mandate for the the introduction of sustainable agricultural technologies worldwide (Wynberg 1993).

Wynberg (1993) relates the findings of UNCED's 'Agenda 21' (the plan of action to integrate environment and development) to the South African rural context, and shows that in many instances, it offers solutions to the problems at hand. For example, a process of integrated rural development needs to be followed; decreased population growth relies on the empowerment of rural women; and the long-term reduction of poverty depends on 'effective, low-cost initiatives which promote self-reliance among communities and are focussed on basic needs' (ibid.:256). Wynberg (1993) highlights the relevance to South Africa of Agenda 21's proposals for appropriate institutional, infrastructural, educational, credit and service facility development in rural areas. If Agenda 21's recommendations on the subject of forestry are applied to the South African situation, it shows that the current practice of commercial farming in this country is unsustainable and inappropriate with its utilisation of exotic species, severe impacts on water recycling, and orientation towards the export market, rather than the satisfaction of basic needs (Wynberg 1993).

The impact of UNCED on the future of South African development policy is illustrated by the incorporation of many of its recommendations into the African National Congress' Reconstruction and Development Programme (1994). This document, which sets out a path towards sustainable development in South Africa, is discussed in more detail in the next section which deals specifically with the South African situation.

Agenda 21 makes reference to agroforestry on a number of occasions. Agroforestry (particularly that incorporating indigenous species) is recommended to combat land degradation (para. 12.24(a)) and soil erosion (para. 13.21(c)), as well as being regarded as an 'environmentally sound technology for integrated production and farming systems' (UN 1993 para. 14.26(b)). In the sphere of biotechnology, research on 'tree species for agro-forestry' (UN 1993 para. 14.55) is promoted, while agroforestry also receives attention under the heading of 'Sustainable plant nutrition to increase food production' (UN 1993 para. 14.90). In effect, Agenda 21 recommends agroforestry as a powerful force in the achievement of sustainable rural development, and parallels the philosophy of this thesis by recognising that 'a farmer centred approach is the key to the attainment of sustainability in both developed and developing countries' (UN para. 32.4).

The sustainable development debate has, therefore, been put on the right path by UNCED, but true success will be measured in terms of actions on the ground. The criticisms levelled at the conference maintain that it has not addressed political-economic issues (e.g. decision-making processes, rural economic flows), and have put it on a par with the Brundtland Report in this regard. However, it has succeeded in consolidating the development debate through the forging of connections between relevant parties and the opening of channels of communication between them. The view taken here is that of French (1992), who identifies the major role of UNCED as the finalising of institutional frameworks to ensure the longevity of the negotiation process that it initiates. In accomplishing this, UNCED has strengthened the ties between the development discourse and development practice, putting sustainable development firmly on the agendas of the governments of the world. It has, therefore, achieved far more on both global and local scales than all previous attempts at solving development problems.

The discussion dealing with the impact of political and institutional issues on rural development is now consolidated by considering a relevant case study. To this end the sub-section which follows will deal specifically with the progress of rural development in South Africa. In this country, the process of development has aimed to fulfil the needs of the most privileged in society at the expense of others. Strong biases exist in land allocation, agricultural development and research, in favour of a minority of the rural population. The argument put forward below will show that this resulted in the achievement of the social and economic objectives of a minority of South Africa's population in an unsustainable and ecologically disastrous manner, but that such problems are now being comprehensively addressed.



### *2.1.1.3 The South African Example*

Looking at South Africa as a case in point, the political economy has been particularly influential in determining the direction of rural development along unsustainable lines. The 'homeland policy' formalised by the Land Act of 1913 restricted the black population of South Africa to 14 percent of the land, halting black commercial farming and black tenancy on white-owned farms (Drummond 1992). By 1980, 52.7 percent of the black population was permanently residing in the 'homelands' (Platzky and Walker 1985). Under this system, population pressure was artificially increased in the 'homelands' leading to a land shortage and subsequent overutilisation, erosion and poverty. Also, the migrant labour system removed able-bodied labour from the 'homeland' farms. 'Indeed, perhaps poverty (which in South Africa, is a direct result of apartheid policies) can best be understood as a form of grave imbalance in the wider ecological system' (Wilson 1990:37). Referring to apartheid policies and their attendant forced removals, Ramphele (1990) states that 'the ecological chickens of this short-sightedness are coming home to roost all over South Africa' (p4). Politics (and related economic policies) in this country have therefore been a major cause of its environmental decline and cognisance must be taken of the fact that 'local use (or misuse) of the environment [is a] function of the intersection of resource managers with extrahousehold, non-local circuits of accumulation and surplus extraction' (Watts 1989:15). Wilson (1990) argues in the South African context that 'in any set of strategies for ecological recovery there has to be a comprehensive economic policy of redistribution and growth that reduces the pressures which cause people to act against their own acknowledged long term interests.' (p38).

Turning now to agricultural development, rural development in South Africa has centred on white commercial farming at the expense of indigenous communities. As Huntley, Siegfried and Sunter (1989:55) comment, 'financial aid and advisory services to agriculture in the homelands have been erratic, often disruptive and wholly inadequate'. The view taken here is that South Africa is an example where the objectives of development for the national economy have differed significantly from those of the 'homelands' (Scoones 1988), with a severely skewed distribution of resources in favour of large white-owned commercial farms at the expense of small-scale farmers. This is a conflictual situation which, in the past, had not been dealt with at government level (even though the problems of separate development are recognised) and the move towards sustainable rural development in the former 'homelands' has been led by non-governmental organisations (e.g. Operation Hunger, Institute of Natural Resources). Structural adjustments were therefore necessary to make black rural communities become 'visible' to policy makers. With the institution of a democratic government, these structural adjustments have been made, and a programme introduced to address the needs of the rural resource-poor.

Moving to research biases, 'the fabric of contemporary geographical rural research in South Africa is threadbare in both black and white agriculture' and 'there is...no coherent body of literature advancing development geography in the South African rural periphery' (Drummond 1992:266). This situation is not confined to geographical rural research, but persists in other forms of research into rural development in the country (e.g. research into improved agricultural methods, energy and water supply). Sustainable development researchers concentrate instead on urban areas (Rogerson and McCarthy 1992), partly because more funding is available from development agencies for such research (politics and economics therefore determine research opportunities). Integrated (multidisciplinary) research in the former 'homelands' is rare with the majority of available findings coming from isolated case studies and government documents. The quote below highlights the unique and important role that geographers can play in researching the former 'homelands':

> 'Geographers have much to contribute to rural development research in the bantustans. They could bring an important environmental perspective to bear on the world of economic planners. Furthermore, detailed analyses on resource management and land-use strategies could go a long way towards providing detailed empirical data on which, it is hoped, post-apartheid planners will base policies and planning.'(Drummond 1992:274-5).

The above discussion has shown that political, economic and research biases have interacted with other factors to result in a path of unsustainable rural development in South Africa. In spite of this, the future of rural development in this country looks more promising now than it has ever been.

South Africa is currently passing through a transition period with the introduction of a democratic political system. As a result of this transition, fundamental changes in structural forces can be expected. With the first democratic government of the country being headed by the African National Congress (ANC) and its affiliates, it has been decided, here, to discuss briefly the government's Reconstruction and Development Programme (ANC 1994), as an indicator of the future direction of rural development in South Africa.

Applying the principles of Agenda 21 to the South African context, the government's Reconstruction and Development Programme (1994) incorporates all the current ideas on sustainable development and environmental management, covering political, social, economic, and ecological aspects, and seeking reforms in resource allocation and women's rights. Central to the promotion of rural development in this document is 'a dramatic land reform program to transfer land from the inefficient, debt-ridden, ecologically-damaging and white-dominated large farm sector to all those who wish to produce incomes through farming in a more sustainable agricultural system' (ANC 1994 para. 4.3.8). It reads like a panacea for South Africa's development problems and supports all the views taken in this thesis.

By stating that 'efficient, labour intensive and sustainable methods of farming must be researched and promoted' (ANC 1994 para. 4.5.2.6), the programme indirectly recommends agroforestry. Within the sphere of agriculture, it sets itself the difficult task of improving the performance of current commercial agriculture by reducing controls, levies and subsidies (in the face of increasing debt), while at the same time concentrating support services on small and resource-poor farmers. Allied to this is the goal of 'household food security', and 'an orientation to the provision of affordable food' in place of 'the expensive pursuit of national food self-sufficiency' (ANC 1994 para. 4.5.2.2).

The programme recognises the need for services in rural areas (e.g. clean water provision, electricity, transport, health, education and finance), promoting marketing and finance opportunities which are accessible to resource-poor farmers. Emphasis is placed on the important roles of women who represent the majority of small-scale farmers, and their inclusion in decision-making structures. Empowering rural communities in local decision-making structures is another objective of the programme. The 'mutually reinforcing nature of urban and rural development strategies through, for example, the benefits of improved agriculture to the urban economy' (ANC 1994 para. 4.3.2) is recognised, as is the need for a more equitable distribution of economic activity and decentralised job creation, through the implementation of integrated rural and urban development (ANC 1994).

It is very difficult to lay any criticism against this document, for, as will become apparent, its recommendations are continually reinforced as this thesis progresses. This section therefore concludes with a cautionary note.

Rural development policies must ensure that there is not a duplication of current large-scale white commercial agriculture (requiring expensive inputs on an unsustainable basis) on the small scale, in which case, instead of there being thousands of farmers in severe debt, there would be millions requiring the continuous support of government funding. Sight must not be lost of the value of reforms in farming methods to accompany land reforms, and the importance of setting structures (e.g. extension services, research and development systems) in place to promote these methods. In this regard, new agricultural development agencies have to recognise the value of indigenous knowledge as a contributor to sustainable rural development in the region; and incorporate applicable components into policy formulation. An effort must be made not to sacrifice low-risk traditional farming methods in the hope of mechanised, high input agriculture for all, a potentially disastrous situation for the future of agriculture in South Africa.

It is in the best interests of the government to forge a path towards sustainable development for the majority of the population (i.e. the rural resource-poor) and support local initiatives, thus facilitating local empowerment and appropriate allocation of research and development funds. Agroforestry interventions provide a means for political institutions to implement sustainable development policy on the ground. The cost-efficiency of agroforestry under these circumstances should make it an increasingly attractive option in the eyes of policy-makers, and it clearly has an important role to play in achieving sustainable rural development in this country.

Finally, sustainable rural development is an impossible goal with the current high levels of politically-motivated violence in the study area and the region as a whole. Before any progress can be made, politicians must commit themselves to a programme of addressing political differences in a peaceful manner. To this end, the power struggle will have to take a back seat to the struggle for survival.



## 2.2 Sustainable Livelihoods

After discussing the role and influence of the political-economy in the sphere of sustainable development, and the importance of a 'bottom-up' approach to development, the remainder of this chapter, and indeed, this entire thesis, focusses attention on the implementation of sustainable livelihoods.

The scale of investigation now moves from the national to the local level. Therefore, rather than concentrating on the political causes of environmental degradation through unsustainable resource utilisation, attention is now shifted towards the search for solutions at the local level, and the achievement of sustainable livelihoods in the former 'homelands' (i.e. a small-scale, farm level approach as opposed to a national policy approach).

The previous sections have illustrated the importance of understanding how political and socio-economic forces shape the relationship between people and their environment. The sections which follow will examine these relationships and discover methods of improving them (from a balanced perspective incorporating 'bottom-up' and 'top-down' viewpoints) with the ultimate goal of sustainable utilisation as a precursor to the establishment of a sustainable development structure in rural areas. Priority will be given to the concepts of self-help and self-sufficiency.

Within the development framework, power can be exercised at two different levels. The State and its political subsidiaries have the power to allocate the resources at their disposal (e.g. capital for infrastructure and services) and determine national development strategies. Notwithstanding the fact that a supporting political-economic framework is essential in providing a context conducive to the implementation of sustainable rural development on a national scale, many of the required methods and means remain extant in the rural environment, in the form of natural and human resources (e.g. indigenous knowledge). Focussing on empowering the resource-poor to maximise the resources *currently* at *their* disposal (e.g. land, labour, plant and animal resources, indigenous knowledge), the sections which follow will show how agroforestry, by applying and utilising available resources at the local level, can contribute to self-sufficiency and the creation of sustainable livelihoods.

Although the majority of South African farmers operate within a political and socio-economic system (one which, hopefully, will experience significant reform under the new constitution in the light of the development programme outlined in the previous section) which imposes severe constraints on production (e.g. forced occupation of marginal land, lack of financial assistance and agricultural extension services), much can be done by resource-poor farmers to improve their immediate situation. As will be shown in this thesis, vast opportunities for increased production exist at the local level in the study area, through the medium of agroforestry.

It is, therefore, not always the farmer who is to blame for the current situation at household level as he or she is often at the mercy of external, usually invisible forces. Political and historical factors determining the allocation of land and other resources to different population groups may also be to blame (e.g. the South African homeland policy). Laying blame, however, is not very constructive. The facts are plainly visible. Rural development for the majority of Africa's population is virtually non-existent, not to mention unsustainable. It has, up to now, been 'strong in rhetoric and weak in substance' , a term used by Thompson (1990:215) to describe international opposition to Apartheid in South Africa up until 1978, and directly relevant in this instance. In most cases, 'rural development' has consisted of the introduction of externally developed technologies (e.g. methods of crop production). Local rural dwellers have received little or none of the benefits of their so-called 'development'.



The picture is one of a situation that has to be rectified. Chambers (1991) supplies the goals which have to be reached in order to achieve this rectification, in the form of three 'Ds' for sustainable development, 'decentralisation, diversity, and democracy' (p9). This thesis suggests the introduction of agroforestry, where possible, as a step in the right direction, its mode of operation (i.e. scale, methods, inputs and outputs) pointing the way towards livelihood sustainability at household level in the former 'homelands'. Indeed, Winterbottom and Hazlewood (1987) regard agroforestry technologies as ideally suited to the promotion of sustainable development, a view shared by Harrison (1987:204) who sees agroforestry as 'arguably the single most important discipline for the future of sustainable development in Africa'. With this in mind, the sections which follow will look at the contributions that agroforestry can make towards sustainable agriculture, its economic advantages, and the benefits of its utilisation of indigenous knowledge and multidisciplinarity.

## 2.3 Agroforestry and its Mode of Operation

### *2.3.1 Sustainable Agriculture*

'No industry is more vital to our present and future well being than agriculture, and few show as clearly the non-sustainability of existing patterns of what is conventionally regarded as development.' (Soussan 1992:32). In this statement, Soussan (1992) provides the basis for the section which follows. 'Sustainable agriculture should involve the successful management of resources for agriculture to satisfy changing human needs, while maintaining or enhancing the quality of the environment and conserving natural resources' (York 1990:7). Allied to this, 'there must be an increase in biological diversity, a gradual reduction in dependence on bought-in inputs as well as a reduction in farm generated pollution' (Auerbach 1990:4). The wellbeing of the people depends on the wellbeing of the land and vice versa, and because people have control over the destiny of their land, it is they who must be the starting point for any rural development programme.

#### *2.3.1.1 Economics and Agriculture*

Agricultural development strategies must aim not just to increase a country's agricultural production, but also to increase the proportion of that production reaching the poor and overcome the 'divorce between nutritional welfare and agriculture' (Pacey and

Payne 1985:184). This quotation refers to the fact that a country's agricultural production does not in any way reflect the prosperity of that country's population. Problems occur in the distribution of wealth within a country, and here the political and/or economic structures are at fault. However, there is another side to this economic coin. It is all very well to say that a government's responsibility lies with its population first and that it should contribute directly to local prosperity by providing opportunities for income generation amongst the rural poor, but it needs revenue to do this (provision of services, infrastructure, training). Within this context, Atkins (1988) proposes a shift from research on crop production, to research into food supply and related problems, through the analysis of the relationship of food chains and systems to political, social and economic structures.

The challenge is to introduce land use systems that are able to fulfil three roles simultaneously: the maintenance of subsistence levels, the provision of income opportunities, and the production of cash crops. Essential to attaining this aim is the fostering of positive human-environment relationships. A comparison between agroforestry and monocropping will show why agroforestry has a crucial role to play in this regard.

*2.3.1.2 Agroforestry versus Monocropping*

On a gradient between man-made and natural systems, agroforestry is closer to a natural system than a monoculture and provides a means for the reintegration of people and the environment (i.e. increased harmony in human-environment relationships).

Agroforestry, as opposed to other forms of multiple cropping, is particularly attractive because of the tree component which fulfils a variety of production and service roles (Nair 1985, Torres 1983). The benefits of trees in the South African context are summarised by Wilson and Ramphele (1989:329): they 'bind and enrich the soil, making it genuinely "indestructible"; they attract the rain and hold the water that falls; they remain (and will do so for a long time to come) the major source of fuel for the poor; and, if carefully chosen and tended, they can be harvested for a wide range of products'. That said, attention must be drawn to the importance of planting trees appropriate to the local context. For example, some species (e.g. *Eucalyptus spp.*) severely deplete groundwater and dry up nearby streams, a major problem in drought prone areas. Other species are invasive, while still others attract agricultural pests or are toxic to people and livestock.

Simplification (as in a monoculture) leads to instability and increases risk to both nature and the human population, requiring large inputs to maintain productivity. In fact, the monocultures of the 'green revolution' (1960s), emphasising inputs such as artificial fertilisers and insecticides, led to increased rural poverty, with per capita food production decreasing between 1964 and 1986 in Africa (Conway and Barbier 1990). Consideration must, however, be given to other possible contributing factors (e.g. drought, civil conflicts, population growth), and it may seem simplistic to blame only the 'green revolution' for increasing rural poverty. In spite of this, the point made by Conway and Barbier (1990) is a valid one, in that the resilience (to variations in climate and inputs) implicit in indigenous systems utilising species combinations is destroyed by the wholesale introduction of crops not adapted to the local environment (ecological, social and economic), often transforming a sustainable system into one that is marginal and fragile. Sustainability is sacrificed to ensure immediate yield, and if the expensive inputs required by introduced crops (e.g. fertilisers, transport, irrigation) are not available locally, both sustainability and yield are negatively impacted and poverty increased.

When simplification of a system occurs to the extent of a monoculture, both people and the natural environment become vulnerable to small fluctuations in environmental parameters (e.g. rainfall) as well as price fluctuations on national and international markets. 'In agriculture, where topography is uneven and rainfall irregular, farming systems are made more stable and sustainable not by standardising through adopting uniform packages of practices generated by normal research, but by diversifying, complicating, and intensifying activities' (Chambers 1991:6). Multiple uses and combinations of resources act as buffers against unforeseen circumstances by providing alternatives in times of need (e.g. in many traditional agricultural systems) with the main advantages of this increased complexity being increased stability, sustainability and productivity.

#### *2.3.1.3 Ecological Principles*

The ecological basis of sustainable agriculture is considered by Gleissman (1990). In this volume, principles of ecology are applied to agricultural systems and structural and functional diversity are shown to contribute directly to sustainability. An example would be a community exclusively producing carrots versus one producing a variety of fruits and vegetables: during a drought, the former would collapse while the latter would survive, sustained by its multiplicity. This point was made above when considering the advantages of a natural system over a monoculture. The ecological advantages of low-input intercropping systems such as agroforestry are highlighted by Gleissman (1990). They include: less disturbance to the natural system, the use of ecological processes (e.g. energy cycles) to maintain productivity, and the absence of pollutants. The argument put forward by this thesis for agroforestry as a sustainable agriculture technology is substantiated in Gleissman's (1990) volume through the consideration of species-environment interactions.

Closely related to the above is the concept of resource sharing as discussed by Buck (1986). Resource pools such as light, water and nutrients are shared by different crop components within spatial and temporal dimensions. This has important implications for the management of agroforestry systems, affecting the distributions in time and space of crop combinations for optimal productivity and sustainability. An example of complementary resource sharing provided by Buck (1986) is a nitrogen-fixing legume which provides adjacent crops with nutrients through leaf fall. Both take advantage of the nutrient pool and a complementary relationship exists.

#### *2.3.1.4 The Human-Environment Interface in Agriculture*

Agricultural land becomes marginalised through overutilisation and the often unbearable cost of the fertilisers and machinery necessary for continued intensive monoculture production. Such a situation is bound to change and the impetus behind this change is most likely to be perturbations in the natural environment. Unsustainable utilisation of resources results in a spiral of poverty with both people and their environment in decline. This reinforces the idea that 'agriculture is both a biological and a social process' (Richards 1985:157) and shows that 'there is a direct and symbiotic relationship between human poverty and ecological destruction' (Wilson 1990:36-7). It must be stressed that 'food shortages and famine are not solely caused by natural disasters (droughts, earthquakes, floods), but...social economic and political factors in particular are also responsible for such crises' (Bohle and Kruger 1993:98).



Radical rethinking and action represent the only solution, where perceptions, practices and philosophies undergo change or reversal to invert this spiral. The ideal is to reverse the trend towards poverty not by distributing food to the poor (not common in South Africa up to the present, but probably more likely, given international donor support in the future), which may lead to an overdependence on aid (e.g. in Lesotho (Joyce and Burwell 1985 in Gregersen, Draper and Elz 1989)), but by increasing productivity amongst farmers (i.e. long term solutions). Where the distribution of food aid is essential, an agricultural training and support programme should be simultaneously introduced, promoting practices and systems suited to local environ mental and social contexts.

A basic cyclical systems approach (i.e. feedback loops) must be adopted by the rural poor in a form suited to their needs (e.g. nutrient recycling using vegetable waste) so that they might gain more control over the outcome of their labours and the options at their disposal. It is obvious that this can only occur if the benefits outweigh the risks in the eyes of the farmer him/herself. A problem in this regard in the context of South Africa is highlighted by Huntley, Siegfried and Sunter (1989:56): 'The need to conserve soil through sustainable agricultural systems is not appreciated by the majority of the homeland population. Their needs are immediate. A hungry stomach cannot accommodate a long-term view on natural resource management.'. Against this, it can be argued in most cases that the need to conserve soil is appreciated, but that it is beyond the means of the majority of rural people to combat soil erosion. For this reason alone, the implementation of farming systems which combine increased food production with soil conservation (i.e. food production as the initial objective with soil conservation and improvement as spin-offs) should be a priority in South Africa (and elsewhere). Agroforestry practices fit into this category. External inputs such as training and capital may be required, but if a farmer can be made aware of the principles of methods such as organic farming and he or she is given support in this regard (the latter being most important, as the majority of farmers are already using organic methods, but do so with depleted resources at their disposal), the possibility exists for the creation of a net resource excess of direct benefit to the farmer and his/her community. In a properly researched and introduced land management system which is tailored to the needs, economic context and environment of its target population, the benefits will always outweigh the costs in the long term.

The discussion now moves from sustainable agriculture as an important component of sustainable rural development, to a consideration of the economy and how agroforestry can contribute to sustainability within the economic sphere.

### *2.3.2 Economic Factors*

The primary aim of rural development is to address resource scarcity. Agroforestry systems may allow for the intensive use of small areas with relatively low impact on the environment and costs for society where land is a constraint (e.g. multi-storeyed home gardens providing fruit, vegetables and cash crops). Where labour is a constraint, they may allow more efficient utilisation of resources for maximum returns (e.g. low-maintenance living fences protecting cropland from cattle invasion while simultaneously providing fuelwood and building material). Agroforestry systems have the capacity, therefore, to maximise returns to the scarce factor of production and increase the economic independence of the land user. An added benefit of a land-use system that maximises returns is that it may stimulate an interest in farming and encourage more people to become producers. The advantages are obvious, but of overwhelming importance to, for example, rural communities in South Africa, would be the restoring of a balance between producers and consumers and hence the reduction of local food and capital shortages. The potential for self-perpetuation of an agroforestry system (i.e. a system able to recycle its inputs and outputs so as to continue indefinitely) exists if the benefits derived are accrued by all involved, chief among these being self-sufficiency and sustainability, not only in food production, but also in the production of fuelwood, building materials and farm inputs.

Further economic benefits may be had from the sale of surpluses; savings from the reduction in the volume of purchased farm inputs such as fertilisers, fodder and building materials; and employment provision through its labour intensiveness and the utilisation of marginal soils. In many cases, marginal land is described as such in terms of current crop requirements. Many indigenous tree and vegetable crop plants are able to utilise soils described by agriculturalists as useless. These are the species promoted by agroforestry practitioners. As an added benefit, these plant species are adapted to Africa's extreme environmental conditions. The result is that more land may be made productive through agroforestry. Ecological benefits include the reduction of soil erosion (e.g. by root systems and surface contour plantings) and contamination of ground-water from chemical fertilisers (reduced/discontinued utilisation of chemicals in favour of organic/plant inputs); maintenance of species diversity; improved soil structure and fertility (e.g. tree root systems aerate the soil and leaf-falls contribute soil nutrients); and increased water infiltration (reduced raindrop impact and water runoff). Both economic and ecological benefits combine and interact to ensure that a farmer is able to maintain his/her land as a viable economic unit. A healthy agricultural environment is essential to a healthy rural economy.

Economic constraints to agroforestry development include: the incompatibility of current mechanisation and marketing opportunities of an agricultural system with a tree component; the time taken for a tree to become productive (and corresponding increase in risk); and credit access which is out of synchronisation with agroforestry production cycles (Arnold 1983).

An aspect that should be considered at the national scale here is the wielding of economic power in agricultural development where 'economic relations [may] prejudice sustainable development' (Redclift 1984:21), and the scale at which agroforestry is able to respond to capital shortfalls.

A reduction in the use of external inputs (e.g. fertilisers, pesticides and attendant mechanisation) through the introduction of agroforestry would, of course, not be welcomed by the manufacturers of those inputs. But since the consideration here falls primarily on those farmers who at present cannot afford these inputs anyway, the effect on the agrochemical producers would initially be limited to a decreased potential for an increased market in regions such as South Africa's 'homelands'. This is especially true if a 'bottom-up' approach is to be applied in agroforestry development. It is only when agroforestry begins to spread to large-scale commercial farming enterprises (a goal of many agroforestry practitioners) with these shifting towards organic farming practices and minimised artificial inputs that, for example, fertiliser and pesticide manufacturers will be impacted severely.

A bleak prospect for sustainable agricultural development on commercial farms in this country as it relates to economics is provided by Cooper (1990), who notes that the price of chemical farm inputs in South Africa has increased faster than that of agricultural produce over the past ten years with farmers operating at a loss. Also, yield benefits from chemical inputs occur only when there is sufficient rainfall. During drought years chemical inputs produce no increase in yield. He concludes from this that 'the only people whose profits have grown consistently are the transnational companies who manufacture the pesticides, fertilisers and improved seeds' (p59). Cooper (1990) goes on to suggest that these companies dominate the farmer service industry and any change in the situation (towards more organic farming methods) requires a change in the farmer service industry system, a system which is profiting from the current situation and is therefore unlikely to change. In the absence of agroforestry support services and infrastructure, commercial farming methods will (if at all) undergo gradual (economically induced) change towards more organic methods and perhaps agroforestry. This promotes the small farmer as the most promising point of introduction for agroforestry technologies under current economic conditions in South Africa (other factors such as fuelwood provision and environmental amelioration considered).

Returning again to the economic advantages of agroforestry systems, increased small scale productivity may stimulate the formation of local market networks should village/regional specialisation occur (e.g. in timber for construction, fruit production), as well as national market networks as a result of localised scarcity. The development of export markets in, for example, indigenous fruits is also a possibility, but requires substantial capital investment from commercial or governmental sources (e.g. for storage and transport). Of overriding importance, however, is the maintenance of subsistence levels and local self-sufficiency. The means to ensure this should be locally adapted to promote sustainability. If local marketing provides capital to achieve this then it should be encouraged. Only then can external marketing be considered.

To summarise, the economic advantages of agroforestry can be condensed into one simple concept: the introduction of an agricultural system of decreased input and increased output. The focus of this discussion now moves towards the implementation of sustainable rural development and the importance of indigenous knowledge in reaching this goal.



### *2.3.3 Indigenous Knowledge*

Local people possess a wealth of experience and knowledge of their needs, difficulties, customs, environment, and resource availability and constraints. Such knowledge forms a potentially useful starting point for appropriate adoptable rural development practice. Indeed, the recognition and consideration of this knowledge may be a prerequisite for development practitioners if their efforts are to succeed at all, especially in terms of identifying target groups for research and issues such as land tenure rooted in custom.

Warren and Cashman (1988) show the value of indigenous knowledge in rural development using a number of scenarios dealing with biases, existing systems, and research and development. Indigenous technical knowledge receives similar recognition by Gregersen, Draper and Elz (1989), while Richards (1985:15) promotes '"people's science" as a decentralised, participatory research and development system which seeks to support, rather than replace, local initiative'. Chambers (1983:92) argues for a balance between rural knowledge and outsider knowledge to counter core-periphery biases in rural development, recognising rural people's knowledge as 'an enormous and underutilised national resource'. Like any other resource it must be wisely utilised. Many rural development authors concentrate too much on indigenous technical knowledge and not enough on modern innovations. The aim here is not to revert back to primitive practices, but to consolidate and utilise all available knowledge to design appropriate technologies for the future. Emphasis must be placed on Chambers' (1983) argument for a balance. Those practices which increase productivity in certain contexts should be promoted, while those which do not should be abandoned or altered to fit in with the social and economic factors with which they are forced to interact.

Indigenous knowledge can play a vital role in determining perceived preferences regarding land management systems and in identifying future directions for rural development. What is needed is a programme of combining this knowledge with modern technology for the introduction of sustainable land management systems (e.g. the development of high-yielding indigenous species, and the design of manual narrow-track harvesters for use in alley cropping).

The principle of using and incorporating indigenous knowledge is implicit in the majority of agroforestry development activities and enjoys widespread support in texts dealing with the subject. In support of Chambers' (1989) 'farmer first' approach, Taylor (1991:186) warns: 'The promise of agroforestry systems as a solution to the widespread practice of monoculture and excessive use of external inputs, must not be undermined by the method in which it is introduced or re-introduced into farming systems.'. Rocheleau, Wachira, Malaret and WanJohi (1989:15) emphasise the importance of the 'priorities, knowledge, innovative capacities and full participation of local people in agroforestry research and development', for both practical and ethical reasons. In an overview of current agroforestry practices in Africa, with case studies from Kenya, Tanzania, Rwanda, Nigeria and Niger, Cook and Grut (1989) point to the necessity of considering the farmer's perspective in agroforestry system design, implementation, adoptability and success. Local knowledge, participation and consultation form the backbone for a wide spectrum of agroforestry activities, contributing to and often facilitating the success of these activities.

### *2.3.4 The Importance of Multidisciplinarity*

Those active in rural development come from a broad range of backgrounds (academic and social), many from outside the so-called 'green' perspective and external to the philosophy of environmentalism. It is important that the links between physical and social systems be both recognised and utilised, as a wealth of experience exists in both fields. The separation of biological and social spheres within problem-solving structures in developing countries is highlighted by Blaikie (1985) who argues that 'the belief that agricultural technologies will be developed for marginal, ecologically fragile areas, *and* for the marginal poor farmers and pastoralists that live there is...a trifle heroic' (p18). In many cases, Blaikie's (1985) argument still holds true, but recently, there has been a shift, especially within development agencies (e.g. UNDP), towards the consideration of local populations first, in designing agricultural development programmes, and local people are often employed as extension agents. There is now a widespread realisation that sustainable environmental management, particularly in marginal areas, relies on the satisfaction of basic human needs in the first instance. Through the integration of different schools of thought and the exchange of ideas between them, methodological entrenchment can be avoided and the reality (all aspects) of the current situation recognised. Only then can problems be tackled successfully. Integration is possible through the use of a multidisciplinary framework tailored to the problems at hand.

Contributors to problem solving could be, for example, scientists, local people, government officials and economists.

Gaps between disciplines must be bridged to enable rural problems to be tackled in a comprehensive and meaningful manner. Chambers (1983:181) highlights this point: 'the built in specialisation, conservatism and rigidities of university teaching, research institutions and government departments point away from the opportunities'. The opportunities cited include agroforestry practices such as intercropping with trees. Through its multidisciplinary, pluralist nature, agroforestry brings together the social and natural sciences to solve practical problems.

## 2.4 Conclusion

Sustainable rural development may be likened to building a house. Capital is the spade that prepares the ground. The foundation is stability - stable social relations in the functional area. Bricks represent modern technology, while indigenous knowledge is the mortar. Electricity, water and telephonic connections may be seen as economic linkages. The completed house ensures a secure environment for all its inhabitants.

In this chapter, sustainable rural development has been recognised as a combination of ecological and economic sustainability, and therefore a product of human-environment relations. In this respect, the importance to sustainability of considering the political-economic framework within which social, environmental, and economic processes operate, has been emphasised. An equilibrial approach to rural development was adopted, including 'top-down' and 'bottom-up' aspects, and the necessity of empowering the resource-poor as actors in the development process and related decision-making structures in this regard, was highlighted. The WCS, Brundtland Report, and UNCED were then utilised to illustrate the evolution of ideas on environment, development, and sustainability at the national policy-making level. These ideas were subsequently consolidated in a case study of South Africa, where the view was supported that political-economic factors have contributed to a process of unsustainable rural development with biases in land allocation, agricultural development, and research; but that the future for rural development in this country is promising if the government's Reconstruction and Development Programme is implemented. The second half of the chapter narrowed down the scale of investigation to the local level, and the achievement of sustainable livelihoods, with sustainable utilisation being understood as a precursor to the implementation of sustainable rural development. The potential strength of agroforestry's contributions towards sustainable agricultural and economic development through its utilisation of indigenous knowledge and multidisciplinarity, were then discussed, along with its role of empowering the resource-poor to maximise available resources in a sustainable manner, thereby promoting self-help and self-sufficiency.

The opinion expressed in this chapter is, therefore, that the consideration of political, institutional, social, environmental and economic factors makes it possible to design land management systems which are compatible with the development needs of a country as a whole. It is maintained that in many contexts, agroforestry as an evolving process provides the means to rise to the challenge stated above, pointing the way towards the recognition and utilisation of opportunities for increased rural productivity and wellbeing through the application of appropriate technology.

# CHAPTER THREE
# METHODOLOGY

Theory informs action, methodology implements it. Any methodology is therefore a product of theory. In this chapter it is illustrated how a methodology was chosen that would reflect the views expounded in earlier chapters (such as a multidisciplinary approach, sustainable rural development and the utilisation of indigenous knowledge) and permit their practical implementation.

## 3.1 Farmer-Researcher Interaction

The aim of this thesis is not to produce a package to solve rural problems (e.g. 'transfer of technology model' (Chambers 1989)), but to suggest components which can be adopted and combined by farmers to suit their particular needs and environment (i.e. promotion of experimentation by farmers) (Chambers 1989). This is an approach utilised in the Shurugwi project in Zimbabwe (Clarke 1991) and has been found to be more appropriate (especially in terms of adoptability) than that utilising researcher-designed packages. Clarke (1991) mentions the failure of the latter on the ground and backs farmer innovation and experience as the key to agroforestry implementation. Taylor's (1991) participatory approach has the same focus. The move is from classification (of practices) to collaboration (with farmers) and the importance of the researcher - farmer link in agroforestry system development must again be emphasised.

'Introductions by researchers of new species have rarely been successful' (Newman 1991:5). Newman (1991) refers to people's familiarity with the value of the tree species in their immediate environment and shows that a combination of grower consultation and researcher trials to design optional agroforestry systems has been found to be most successful in the European context. Rocheleau, Wachira, Malaret and Wanjohi (1989) found the same to be true in the African (Kenya) context. This success relates to adoptability, biological yield and cash flow as compared to monocultures. The benefits of farmer consultation are further highlighted by Kerkhof (1990) using African examples of how farmers have adapted introduced systems to their needs (e.g. alley cropping). All of the 21 projects evaluated by Kerkhof (1990) had this element of off-site planning and on-site adjustment/fine-tuning.

As alluded to above, interaction between researcher and farmer (e.g. through interviews and demonstration) is vital in isolating elements suitable for on farm adjustment. Farmer input is particularly important in providing information on indigenous woody and herbaceous plant species, an underutilised and underrated local resource, especially in South Africa where 'the general opinion is that the potential is limited' (Gandar 1991:12). The large number of currently utilised species and potential for improved productivity (e.g. through genetic engineering) show how the 'general opinion' is uninformed and Fenn (1991) pushes for research into indigenous (and therefore locally adapted) species utilisation in agroforestry in South Africa. Reference must be made here to the utilisation of indigenous knowledge explained in the earlier chapter on sustainable rural development and agroforestry. Individual farmers' needs, resources and problems must be identified and combinations of these resources suggested to solve problems. In essence, the farmer must be provided with an awareness of the solutions available to him or her. At present, the best way to do this would be through the mechanisms of non-governmental organisations (NGOs) and government funding departments concerned with rural development and with established links to local communities.

To place the selection of research method into perspective, its theoretical context will now be explored. It will be shown why the survey method chosen was both relevant to the problems requiring investigation and a suitable starting point for the identification of possible solutions.

## 3.2 Participatory Technology Development

Carrying through the argument put forward earlier in this thesis for a balance between the 'top-down' and 'bottom-up' approaches to development, the research method chosen here should support this process. Therefore, the choice of research method was based on the premise that a balance should exist between physically and socially sourced information. Such information could, for example, include on the one hand geological surveys and species adaptability studies, and on the other, indigenous knowledge and attitudes to tree cultivation. The investigation into rural problems and possible solutions in the study area therefore draws on the results of statistical surveys, personal observation and discussions with rural inhabitants. Once again, a key aspect of this study must be emphasised - the promotion of agroforestry technologies as possible solutions to rural problems where applicable. These technologies must be compatible with the needs, socio-economic systems and resources of the target population.

The practical application of this development model is embodied in the 'Rapid Rural Appraisal' (RRA) approach (Chambers 1979, Collinson 1979) which attempts to reverse the biases inherent in research by the 'normal professionals' who engage in 'rural development tourism' (Chambers 1983) (see Chapter Two). Four key features distinguish this approach to development research: it is rapid and multidisciplinary; rural people are the primary source of information; and it is iterative. The RRA approach seeks to give rural people a say in their own development by promoting the incorporation of indigenous knowledge and expertise into the rural development process. Subsequently, this approach has evolved into a more insider-orientated, interactive approach known as 'Partcipatory Rural Appraisal' (PRA) (Chambers 1989), emphasising the importance of farmer innovation and transference of the power to decide to the rural dweller. In PRA, the development practitioner acts as a catalyst for development and rural people conduct their own research and analyse the results.

The methodological practice utilised to inform this thesis uses the framework of RRA (i.e. its rapid, multidisciplinary, rural people-orientated nature) while the research tool is a questionnaire (see argument in favour of questionnaires below). Although differing fundamentally from the methodological practice of PRA, this approach nevertheless utilises PRA ideology in its ultimate aim - participatory technology development. The questionnaire is therefore promoted here as an appropriate methodology within PRA and not as an alternative to it.

Having provided a background to the concept of participatory technology development, the discussion now focusses on this project and how an appropriate methodology for investigation was chosen. In the context of this study (Kwazulu/Natal) there exists, in both economic and political spheres, a void between farmer experience and development policy formation. This void prevents local initiatives and innovations from reaching decision-makers at government level. What is needed is a structure to permit the free exchange of information. One possible solution advocated in this thesis is the utilisation by development practitioners of information gathered by the researcher from local farmers, personal observation and available literature to form a framework for farmer innovation. The same process would to some extent overcome the related voids between researcher and development agency, and between researcher and researched, through the promotion of the interactive application of research proposals. For example, the aim of this thesis is to put forward suggestions to development agencies for implementation - this can be seen as the first stage in a two-stage process, laying the foundation for participatory implementation and iteration.

Such a two-stage process is an attempt at providing a participatory method of introducing technologies for rural development within the current social, economic, political and environmental context of the study area. The first stage consists of a survey to generate information sourced from the circumstances, problems and suggestions of rural people. All possible sources of information (e.g. local people, statistical surveys, research institutions) are utilised to provide a framework for practical implementation and to define the boundaries of technology introduction. It is necessary to consider all factors impinging on local people and their environment to gain a full understanding of the problems experienced in these areas and opportunities for their solution. Before any proposals for participatory implementation can be put forward, cognisance must be taken of successful local initiatives. The situation may exist, like that in the Machakos District in Kenya (Rocheleau, Wachira, Malaret and Wanjohi 1989), where local innovations are capable of solving problems with very little support from external agencies and all that is needed is to build upon these innovations as precursors to and vehicles for agroforestry introduction through local participation. Any proposals put forward must be adoptable by local people and appropriate to their social, ecological, economic and political environment. Combining information from the abovementioned sources helps to achieve this and prevents expensive (social and economic) mistakes from occurring at the implementation stage through inappropriate development interventions (e.g. imposed researcher-designed packages).

The second stage follows with participatory implementation using ideas resulting from the survey (especially suggestions made by rural dwellers) as starting points for further investigation and participatory technology development (i.e. support for local initiatives). In the context of agroforestry interventions, the second stage might include the introduction of trials for farmer experimentation or the establishment of advice centres where agroforestry components are demonstrated and from which farmers may choose and combine at will with support from staff at hand.

Finance for on-farm establishment of technologies may be made available through small loans repayable from income earned directly from these technologies. Emphasis is placed on the spread of local initiatives and trials of system components using species currently utilised and prefered locally. This two-stage process links in with the RRA approach discussed above by promoting a balance between indigenous knowledge and modern technology through integration at both the appraisal and implementation stages. The farmer chooses what he or she wants to implement and has access to information. The scope of this thesis covers only the first stage of this process of participatory technology development (i.e. the survey and its analysis). A discussion of the type of survey undertaken and its relevance to the problems at hand now follows.

## 3.3 The Questionnaire Survey

The heading of this section might seem incongruous to some, going against the grain in RRA and bringing to mind thoughts of Chambers' (1983) 'tyranny of the questionnaire'. The use of questionnaires for gathering information on rural situations has come under fire from rural development theorists and practitioners (e.g. Chambers 1980, 1983). It is deemed to be extractive and exploitative of rural people with little of the information gleaned ever becoming available to the rural dweller. A case is made here in favour of the questionnaire format, supporting the view that a sensitively designed and utilised questionnaire need not be exploitative. In many countries a development programme culture has existed for some time and 'questionnaire fatigue' has set in, but in South Africa, research into rural development has been neglected to the point where questionnaires offer not only the first, but the most appropriate method of investigation. It is maintained in this study that the researcher, using tools such as the questionnaire, is able to lay the foundation for participatory technology development and the introduction of institution-farmer feedback loops.

The utilisation of questionnaires may be seen as being in direct conflict with the views of RRA and PRA practice, but as argued above, it is possible to utilise the information generated (stage one) in such a way as to encourage participatory technology development (stage two of the two-stage process). When ideas are implemented (and it must be stressed that the ideas referred to, which have been identified through a questionnaire survey, are those of both the target population and the researcher) and take shape on the ground, a host of challenges become apparent. These challenges are best met by farmer innovation and farmer-researcher consultation. As at the survey stage, farmer-researcher consultation and indigenous knowledge find great value at the implementation stage where the range of possibilities constructed undergoes a process of appraisal and adaptation by farmers according to their individual needs.

Where capital and time constraints apply (in most research), the 'rapid' aspect is essential. This aspect may be lost during in-depth PRA, while the problem-solving approach taken in this thesis seeks only that information which is relevant to the task at hand. Increased 'lead-time' (information relevance period) and reduced 'lag-time' (period for response to negative feedback) (Jamieson 1987) are also essential. If an emphasis is placed on questions and discussions directly related to planning interventions, the time constraint need not result in a lack of accuracy or relevance. Furthermore, the use of questionnaires has the advantages of comparability and replicability. The approach to questionnaires taken in this thesis is similar to that taken by the Environment Division for Africa of the World Bank in a review of sub-Saharan agroforestry systems completed in 1988. In the past, the World Bank has been viewed as a First World institution embodying the top-down approach to development. Its recent approach to development, however, illustrates the increasing integration between top-down and bottom-up aspects through a farmer-based approach. The distinction between top-down and bottom-up is now becoming increasingly artificial. In the abovementioned review, a farmer-oriented approach was adopted and the reasons for the success or failure of agroforestry systems investigated (Cook and Grut 1989). The project consisted of two phases; the first phase was a literature search, while the second was a series of visits to five agroforestry projects utilising key informant and group interviews (questionnaires). From this two-phase project, important social, economic, technical, institutional and research issues were raised and recommendations made for agroforestry development in sub-Saharan Africa. One of the research priorities put forward by the study was that 'research methodology should adopt the farming systems approach, so that activities would be phased and resource allocation priorities established to reflect the farming and off-farm activities of the participating population' (Cook and Grut 1989:50). The Agroforestry Diagnosis and Design methodology of the International Council for Research in Agroforestry (Raintree 1987) expounded upon later in this chapter, utilises such an approach.

The usefulness of research tools such as questionnaires cannot be denied - they provide a format for detailed, organised and efficient investigation with the rural dweller as the source of information, while the inclusion of open-ended questions facilitates discussion. It is what is done with this information afterwards that distinguishes individual approaches. If it is utilised to generate proposals for farmer experimentation and these are made available to relevant NGOs, has the exercise been extractive? The farmer-researcher link can be maintained through all stages of the development process with each informing the other on an equal basis. This is ensured by keeping open channels of communication between the two parties and through regular consultation and sharing of ideas. The questionnaire used in a survey to provide a framework for practical implementation of technologies can therefore support the RRA and PRA approaches. It should be seen as an intermediate approach falling between purely external and full participatory problem analysis.

The case made above supports the decision made to utilise a questionnaire survey for this project. As will be seen later, the type of questionnaire chosen was able to define problems within the study area and suggest potential points of intervention for development practitioners. However, appraisal is but one stage in the process of rural development. The information gathered from different sources must then be combined to form proposals to be offered to decision-makers (e.g. government departments, NGOs, funding agencies, research institutions). The role of the researcher in this instance is therefore to gather information and then to utilise expertise accumulated throughout his or her (multidisciplinary) training, combining this with local farmer expertise to develop ideas for implementation by rural people in conjunction with development agencies.

Although the ideal situation would be for rural dwellers to arrive at their own solutions with the help of researchers and then implement these on their own, in reality this is usually beyond their means. The strength of rural people's arguments in such a situation relies heavily on how these ideas are presented to the decision-makers mentioned above. For this thesis, I aim to utilise my multidisciplinary background in the physical and social sciences to synthesise a range of ideas into a proposal for action with the help of rural people to be submitted to decision-makers. Multidisciplinarity helps to bridge gaps in knowledge and overcome methodological entrenchment. The harsh reality is that at present the decision-makers are more often than not 'outsiders' and rural people need assistance from these sources to communicate and implement their own ideas. Also, the current state of the rural economy in most regions of the world (including the study area) prohibits farmer innovation and rural people are usually spectators to their own 'development'. This is a situation that has to change if sustainable rural development is to succeed. The only way to ensure that such change occurs is to promote 'bottom-up' processes and change the status of rural people from 'the developed' to 'the developers', empowering the resource-poor to take charge of their development and guide its direction. The process of investigation and implementation advocated here is an attempt to address this situation.

Far from being status quo-supporting, the promotion of a process of agroforestry technology development using baseline, supporting data gained from the abovementioned questionnaire survey represents a fundamental transformation in rural technology development in South Africa. Up to now, the introduction of new technologies has usually occurred in package form (e.g. closed forestry systems) and there has been little incentive for farmers to spread innovations developed on-farm through the community. A two-way flow of information between all three parties involved in rural development (individual farmers, the community and institutions) is the only way of ensuring that individual innovations benefit the community as a whole. Within the study area (part of KwaBiyela) the Institute of Natural Resources (INR) of the University of Natal maintains constant links with the community. The Ndundulu Rural Service Centre (RSC) (established in 1988 by the INR) acts as the headquarters for rural development research and practice in KwaBiyela. This RSC therefore serves as a core for rural development, and with established links to the community is a valuable platform from which to launch initiatives. A problem that has to be overcome, however, is that at present individuals not selected for participation in projects (e.g. agroforestry trials) find themselves on the periphery of development processes, cut-off from available information. The full potential of this RSC is therefore not being realised and its influence needs to be extended, perhaps through decentralisation of some of its activities. The Centre provides a potential venue for community meetings and community - institution interaction where ideas could be shared and successful practices introduced to all interested parties. An agroforestry project is already under way. It is hoped that the proposals generated by this thesis will influence present rural development practice by being made available to the staff of the INR involved in the Biyela Integrated Rural Development

Programme. In this way, opportunities for reaching the community will be maximised and suggestions can be put into practice. Farmers should be able to develop their own farm-specific systems of agricultural production utilising components suggested by other farmers and research institutions. It is hoped that agroforestry development in KwaBiyela will contribute to this aim by providing a large number of options for introduction.

The process of agroforestry development must be open to continual adjustment and augmentation as new problems and opportunities emerge - this aspect of iteration is a key concept in the methodology of Agroforestry Diagnosis and Design (Raintree 1987). All parties involved should therefore necessarily have access to information being generated at all times to be able to pass that information through their own spheres of influence and return it, with comments and alteration, into the process of rural problem-solving and technology development. Mechanisms to ensure this may include regular community meetings at research farms, conferences held in problem areas to discuss possible solutions, and decentralised information centres manned on a daily basis where suggestions can be made by rural people and information from research and farmer experience supplied. Decentralised information centres are a necessity in the project area to reach remote areas not served by transport services. Communication channels in the project area, especially between individual farmers not involved in set programmes and the INR, need to be improved if ideas are to spread throughout the population. An attempt should be made to integrate all those (in addition to farmers and researchers) with an interest in rural development (e.g. NGOs, farmers' organisations, local government and the private sector) into the process of problem solving, as agricultural problems cannot be solved in isolation to the broader political-economy. The political-economy influences systems, constructs constraints and provides mechanisms through which solutions may be found.

Researchers should strive to build a bridge between development practitioners and rural people, and catalyse a two-way flow of traffic over the bridge, linking the two parties through practical involvement in sustainable rural development. As argued here, the questionnaire survey is capable of eliciting the information required for the construction of the bridge superstructure and encouraging the free flow of the vehicles of farmer innovation and institutional support across its span.

The discussion now shifts towards the survey method chosen specifically for this thesis, and how the views expressed above were applied in practice.

## 3.4 Choice of Survey Method

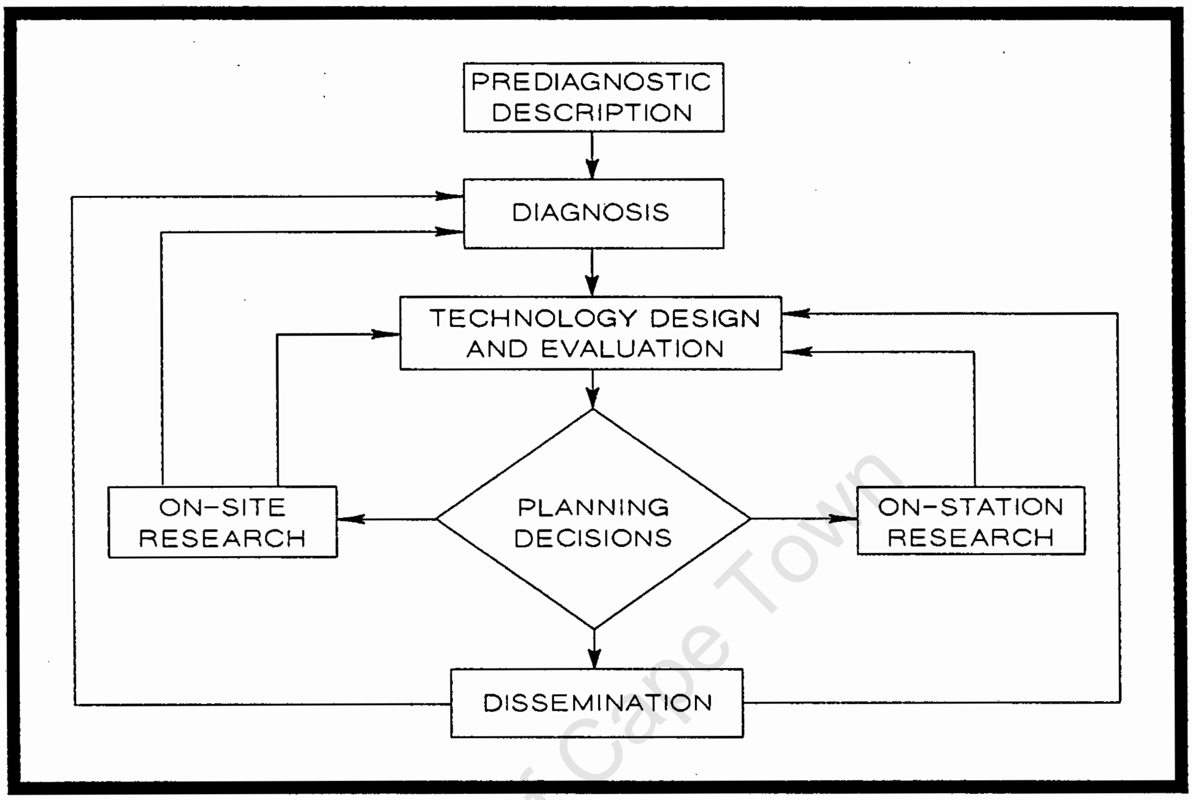
For the reasons cited earlier (time-efficiency, multidisciplinarity, rural informants and iterative processes) an RRA framework for investigation was chosen. Other reasons for this choice were capital and time constraints. This framework was required to identify agroforestry systems currently in operation in the study area and the level of indigenous knowledge regarding woody and herbaceous plant species utilisation. Included in the process was the discovery of people's perceptions of agricultural systems incorporating a woody component as possible solutions to local problems.

It was realised that, for reasons of comparability and replicability, it would be difficult to gauge problems and perceptions over a range of households through informal conversation without using a set of logically ordered questions. A formal set of questions with 'yes' or 'no' answers would have been equally inappropriate as it would not have allowed the determination of the 'why?' 'why not?' 'where?' 'what else?' and 'how?' found later to be so essential in problem isolation and personal viewpoint identification. The causes of problems are often as important, if not more so, than the problems themselves. It is these causative factors that have to be addressed as well, rather than just their outcome, as interventions early in the process are preferable to curing symptoms (prevention is better than cure). The method of investigation into local problems, perceptions and possible solutions would have to include a set of definite questions (i.e. a questionnaire), but also offer possibilities for further discussion (i.e. include open-ended questions), allowing respondents to put forward their own views and recommendations.

What was needed, then, was a series of easy-to-answer, non-intimidating, open-ended questions tailored specifically to elicit information on the identification of rural problems and of possible agroforestry solutions. Importantly, rural people are a primary source of information on their environment and what it has to offer. They know, first hand, about their problems and needs, and should therefore be the starting point for any problem-solving exercise.

The choice was made, therefore, to utilise the International Council for Research in Agroforestry's Diagnosis and Design approach and specifically the diagnostic survey guidelines incorporated in this approach (Raintree 1987). This was deemed appropriate for both practical and ethical reasons with the object of providing decision-makers with a range of possibilities which would be acceptable to the local population. Subsequent to this appraisal phase, the possibilities raised could be constituted into a data bank from which choices could be made, options interlinked and systems introduced on the ground.

Figure 3.1 Repetitive Activities and Feedback in a Diagnosis and Design Based Project




(source: Raintree 1987)



Agroforestry Diagnosis and Design is 'a methodology for the diagnosis of land management problems and design of agroforestry solutions' (Raintree 1987:4). It is a logical, stepwise, iterative and system-specific process consisting of five stages: prediagnostic, diagnostic, design and evaluation, planning, and implementation; offering flexibility, speed and replicability (Raintree 1987). Figure 3.1 illustrates the iterative nature of the diagnosis and design process. The diagnostic aspect fits in well with the RRA framework, minimising time usage for maximum results. The scope of this project had to be limited to the first four stages in the short term. These are (as described by Raintree 1987):

1) Prediagnostic stage: where objectives are finalised and choices made as to what geographical area to study and

methods to be used; and sources of information identified. The geographical area is mapped and land use systems described.

2) Diagnostic stage: utilising interviews, field observations and procedures to identify land use problems as well as causes, constraints and intervention points with the aim of compiling a list of specifications for appropriate interventions.

3) Design and Evaluation stage: where it is decided how to improve a current system. Alternatives for problem solving are considered through an iterative process in terms of: productivity, sustainability and adoptability as compared to existing systems. Candidate technologies are identified and suitable agroforestry systems designed. This stage incorporates an ex-ante evaluation and redesign component which is not conducted in this study - it requires a determination of the land user's response to the proposals made and a second post-introduction survey is necessary.

4) Planning: this is the final stage considered in this study as implementation falls beyond its scope. Here, research development and extension needs are outlined with a view to developing a plan of action regarding the spread and improvement of systems designed at the previous stage.



An example which illustrates the successful utilisation of Agroforestry Diagnosis and Design, and relates specifically to the ideology employed in this thesis, is a study conducted by the International Council for Research in Agroforestry (ICRAF) in the Machakos District in Kenya (Rocheleau, Wachira, Malaret and Wanjohi 1989). Here, a local farm survey was successful in discovering problems and suggesting points of intervention, but the information gathered was utilised initially in a way which proved not to be adoptable by local farmers on a significant scale. The data were used to design system packages for implementation without input from farmers at the design stage. Later, after consultation with farmers on the method used, successful agroforestry implementation was achieved by demonstrating practices and species (many of which were mentioned by farmers) from which farmers could 'mix-and-match'; and initiating discussions on the topic at community meetings. Such discussions brought to light indigenous responses to farming problems and possibilities for building onto these practices and enhancing their effectiveness. In this way information was exchanged among individual farmers. The fact that it was able to provide a base from which to launch into appropriate land-use investigations with local people demonstrates the success of the survey component for generating baseline data and contextual information on problems and potentials. Once again, the integration of indigenous technical knowledge and suggestions has been shown to be essential for successful development intervention. Also, as discussed earlier in this chapter, it is how the information gleaned from research is utilised which determines the success of any rural development initiatives. This point is substantiated by a project in Rwanda, where the successful identification of agroforestry interventions for local farmers using the Diagnosis and Design approach, relied on the iterative processes of re-evaluation and re-design with farmer participation (Pinners and Balasubramanian 1991). The Agroforestry Diagnosis and Design diagnostic survey guidelines have therefore proven themselves in the field to be capable of generating meaningful data and leading to successful agroforestry implementation through the Diagnosis and Design methodology, provided that participatory technology development is incorporated into its modus operandi.

Turning to the project at hand, the four stages of Agroforestry Diagnosis and Design as applied in this thesis will now be outlined. For the prediagnostic stage, due to an extensive survey of the Biyela project area completed in 1985 by Loxton, Venn and Associates, a mapping exercise proved unnecessary. Information was also available on physical, economic and demographic factors from this survey and a literature search was all that was required to obtain this information. The literature search included a number of visits to the Institute of Natural Resources of the University of Natal in Pietermaritzburg in November 1992. Because the project area chosen by the INR has arbitrary boundaries which do not correspond with enumerator sub-districts, the 1991 South African Census Data could not be utilised for demographic and socio-economic indicators. The most recent source of such information was, therefore, the survey conducted by Loxton, Venn and Associates in 1985. The 1991 census data was, however, used as an indicator of population growth in the study area since 1985.

The diagnostic stage forms the practical fieldwork aspect of the study. A questionnaire survey was conducted, personal observations noted and a photographic record compiled. Agroforestry trials introduced by the INR were visited. With the information obtained during these activities, opportunities for and constraints to problem-solving are identified, forming the basis for the design and evaluation stage. Within the design and evaluation stage, this thesis only suggests possibilities regarding suitable agroforestry and related technologies, and even then, breaks these down into components from which farmers can choose and with which they can experiment in different combinations. Finally, in the planning stage, strategies for system component introduction and development are discussed at local and national scales. These four stages therefore combine to allow the determination of farming problems within the study area, the discovery of local agroforestry initiatives and attitudes towards such practices, and the suggestion of suitable interventions and directions for future agroforestry development.

The Agroforestry Diagnosis and Design methodology meshes in well with the views put forward earlier in this chapter. It is systematic, time-efficient and utilises only that information necessary to design possible agroforestry solutions to rural problems (i.e. fairly-quick-and-fairly-clean (Chambers 1983)). Also, it is inter-disciplinary, utilises indigenous knowledge with rural people as the main source of information, and incorporates a process of iteration. Finally, as argued above, this methodology has the potential to support participatory technology development in rural areas.

Having outlined the methodology of Agroforestry Diagnosis and Design, attention is now drawn to the diagnostic survey itself as the vehicle utilised for obtaining social, economic and environmental information from local people and sharing ideas for improved farming systems. The questionnaire (Appendix A) will be described to show how each aspect of rural life is approached.

## 3.5 Questionnaire Description



The introductory portion of the questionnaire aims to describe the farming environment and any visible problems. The description is aided by the provision of space to sketch the relative positions of farm buildings, fields, crop stands and trees, as well as landscape morphology. Subsequent to this, the first series of questions begins and deals with land use history, seeking information on changes in land use form, practice and success since farming began on the area of land being investigated. This is followed by a section summarising land, labour, water, tree and livestock resources currently on the farm. Examples include questions on land area, use and terms of usage; the number of people working on the farm and degree of labour hire; water sources; location and use of trees; and the number and type of livestock. The section concludes with a question on the factors preventing an increase in farm production aimed at identifying suitable points of intervention.

The next section forms the major part of the questionnaire and identifies problems and their causes in farm production subsystems. Cash, savings/investment, food production, energy, shelter and raw material subsystems are each investigated in turn to elicit information on resource shortages and constraints to farm development. Problem checklists covering food production (crop and livestock) are provided to help the interviewer to construct a detailed picture of this aspect of farming life. The information gleaned from discussions covering issues concerned with farm production permits the isolation of major farming problems, their causes, and possible solutions.

The questionnaire then goes on to consider water and tree resources in more detail. Here, problems with water supply and quality, and potentials for improvement are outlined. Also, the role of trees in the farming environment is discussed. Most importantly, the attitude of the farmer towards the planting of trees or shrubs as a possible solution to certain on-farm problems is assessed at this stage.

In conclusion, each farmer's response towards agroforestry as a practice and its application to local conditions is noted. Finally, provision is made at the end of the questionnaire for a 'summary of indicative findings' (Raintree 1987) where potential agroforestry interventions are identified according to function, location, arrangement of components, management, suitable species, and scale of implementation. This succeeds in summarising the information gathered during the interview and relating it directly to agroforestry potentials.

The fieldwork procedure during which this methodology was put into practice is now outlined.

## 3.6 Fieldwork

The object of this exercise was to interview a broad cross-section of the community, male and female, of different ages. These respondents resided on a range of small, large, traditional and modern farms or homesteads. Surveyed farms were selected to include farms located on different aspects of the same slope, on steep or gradual slopes or level ground, and at different positions along a slope. Homesteads with and without trees visible in the farmscape; and those with large and small maize fields, were selected. Finally, the locations of surveyed homesteads varied from nearby to far from: rivers, roads, shops, boreholes, tanks and forests. One reason for the above was to identify possible differences in rural problems according to social, economic and ecological circumstances. Another was to ensure that the sample population was as representative of the wider study area population as possible. A discussion of the logistical aspects of the survey follows. It includes an outline of the process of investigation and the opportunities and constraints encountered.

The study area (KwaBiyela) has been divided into physiographic regions by Loxton, Venn and Associates (1985) and it was decided to use these to provide a framework for investigation and to sample from each to discover any regional differences. Respondents were chosen in the field according to the criteria mentioned above. In retrospect this turned out to be preferable to selection of homesteads from existing sources of information (e.g. a statistically random sample), as these were found to be very dated (1985) (understandable considering family out-migration, relocation and population increase), a fact borne out when trying to locate homesteads on aerial photographs from the 1985 survey, a frustrating and often fruitless exercise.



Maps of the project area (1:50 000, 2831CB Melmoth and 2831DA Nkwalini) were purchased and used as the main source of reference during the survey, in conjunction with aerial photographs. Accommodation for the one month (14 February to 14 March 1993) spent in the field was at the Nyala Game Ranch, about 30 kilometres from the Ndundulu Rural Service Centre. I would have liked to have stayed within the project area itself, but due to my inability to speak the Zulu language fluently, the prevailing state of violence in the area (witnessed during my stay), and the cost of having to purchase all supplies, this was not possible. A soon-to-be-completed visitors centre at the Ndundulu RSC with accommodation for researchers will alleviate such problems (Gavin Pote, Field Co-ordinator and Technical Facilitator of the Biyela Integrated Rural Development Project, pers. comm.). The Ndundulu Rural Service Centre is the headquarters of the Biyela Rural Development Project run by the Institute of Natural Resources (INR) and was the point of departure for each day's fieldwork. A meeting was held at the game ranch with Gavin Pote, Field Co-ordinator and Technical Facilitator for the Biyela Rural Development Project of the INR. The aims of the project were discussed and arrangements made to meet the interpreter and other INR staff with whom I would be working. These staff members were Roy Dandala, Rural Development Facilitator and Agrippa Zondi, Agroforester. The interpreter was chosen by Roy Dandala from the local community and was familiar with the project area. His name was Lieutenant Zweliyabuya Sibonakaliso Ntombela (Lieutenant being a name and not a rank) and he had recently finished his schooling. He was briefed by the INR staff.

To conduct research in the study area, the permission of two Zulu Chiefs was required: Chief G. Zulu and Chief N. Biyela. I was only informed of this on arrival at Ndundulu on 16 February. Chief Zulu's permission was granted on that same day. I had gone with Mr. Zondi to meet the Chief, we were introduced, the project explained, and I was welcomed wholeheartedly. It required four days, however, to secure permission from Chief Biyela (he was away at a meeting in Empangeni and the Indunas could not authorise permission on his behalf). During this period we were restricted in our survey by the Entembeni Tribal Authority boundary. This is, however, the most densely populated section of the project area.

A preliminary survey was conducted (in Ekutuleni, outside the study area) to test the questionnaire in the field before the main survey began. The results were studied and simple questions (e.g. why?) added where necessary to give more clarity and support to responses. Also at this stage, the sketch format (each farm was sketched) was finalised and interpreter prompting improved. Lieutenant (interpreter) was asked to translate the questionnaire (see Appendix B) and use the translation for interviews so that each question was asked in the same way every time; this was promptly done. Translation was required in all but one case where an interview was conducted in English.

Lieutenant was very careful to introduce us properly to each respondent, explaining the reason for our visit, that we were working with the INR and that we had the Chief's permission. This, combined with his shyness and respect towards local people helped, in most cases, to dispell any fear and suspicion towards us. In two cases I was suspected of being a policeman, while some women wanted their husbands to be present and one individual who was very suspicious of our motives, accused me of wanting to take his land. On the whole, however, people were very accommodating and identified with the aims of the project. On many occasions we were invited inside and given chairs to sit on, other times chairs were brought outside, and many people thanked us for our visit. The formula worked well and provided a prominent family member was home, we were usually able to proceed after some explanation.

Due to the heavily dissected nature of the terrain a 'park and walk' process was adopted. We drove as far as possible into an area and walked from there, interviewing at households at different positions on a slope and adjacent slopes, while keeping to a time limit and boundaries marked on the map (physiographic and project). An attempt was made to select a representative sample from each section of the study area by choosing homesteads on different topography, of different sizes and in different locations within each physiographic region. Figure 3.2 illustrates the distribution of surveyed households, while Figure 3.3 shows this distribution relative to the physiographic regions. Interview time, including walking, averaged out to between a half and one hour per household. Driving time varied from one to three hours return from Ndundulu Rural Service Centre.

**Figure 3.2** Distribution of Surveyed Households

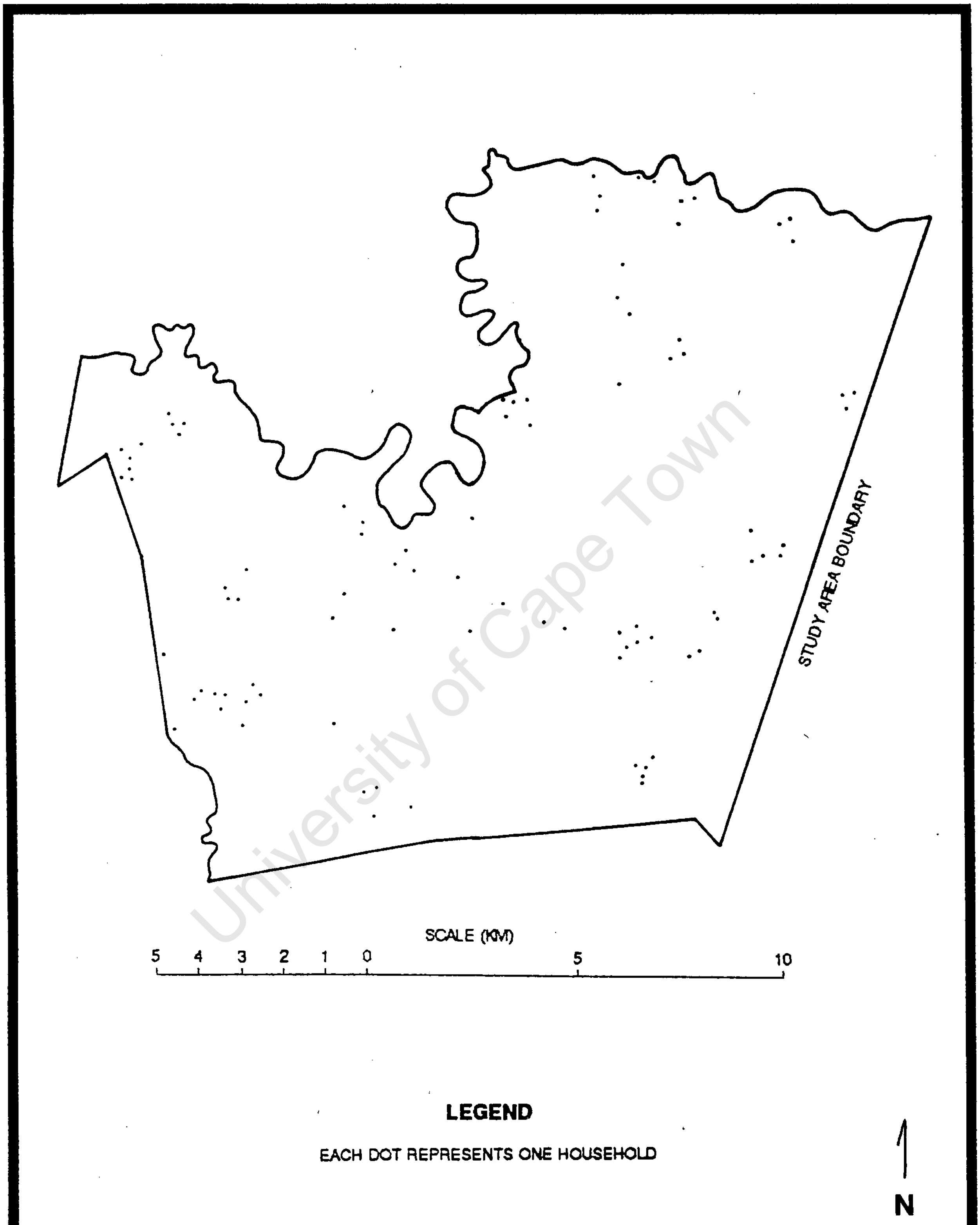
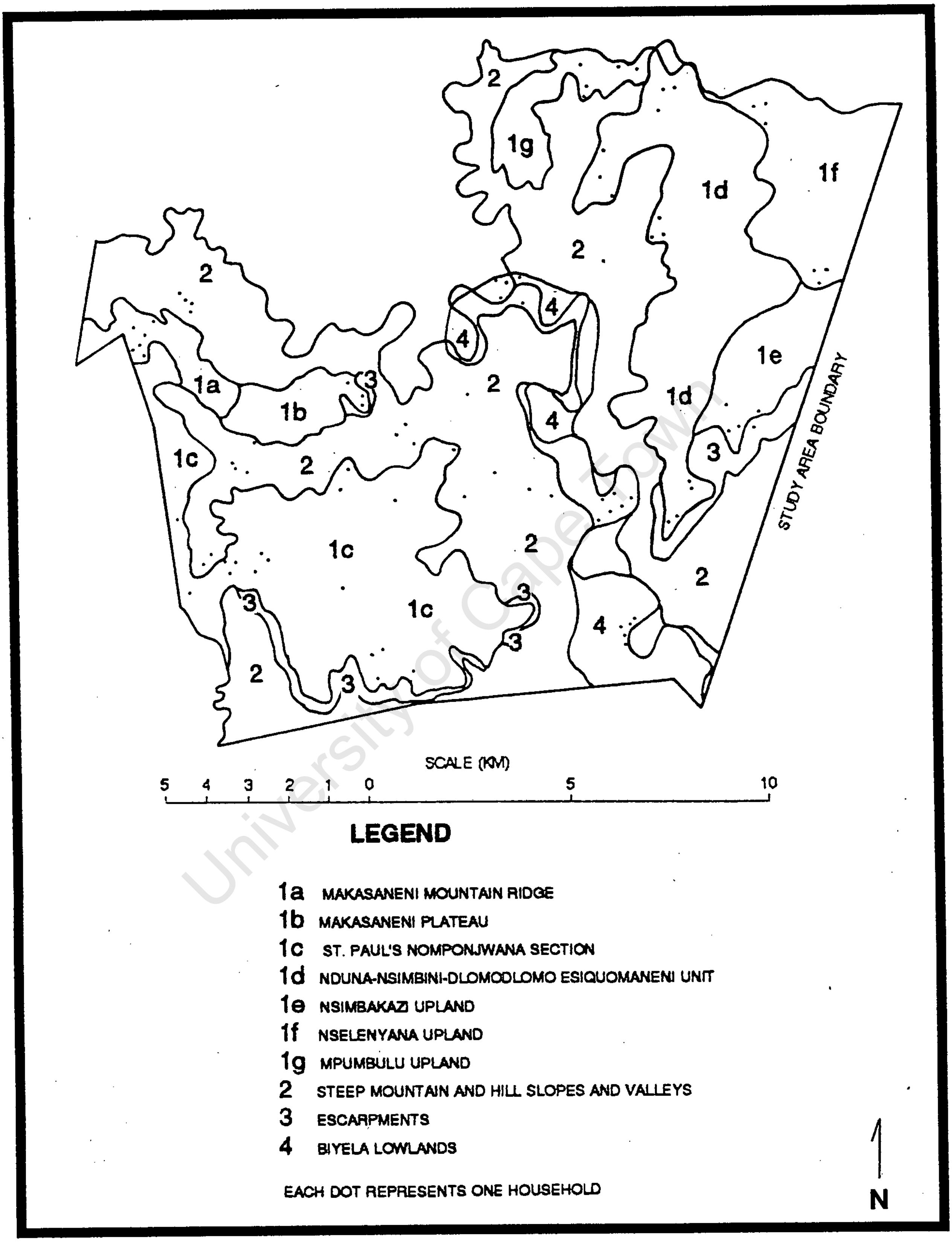


Figure 3.3 Distribution of Surveyed Households within the Physiographic Regions



Fieldwork was limited to 15 days by capital (and hence time) constraints as well as the fact that the interpreter was employed elsewhere on weekends. The process adhered to above effectively overcame some of the researcher biases outlined by Chambers (1983), including spatial, person, dry season and professional biases. Spatial biases refer to the tendency of 'outsiders' to visit urban rather than rural areas, areas served by tar and not gravel roads, and places close to the roadside. This survey was conducted in a rural area, utilising gravel roads, sand tracks and footpaths, and a concerted effort was made to reach homesteads far from the roadside. Person biases occur through concentrating on the elite rather than the poor, male rather than female, and users and adopters of interventions. For this project, people were interviewed who ranged from the relatively well-off to the poorest of the population, both male and female, with and without agroforestry, participating and not participating in trials and projects. Chambers' (1983) dry season bias is self-explanatory referring to researchers' preference for engaging in study during fair weather. Fieldwork for this thesis was timed during the wet season, at the hottest time of year, and many worst case situations were witnessed, including the effects of erosion (water and wind) and drought. Professional biases (i.e. those emanating from a concentration on only those aspects relevant to a researcher's academic background) were reduced by the use of a multidisciplinary approach. The choice of a well researched area was essential here, given the limits of the exercise. The target was five interviews per day, making a total of 80. We succeeded in surveying 90 households (excluding pilot) at an average of 6.4 per day.

The majority of the interviews were conducted with married women, but many interviewees were small family groups, married couples, mother and daughter groups, single males and females, brothers, pensioners, and in one instance a group of 18 people from one homestead consisting of four women and their children, all of which contributed to discussions, with a head speaker. The large number of married women respondents reflects the social structure of the project area where the majority of able-bodied men are employed in the formal economic sector and often remain in urban areas during the week, or even for weeks/months at a time. Also, the men usually look after the cattle, so those not employed elsewhere were often with the cattle in grazing lands far from the homestead. The task of tending the fields as well as most of the household chores falls squarely on the shoulders of the women of the community. It is therefore understandable that most of the people encountered in the fields adjacent to homesteads, at water sources, and at home, were women.

Problems encountered during the survey included: people not being home; people not cultivating; unwilling respondents; new arrivals and lodgers with little knowledge of particular farms; poor 'road' and track conditions (mud, rocks, sand, severe gradients, potholes, dust); extreme weather conditions and reckless bus drivers. It would have been useful to conduct interviews on weekends, when family members employed in the formal economic sector might have been present to contribute to discussions (only one respondent was a formal sector employee, on leave at the time), but as mentioned above, the interpreter was employed elsewhere on weekends. This fact only emerged after negotiations had been completed and some interviews conducted. The success of these interviews, however, weighed in favour of continuing with this interpreter rather than seeking another not employed at weekends.



The main logistical problems were connected with transport within the study area. 'Roads' and tracks were rough and often slippery, necessitating slow progress. Our vehicle lost traction up two steep inclines, one in Hlambanyati and the other in Makasaneni. This consumed valuable time, but provided opportunities for meeting the local people who assisted us. The climb over Makasaneni Ridge cut short our survey time at the edge of Makasaneni as a thunderstorm was brewing and we were warned by a local man of the impassability of the track when wet.

Visits to existing agroforestry projects with Agrippa Zondi (Agroforester for the INR) concluded the fieldwork for this thesis. These yielded valuable information as to the current state of agroforestry introduction in the project area, the difficulties experienced and the research being conducted.

A photographic record was compiled throughout the duration of the fieldwork. It has provided useful contextual information as well as opportunities for in-depth, post-survey, landscape, land use system and population distribution study, while recording examples of problems such as drought ravaged crops and soil erosion, as well as indigenous agroforestry technologies.

The utilisation of a survey format in practical fieldwork conditions exposes many issues not contemplated at the selection stage. An evaluation of the questionnaire used in this study follows, expounding the problems experienced and alterations which, in hindsight, might have improved the quality of the results.



## 3.7 Evaluation of the Diagnostic Survey Questionnaire

The questionnaire (Appendix A, Zulu translation: Appendix B) proved itself in the field to be well structured, following a logical sequence from one aspect of land management to the next. The open-ended questions allowed space for discussion around topics which yielded important additional information (e.g. attitudes to tree growing, costs related to fuelwood provision, indigenous crops). Only one question, that on off-farm tree resources, was inappropriate as the answer was always 'fuelwood' and this was covered in a separate section. The problem check-lists for crop and livestock production were invaluable in prompting each respondent to provide more information on his or her situation. Respondents' emphases on certain key problems were noted on each questionnaire.

One aspect of the questionnaire which could have been improved were the links between the sections. Although the sequence of questions is logical, the present layout allows one to move too easily from one section to the next (e.g. from the food subsystem to the energy subsystem) encountering new subjects without their being introduced. The blame here lies not with the survey guidelines, but with the researcher. They are, after all, only guidelines and how they are implemented is the choice of the researcher. In retrospect, one alteration might have been to ask the farmer about overall farm problems before engaging in discussions about the problems within each category, to maintain a link between categories and form a picture of problems, specifically, and how they are related (i.e. a tree-like approach starting with general problems and branching off into specific problems). This would separate discussion topics (e.g. causes of food production problems) from purely statistical aspects (e.g. fuelwood expenditures). Useful additions might be questions to elicit information on local perspectives on changes within the community over time, such as population dynamics, and general regional changes beyond the individual farm which have influenced farming life (for example, increased population concentration and the degree of influence of governmental and non-governmental organisations in the study area), all of which have major implications for agroforestry development. Although it has been possible to acquire knowledge on regional problems through analysis of individual responses, it would have been advantageous to hear the views of each respondent on the region as a whole and its problems for comparative analysis.

This questionnaire can be recommended for any survey seeking farmer-sourced information. To promote free discussion about farming issues, the questions may need to be adapted to the survey context (as stated by Raintree (1987)), taking into account the abovementioned factors which became apparent during the survey conducted for this thesis (the questionnaire did not, however, require any major modifications, and was almost directly transferable to the Kwazulu/Natal context). Although seemingly involved and lengthy, with some practice and teamwork (researcher and interpreter), even with the need for interpretation into Zulu, it demonstrated itself to be easy to use, progressive and flexible. The farmer could understand the questions and the researcher could understand the results with a minimum of tedium. Most importantly, the information gathered has proven to be directly relevant to the task at hand and of sufficient quality to permit integration with theory and encourage further investigation.

A discussion of the results of the questionnaire survey forms the chapter that follows.

# CHAPTER FOUR
# DIAGNOSTIC SURVEY RESULTS

The results of the diagnostic survey will be discussed following the structure of the questionnaire utilised. A sample questionnaire forms Appendix A (for a description see the previous chapter) and its Zulu translation as used during the survey comprises Appendix B. Each farm was sketched in the plan view, showing buildings and fields. Landscape features were also included (e.g. slope direction and angle, relation of farm to water sources, erosion gullies), and the relative locations of homesteads surveyed within certain areas (especially heavily dissected) were noted. The chapter concludes with five survey case studies.

## 4.1 Land Use History

As mentioned in the previous chapter, the first series of questions in the questionnaire deals with the type of land use practice and how it might have changed since the land was first farmed. Any change in the condition of the land over time is also noted. The aim is to set the scene for investigation through an exploration of farming experience in the study area.

It was found that most people have been farming the same land all their lives. Although land is distributed according to tribal law, the farmer regards allocated land as his/her own. The land right pattern differs from that found elsewhere in KwaZulu/Natal. In the study area, often only part of a land right is utilised for cultivation, the remainder forming part of community grazing land. Elsewhere in KwaZulu/Natal, the entire land right is utilised for cultivation (Loxton, Venn and Associates 1985). Four households visited during the survey did not cultivate any of their land. With the survey being concerned only with farmers, these were not included in the analysis. Cattle are not farmed in the normal sense, but accumulated as wealth. The survey carried out by Loxton, Venn and Associates in 1985 found 11 percent of farms in the Entembeni and Obuka Tribal Authority areas with uncultivated land. All families have grazing rights on communal land and no restrictions are placed on livestock ownership (Loxton, Venn and Associates 1985). This, combined with the status of cattle in the local population's socio-economic system, ensures that all members of the community strive for maximal cattle ownership. Consequently, overgrazing is commonplace within the study area and erosion scars bear evidence to this.

**Plate 4.1** Cultivation on a Steep Slope in Ndabazentshangu

Only dryland cropping is present on the farms surveyed and respondents stated that there have been no changes in its form or practice within living memory. Cultivation occurs on level land wherever possible, but the topography of the area and fixed location of land rights forces the majority of farmers to cultivate on slopes, some of these extremely steep (45 degrees and more) (see Plate 4.1). Maize is planted by all respondents. Other crops include: sorghum, ihlobo (ground nuts), peanuts, beans (e.g. izindlubu), sweet potatoes, amadombe (*Colocasia esculenta*, a tuber commonly known as 'taro' (Mr. K. Roux, Scientist, Kirstenbosch Botanical Gardens)), ibhece melons and pumpkins. Fruit trees are present on the majority of farms, often near the homestead and sometimes scattered in the fields or used as hedges (e.g. guava). These trees may be watered by hand if there is little rain and it is thus evident that they are highly valued. They include: orange, naartjie, mango, umDoni (*Syzigium cordatum*), marula, peach, avocado pear, banana, sweet-banana, and guava. Fruit trees are surviving particularly well under present circumstances (due, in part, to individual watering and deep rooting systems of older trees) and stand in stark contrast to dead or dying maize in exposed fields (sheltered, smaller fields are in better condition). Plate 4.2 illustrates the effects of drought, nutrient depletion and wind damage on an exposed maize crop.

**Plate 4.2** A Maize Crop Destroyed by Drought, Wind and a Shortage of Nutrient Inputs

In many cases, fruit trees were planted by now-deceased relatives. On one farm they are being cut down to make room for maize, while on another, banana trees are seen as a hindrance to farming and a haven for poisonous snakes. Where the current land owner/worker has planted the trees him/herself, they are well looked after (particularly peach trees). Windbreaks have been recently planted (gum, pine, pepper) by a small minority of farmers, but only on one homestead boundary.

The dryland cropping system practised in the project area is of the low input - low output type, the low input aspect being due to financial constraints (particularly cash for manure) and shortages of land or labour. The current infertility of the land is often the result of a history of low input. With time the land has become overutilised and deficient in nutrients. This is due, in part, to increasing population numbers and is a consequence of being hedged in by large white-owned commercial farms and/or steep topography with nowhere to expand except inwards. Simultaneously, the prohibitive cost of fertilizers prevents farmers from improving their land. Kraal manure is in short supply and often needs to be purchased (a possible result of cattle mortality from drought). Respondents' views coupled with personal observation suggest that continuous maize monocropping has taken its toll on the soil and a stage has been reached in the project area where considerable nutrient and labour inputs are required to maintain (let alone increase) the meagre yield obtained by farmers.

Many fields, especially those on valley floors and less-steep land, were reported by respondents to have been fertile in the past with little nutrient input being required to maintain yields. Only one farmer interviewed maintains that he has increased the fertility of his land*.

Wind- and water-related soil erosion on cleared land and dead crop stands has attacked the topsoil (see plate 4.3), exposing bedrock in some cases. A vicious cycle of events exists where low input results in low output, and this output is unable to sustain the surpluses required for investment in crop and animal production. The current drought conditions have exacerbated the problem, rendering households unable to provide for their basic nutritional needs, not to mention the surplus required for the purchase of farm inputs. 'Indigenous crops' (e.g. amadombe and izindlubu) have survived the ravages of drought better than the maize, which at the time of fieldwork was dead or dying in almost all areas (see Plate 4.4). In a 'normal' non-drought year, the situation would be much improved, but as will be shown later, regarding food production, anything up to the last seven years have been classified by farmers as 'bad years', suggesting that the above situation is not drought-specific.

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*This was verified by the obvious prosperity of his farm relative to others nearby. It is his major source of income as he sells the fruit produced. Current drought conditions, however, have severely reduced his output.

**Plate 4.3** Gully Erosion in Mkwakwini, Biyela Lowlands

**Plate 4.4** A Field of Amadombe in Mphemvu, Biyela Lowlands

The land use systems of the present will have to change in the future to accommodate the damage done by monocropping under marginal conditions, and by soil erosion on over-utilised land, if any hope of sustainability is to be realised. From questionnaire responses, it is possible to deduce that approximately 20 years ago is perceived by respondents to be the turning point regarding the above. Previous to this, if the 'good old days' syndrome can be dismissed, the land had reportedly been fertile and yields fairly consistent. Connections can be made here with demographic, socio-economic and environmental factors such as population growth (putting pressure on the land), migrant labour (removing much-needed farm labour inputs) and drought (imposing severe water and nutrient restrictions).

The section which follows deals with land, labour, water, tree, and livestock resources on the farm as well as the inputs required to increase farm production.

## 4.2 Farm Resources

### *4.2.1 Land*

Before discussing the results from this section of the questionnaire, it is necessary to clarify what is meant by the terms 'farm', 'family', 'other land', and 'individually-held' in the context of this study. A farm is defined as that part of the land allocated to the head of a household under tribal tenure on which the homestead is situated. 'Family' refers to all those residing at the homestead on a permanent or temporary basis, and 'other land' is the additional land 'owned' (under tribal tenure) by the household head which is not directly adjacent to the homestead. The term 'individually-held' should be taken to mean 'allocated under tribal tenure'. With these terms defined, their application within the discussion of the land resource is now considered.

Land holdings are scattered within the project area, with cultivation occurring on land ranging from extremely steep to absolutely level. Individual farm land area ranges from an estimated 0.04 hectares to 80 hectares with a mean of approximately 0.9 hectares (land area was estimated with farmers indicating boundaries). In all cases, this is said to be unable to provide sufficient food for the family under the present agricultural system (primarily maize monocropping). This is often not the result of land shortages. An extreme example is the approximately 180 hectares of individually-held land (80 ha adjacent to the homestead and 100 ha along the Mfule River held under tribal tenure), which at present cannot feed a family of eight adults and their children. There is said to be a food shortage every year, forcing purchases. The 100 ha field is at present unutilised, purportedly as a result of the lack of cash for inputs. It is also one hour away from the homestead and both land holdings suffer from a multitude of pests (insects and monkeys feed on maize, wild buck on peanuts). Another explanation could be a preference to buy food rather than attempting to grow it under drought conditions, the household receiving income from informal economic sector employment and a pension.

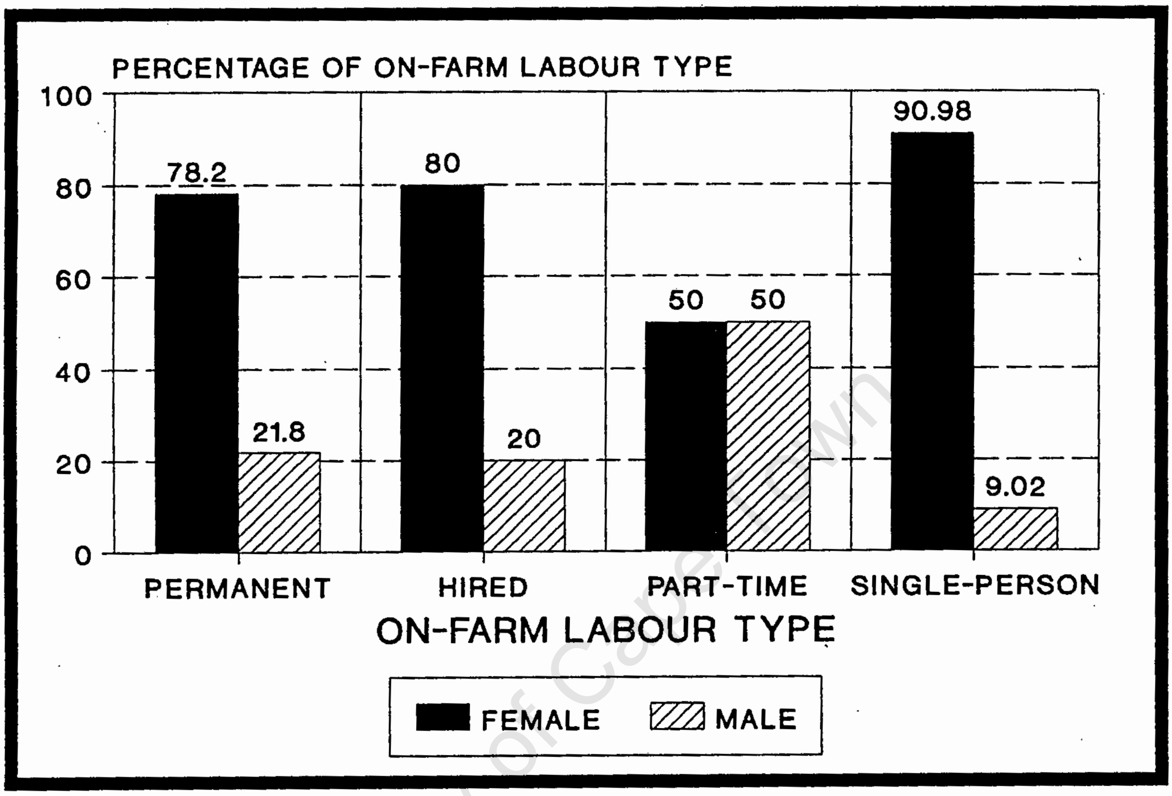
Large communal land areas are utilised for grazing, while small vegetable gardens occur on valley floors and along rivers. More than 43 percent of respondents had access to 'other land'. Of these, over 92 percent have individually-held land (tribal tenure), the remainder being communal. One respondent has access to a communal vegetable garden. This 'other land' is usually within one hour's walk from the homestead and never more than two hours away. Two respondents have access to four 'other fields', while one respondent has access to two 'other fields'. Two exceptions to the norm are: a respondent with individually-held grazing land of more than 25 hectares on nearby hills, and another with a very large individually-held (but presently unutilised) maize field of approximately 100 hectares near the Mfule River. A distinguishing feature of the Makasaneni section of the project area is the large number of small valley-floor vegetable gardens linked to homesteads on steep slopes.

Access to 'other land' has both advantages and disadvantages. Often, the 'other land' held by a family is more fertile and/or in a more favourable position (e.g. sheltered from wind, near water source) than that adjacent to the homestead. The disadvantage is that with, on average, two hours travelling time to and from the field/s, the farmer finds it difficult to tend all the land to which he/she has access. Where labour availability is limited and the family does not have the resources to hire labour, fields are neglected and their full potential never realised; a problem exacerbated when the crops planted require constant maintenance to keep pests and weeds at bay.

### *4.2.2 Labour*

The subject of labour comprises this section. It will be seen that the pattern of labour application is not conducive to increased or stable farm productivity under current economic and climatic conditions.

**Figure 4.1** On-Farm Labour Input by Gender




Survey results show that farm labour is mostly female with the males working in the cities and mines, sometimes returning on weekends to contribute part-time labour. Figure 4.1 compares female and male on-farm labour inputs. The genders are distinguished by different bar shadings, while the percentages refer to each on-farm labour type for surveyed households. The first three 'labour type' categories of the graph are mutually exclusive, but 'single-person' labour refers to farms worked by only one person full time, 25 percent of which receive hired or part-time labour inputs. The graph shows that permanent, hired and single-person on-farm labour inputs are primarily female, while part-time labour (i.e. the labour input of family members often away from the farm) is contributed by males and females on an equal basis. This reveals the gender structure of the resident farming population to be mostly female.

All but one of the farms surveyed are worked by females, 27 (30 percent) exclusively, while 14 farms (15.5 percent) utilise male part-time labour. Often, there is a shortage of labour for cultivation: in fact, over 12 percent of farms of varying sizes are worked by only one person full time (11 of the 12 percent are worked by females). The low labour availability is not compatible with the high labour requirements of monocropping with maize (for pest and weed control, and fertilizer application), and partly explains the high incidence of crop failure. Labour shortages were often expressed by farmers in terms of the extensiveness of a farm and the difficulties experienced in managing large areas of land.

Any strategy to increase farm productivity must take these factors into account. It must be aimed primarily at the female sector of the population and should be intensive, small-scale and near the homestead.

Those who can afford to hire labour for hoeing and weeding (11.1 percent) do so and 80 percent of the labour hired is female. Seventy percent of the farms hiring labour are less than two hectares in size (see Table 4.1 for the relationship between farm size and labour hire).

**Table 4.1** Farm Size vs Labour Hire

| FARM SIZE (HECTARES) | NUMBER OF RESPONDENTS HIRING LABOUR | PERCENTAGE OF RESPONDENTS HIRING LABOUR |
|---|---|---|
| 0 - 0.5 | 2 | 20 |
| 0.5 - 1 | 2 | 20 |
| 1 - 2 | 3 | 30 |
| 2 - 5 | 1 | 10 |
| 5 - 10 | 0 | 0 |
| >10 | 2 | 20 |

**Table 4.2** People per Hectare vs Labour Hire

| PEOPLE PER HECTARE | NUMBER OF RESPONDENTS HIRING LABOUR | PERCENTAGE OF RESPONDENTS HIRING LABOUR | RANGE IN NUMBER OF PEOPLE HIRED |
|---|---|---|---|
| 0 - 1 | 3 | 30 | 3 - 10 |
| 1 - 2 | 3 | 30 | 2 - 4 |
| 3 - 4 | 1 | 10 | 2 |
| 5 - 6 | 1 | 10 | 2 - 3 |
| 7 - 10 | 1 | 10 | 4 |
| >10 | 1 | 10 | 3 |



Labour hire is therefore not proportional to farm size. Rather, it can be attributed to the extent of cultivated land on the farm (not all land is utilised for cultivation) and the availability of family members to work the land. Table 4.2 supports the latter, by showing the reciprocal relationship between the number of people per hectare of farmland, the number of respondents hiring labour, and the number of people hired to work the land. Only two respondents hired tractors for ground preparation and another two hired oxen, both very costly in relation to other expenses. A trade-off between working the farm for food and buying food is therefore often apparent. A considerable portion of the day is spent on the land by the female population during the planting season and under present economic and climatic conditions the return is very low - a factor which does not encourage increased inputs during the growing season. It is also apparent that there is considerable inequality in labour input between the planting and growing seasons for various reasons - climatic (drought, wind), economic (e.g. shortage of capital for sustained inputs) and agronomic (i.e. a concentration on monocropping) - and young, growing crops often become overrun by weeds and pests, reducing or destroying potential yields.

### *4.2.3 Water*

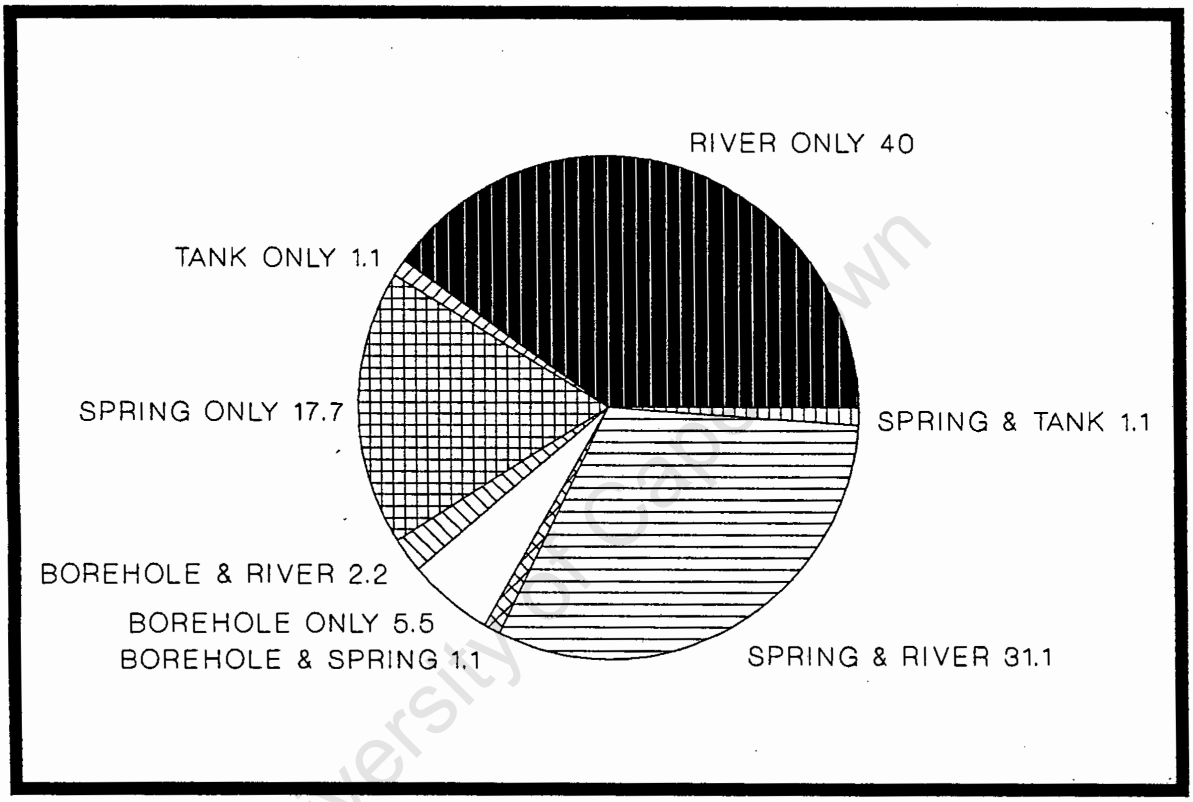
Water sources include springs, rivers, boreholes and tanks. Only 9 respondents (9.9 percent) have a water source on or adjoining the farm (5 springs, 4 rivers). Two respondents use tanks. One tank belongs to the neighbour of a respondent and both parties have organised with the (then) KwaZulu government for it to be filled by water van; the other is located at a central shop. The distribution of water sources is shown in Table 4.3.

**Table 4.3** Water Sources

| WATER SOURCE | NUMBER OF HOUSEHOLDS USING WATER SOURCE | PERCENTAGE OF HOUSEHOLDS USING WATER SOURCE | NUMBER OF HOUSEHOLDS USING WATER SOURCE EXCLUSIVELY | PERCENTAGE OF HOUSEHOLDS USING WATER SOURCE EXCLUSIVELY |
|---|---|---|---|---|
| SPRINGS | 46 | 51.1 | 14 | 15.5 |
| RIVERS | 66 | 73.3 | 36 | 40 |
| BOREHOLES | 8 | 8.8 | 5 | 5.5 |
| TANKS | 2 | 2.2 | 1 | 1.1 |

The people interviewed indicated no variation in the source of water with different seasons, suggesting that either the springs and streams utilised are perennial, or alternative sources do not exist within walking distance. Where there is a choice between a spring and river, in 92 percent of cases, people use the spring and livestock use the river. Figure 4.2 depicts the percentage of households surveyed using the various water sources and their combinations. Boreholes and tanks are utilised only by those living nearby, while the majority of those interviewed have to travel on foot to rivers and springs every day (see Plate 4.5).

**Figure 4.2** Percentage of Respondents Utilising the Different Water Sources




Respondents expressed the distance travelled to water sources in terms of the time required to reach them. For springs, this ranged from 30 minutes to five hours return, for rivers, 10 minutes to three hours return. In the latter cases it is clear that up to half a day is required for water collection which is almost always handled by women. This leaves only a few hours to recover from the trip, to purchase/harvest and prepare food, care for children, farm the land and construct dwellings. Although these activities are often delegated amongst household members, where numbers are low the impact of water collection on the quality of family life is severe.

**Plate 4.5** Mrs. N. Nxumalo Collecting Water from the Mfule River



### *4.2.4 Trees*

The number, type, location and uses of trees on each farm were discovered utilising the questions in the subsequent section of the questionnaire. Important information gleaned during discussions included tree species, site, and usage preferences, as well as the interrelationships between these factors. The questionnaire made provision for relating the use of trees to their relative locations, an essential consideration if agroforestry interventions are to be compatible with local practices.

All respondents have trees on their land, the number ranging from a single tree to forests (indigenous) and plantations (exotic) consisting of thousands of trees. Indigenous forests are left to grow on land not utilised for cropping, while some blocks of land on steep slopes are set aside for plantations with support from external agencies (e.g. Mondi Forests). Where individuals have planted trees themselves they have chosen boundaries (homestead, field, farm) and positions adjacent to dwellings (e.g. yard) as their favourite sites. A few trees are scattered in crop fields, but these are usually self-seeded. Trees on the farm are used for food, shade, fuel, windbreaks, live fences and building material. For a list of tree species and how they are utilised by the surveyed population, see Appendix C. Those for shade and fruit occur near the homestead and scattered in nearby fields. Windbreaks, live fences and trees harvested for building material occur on boundaries.

The major off-farm tree resource is fuelwood. The question relating to off-farm tree resources became irrelevant as it is covered later in the questionnaire by a section devoted specifically to aspects of fuelwood utilisation.



### *4.2.5 Livestock*

The types of livestock owned by those interviewed include: cattle, oxen, goats, donkeys, chickens, ducks and geese. Four respondents (4.4 percent) have no livestock. For a distribution of livestock ownership see Table 4.4.

pattern of the number of livestock owners is similar, while the number of goat owners and percentage of owners of chickens are identical. It is evident that, in comparison to 1985, more people currently own cattle, but in smaller numbers (possibly due to drought-related mortality and grazing shortages). This comparison highlights a worsening situation regarding the assets of local farmers, as well as emphasising the effects of resource depletion over the past decade (although possible sample error must be taken into account). Another explanation for the above could be the disappearance of the 'cattle culture' in the face of a modernising society and economy. Both these factors could be closely linked.

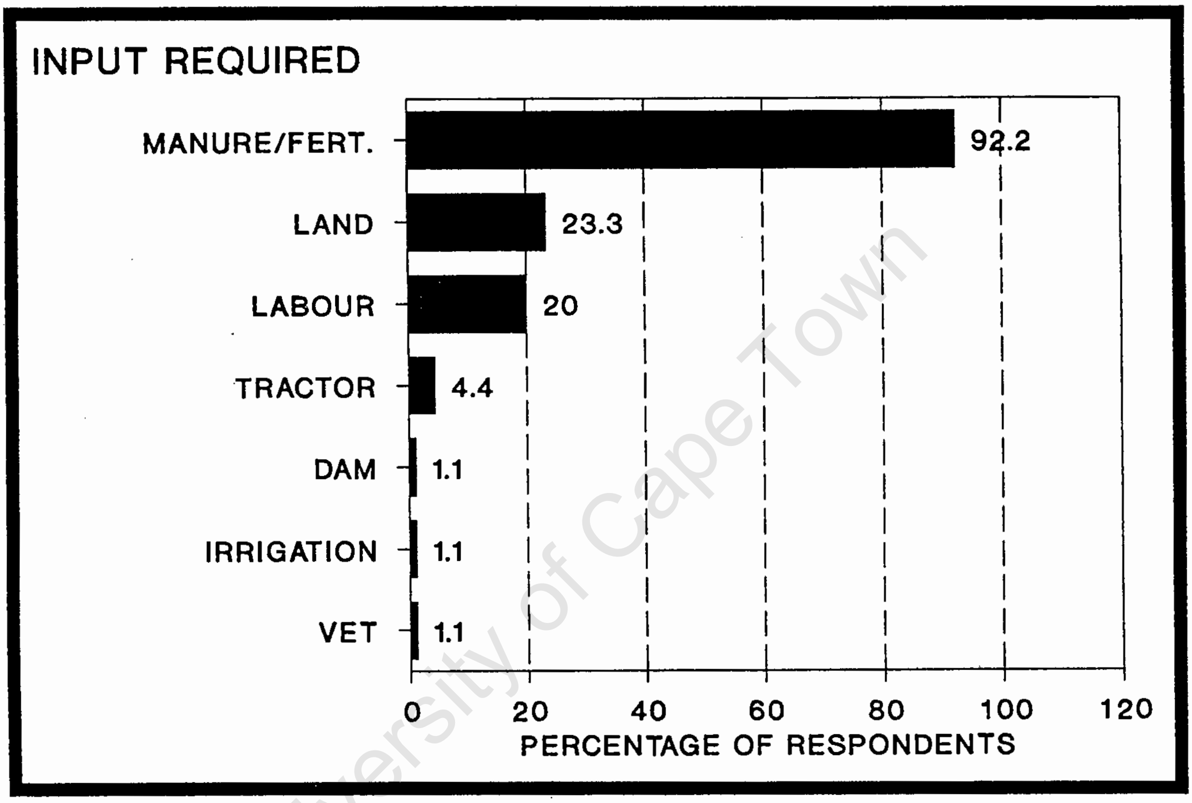
Cattle provide milk, are slaughtered for special occasions/ceremonies, utilised as bridewealth (lobola) and act as a form of investment. Only one respondent owns oxen (four) for ploughing. Table 4.6 shows that cattle ownership amongst respondents is concentrated between four and ten animals.

**Table 4.6** Cattle Ownership

| NUMBER OF CATTLE | NUMBER OF OWNERS | NUMBER OF OWNERS (PERCENTAGE) |
|---|---|---|
| 0 - 1 | 2 | 2.2 |
| 2 - 3 | 7 | 7.7 |
| 4 - 5 | 18 | 20 |
| 6 - 10 | 28 | 31.1 |
| 11 - 20 | 11 | 12.2 |
| 21 - 30 | 2 | 2.2 |
| TOTAL 522 | 67 | 74.4 |

Goats are also a form of investment, and are slaughtered during ceremonies. Almost all respondents own chickens and these form the primary source of meat and eggs (i.e. protein) for family consumption. A minority of farmers have geese or ducks and both are kept for investment. Three respondents (3.3 percent) own ing, the farmer was prompted with: 'land, labour, cash?' Answers were given more substance by asking the respondent about shortages of land and labour, and the reasons for the cash requirement where applicable. Figure 4.4 compares the stated requirements for increased farm production.

**Figure 4.4** Requirements for Increased Farm Production






From the responses received it is clear that the most serious barrier to increased farm production is a shortage of nutrient inputs; the shortage of cash to buy manure or fertilisers being emphasised by 83 of the 90 respondents (92.2 percent). The next most cited hindrance was a shortage of land, followed closely by a shortage of cash for hiring labour. Other limiting factors were: cash for tractor hire, cash for building a dam, and cash for an irrigation system. It is obvious that either the income received from the farm, informal and formal economic sector employment is inadequate to improve production, or that the income from other activities is adequate and there is little incentive to increase production. Development interventions must therefore seek to increase income-earning opportunities wherever possible and investigate methods for increasing farm production which are not capital-intensive. One interviewee mentioned the inadequate veterinary services - a vet visits only once a year. The overwhelming majority of farmers interviewed therefore have a shortage of cash for farm inputs.

The manure input that is available may be dried and used in place of fuelwood where the latter is scarce or expensive. As alluded to earlier, current farming practices are unable to provide the necessary inputs for sustained/increased production, with little or no nutrient recycling occurring. A concentration on maize monocropping on the same land season after season has led to a sharp decrease in available nutrients and the inability of the land to sustain further outputs. The situation can only deteriorate with the present shortage of the capital required for nutrient inputs to support monocropping.

## 4.3 Farm Production Subsystems

Forming the greater part of the questionnaire, this section delves into the cash, savings/investment, food, energy, shelter, and raw material farm production subsystems. An effort was made to expose constraints and opportunities in each subsystem through consultation with farmers. The discussion begins with the cash subsystem.

### *4.3.1 Cash Subsystem*

Here, cash expenditure and income are discussed and the position of households within the local economy determined. Farmers were required to answer questions such as: 'What are your main expenses?' and also had to characterise the 'role and adequacy of cash income in the household economy' (Raintree 1987). In analysing the results, it was deemed necessary to distinguish between formal and informal economic sector employment. Since permanent residents are engaged almost exclusively in informal sector employment (see below), opportunities and constraints in this area deserve greater attention from development practitioners. A discussion of survey results now follows.

The main cash expenditure is staple food (particularly maize and beans, planted by all those interviewed) which is followed by school fees. This is true for each household surveyed. All but two of the households visited have some children at school and school fees are expensive when taken collectively. For example, one household has nine children (belonging to four people) at school and the annual fees are R160 per child. Other expenditures mentioned include: building materials, seedlings, manure, clothing, cattle, and hiring tractors and oxen.

The failure of current farming practices to supply even sufficient staple foodstuffs is again apparent from the results above. A major portion of a family's income is directed towards purchasing the very products which subsistence farming methods are expected to provide (i.e. staple foods such as maize). Although it may be argued that all farmers strive to produce something to sell, current conditions preclude almost all respondents from participation in the produce market. The survey conducted by Loxton, Venn and Associates in 1985 found incomes derived from agriculture to be insignificant, and with very few exceptions, that is still the case.

The primary source of cash for the household is formal sector employment with just over 61 percent of households receiving income from this source. Of these households, over 94 percent receive formal sector income from male family members, while the equivalent figure for female family members barely exceeds three percent (see Table 4.7). Two respondents' families own 'tea rooms' (general supply stores). Formal sector employment occurs in cities and towns sometimes considerable distances from the homestead. Responses included: security companies (Empangeni), Escom (Empangeni), steel works (Richards Bay and Johannesburg), sugar mills (Tongaat), the timber industry (Enseleni and Johannesburg), shipping (Richards Bay), Spoornet (Durban, Richards Bay, Empangeni), brick works (Durban), painting (Durban), manufacturing (Durban), the Natal Provincial Administration (Durban), shops (Eshowe), butcheries (Johannesburg) and mines (Johannesburg). One respondent works locally in the cane fields. Female formal sector employment takes the form of school inspectors, teachers, 'tea ladies' and shop attendants, both locally and in urban centres. Formal sector employment is the major cause of migrant labour which has a significant effect on the remaining population. Table 4.7 shows that over 93 percent of absentees (i.e. those receiving urban-sourced income) are male, a marked increase since the survey conducted by Loxton, Venn and Associates in 1985. Loxton, Venn and Associates (1985) found 75 percent of absentees to be male, 63 percent of the permanently resident population to be below 20 years of age, and 86 percent of absentees to belong to the 20 - 59 year age group. The permanently resident population is therefore mainly female and either relatively young (under 20 years of age) or 60 years of age and beyond. It is this resident population that is engaged almost exclusively in informal economic sector employment.

**Table 4.7** Comparison of Female and Male Sources of Income

| SOURCE OF INCOME | PERCENTAGE OF HOUSEHOLDS RECEIVING RURAL-SOURCED INCOME | PERCENTAGE OF HOUSEHOLDS RECEIVING URBAN-SOURCED INCOME | PERCENTAGE OF HOUSEHOLDS ENGAGED IN INFORMAL ECONOMIC SECTOR EMPLOYMENT | PERCENTAGE OF HOUSEHOLDS ENGAGED IN FORMAL ECONOMIC SECTOR EMPLOYMENT |
|---|---|---|---|---|
| FEMALE | 16.6 | 3.3 | 17.7 | 3.4 |
| (PERCENTAGE OF EACH CATEGORY) | (51.7) | (6.7) | (61.5) | (5.6) |
| MALE | 15.5 | 46.6 | 11.1 | 57.7 |
| (PERCENTAGE OF EACH CATEGORY) | (48.3) | (93.3) | (38.5) | (94.4) |

A significant proportion of the households (25.5 percent) earn income from informal sector employment. This is always household-based and includes: selling mats, brooms, farm produce, goats, cattle, biscuits and building poles; working for local people on a temporary basis; brewing beer; buying and selling second hand clothes; hiring out a tractor; and herbal medicine. Those who work for the local population are employed in the fields (hoeing and weeding) and for construction of farm buildings. One enterprising respondent chops umThomboti (*Spirostachys africana*) poles from the indigenous forest and sells them to the locals for building; he expressed an interest in cultivating these trees, but complained of a lack of knowledge in this regard. Goats or cattle are usually sold only if there is no other source of cash. Informal sector employment is dominated by women (see Table 4.7) and is often the most direct and regular contributor to the household economy with the male sector of the population sometimes absent from the homestead for long periods. It must be remembered that informal economic sector employees are the same people tending the farmland and homestead and this holds important implications for development planning.

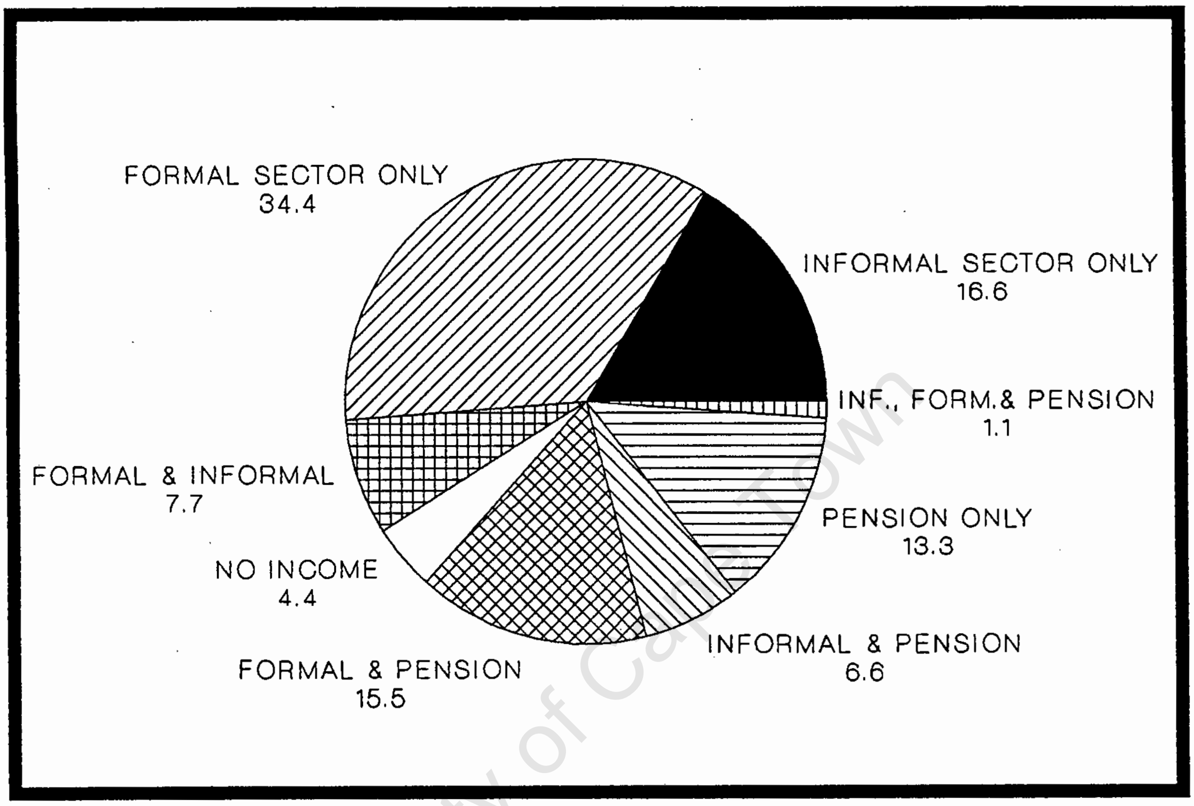
Table 4.8 shows that more households receive urban-sourced than rural-sourced income. This illustrates the high level of urban dependency of the local population, and the need for the promotion of local agricultural initiatives and agribusiness development in the study area.

**Table 4.8** Comparison of Rural and Urban Sources of Income

| SOURCE OF INCOME | NUMBER OF HOUSEHOLDS | PERCENTAGE OF HOUSEHOLDS |
|---|---|---|
| RURAL | 34 | 37.7 |
| URBAN | 44 | 48.8 |

Four respondents (4.4 percent) have no income and are presently living on the life savings of retired family members, while 11 respondents (12.2 percent) live on old-age pension alone and one lives only on a sickness fund/pension received after undergoing a medical operation. Figure 4.5 provides a summary of the sources of income among survey respondents.

**Figure 4.5** Percentage of Respondents Receiving Income from Different Sources






None of the households feels that they have enough cash to meet their needs and food is the most difficult expenditure to meet, followed by school fees.

In 80 cases (88.8 percent), the role and adequacy of cash income in the household economy can be characterised as follows: cash income is low and mainly used to meet subsistence needs. A small number of respondents (4.4 percent) have a low income in addition to savings, and an even smaller number (2.2 percent) own luxury goods such as a radio/tape player. Only one household has a cash income which is adequate to maintain a higher than average standard of living for the area with sufficient left over for saving or investment; the head of this household owns a 'tea room'. The other 'tea room' owner had a very large family to support and so characterised cash income (even if higher than average) as 'low and used to meet subsistence needs'.

The current drought has had a significant negative impact on cash crop production and those who have relied on this source of income in the past have been left with no income. A shortage of suitable reeds (especially 'incema' (*Juncus kraussii*)) exists and is a limiting factor in mat and broom production. Often, a market exists, but insufficient raw materials inhibit the employment of local people in money-earning activities. Where there is a lack of customers, transport problems (cost, road conditions, distance) prevent the distribution of goods for sale elsewhere. From cash, the focus now falls on savings/investment.

### *4.3.2 Savings/Investment Enterprises*

Savings and investment are direct indicators of a community's reserves and ability to see themselves through difficult periods (e.g. droughts, production shortfalls, unforeseen expenses). A look into this farm production subsystem shows that the people surveyed have very little to protect themselves from the risk inherent in any farming enterprise.

Of the 90 respondents, eight (8.8 percent) have savings, seven at banks and one at the post office. Livestock such as goats, cattle, ducks and geese are all utilised for savings/investment. Goats are most important here and fetch about R200 each. Cattle are only sold out of necessity and are rather accumulated for investment and social obligations. A few of the households surveyed have Mondi-owned plantations as investments (long term). The household pays towards their establishment and receive income when they are felled. One respondent was optimistic that the return would be more than double the investment of R2000.

A number of problems prevent the formation of stable and appreciating savings/investment enterprises. The low wages received by those employed as unskilled labour in the formal economic sector do not permit capital accumulation, and often very little of what is earned in the city actually reaches the rural homestead, with a substantial proportion going towards supporting the migrant worker in the city. The drought is causing great reductions in accumulated livestock wealth. Private plantations are being sabotaged (burnt) and in at least one case the authorities (forestry) have neglected to return with advice on plantation establishment promised to the farmer, drastically reducing the quality and volume of his yield.

Having discussed savings/investment enterprises, attention is now drawn towards the food production subsystem. The inability of local farming methods to provide for the nutritional needs of project area inhabitants under current conditions will become apparent after an analysis of questionnaire responses.

### *4.3.3 Food Production Subsystem*

A mere 2.2 percent of households surveyed usually succeed in producing nearly all of their staple food requirements, while the overwhelming majority (93.3 percent) would like to do so, but often fail in this regard. Farm-produced food is regarded only as a supplement in four cases (4.4 percent). Here, income generation for cash food purchases is the main aim.

Over half of those interviewed (58.8 percent) maintained that shortages of farm-produced food occur every year, with 40 percent mentioning shortages only in 'bad years'. The reported frequency of 'bad years' varies greatly and includes: often; the last two, three, four, five or seven years; six out of ten; three out of ten; two out of ten; two out of five; and three out of five years. One household has a shortage 'in most years'. There is a degree of overlap between possible answers within question number 24 (i.e. do shortages of farm-produced food occur: a) only in bad years, b) in most years, or c) every year? (Raintree 1987:62)), especially where 'bad years' are regarded as the last five to seven years and 'six out of ten years' - both of these could be termed 'most years'. The fact is, however, that shortages of farm-produced food are experienced at some time by all the households at which interviews were conducted, forcing cash purchases with low and decreasing income as potential contributors to household economies move out to start lives in the city, returning infrequently (if at all) to act as part-time farm labour.

Shortages of all foods occur, particularly maize and beans (staples), with almost no seasonal pattern - they occur all the time. Current drought conditions have resulted in extremely poor yields and have thus reduced any seasonal effects (i.e. shortages of all staple foods occur even when they are in season, even though more food is available post-harvest). Also, mechanisms to cope with seasonality (e.g. storage of maize) are ineffectual in the study area as a result of the previous season's low yield. This fact was made clear by the empty grain storage huts evidenced throughout the survey. No 'famine foods' are utilised (or people do not want to admit to consuming wild foods for fear of being ridiculed or associated with wild animals - as one woman said: 'there are wild fruits, but I am not a monkey') and people buy food when harvests are inadequate. External famine relief is needed, but only one respondent has received such relief in the past (Red Cross). Another respondent mentioned that the government had distributed food aid (maize meal) in the past, but because of the large number of needy people, it had not reached them.

The causes of food production problems experienced in the project area are many and varied with all sections of the problem checklist for crop production enterprises being relevant. Resource constraints include: shortages of land, labour and cash for inputs. Farm management problems include: soil erosion (sheet, gully, rill, slump), weeds (particularly *Xanthium spinosum* (indicated by farmers, pers. observation)), diseases, insect pests (locusts, ladybirds, caterpillars) and other pests such as moles. Constraints on plant growth occur in the form of:

inadequate seasonal rainfall, poor infiltration of rainfall, high temperature stress, wind desiccation and damage, inherently low fertility of soils, lack of nutrient return or input, and poor soil workability. Rainfall during the maize growing season is unreliable, particularly in the lowlands. The relative variability of rainfall ranges from 35 percent in December to 55 percent in March (Loxton, Venn and Associates 1985). The crop production problem checklist ends with the subject of marketing problems for cash crops. This question might be more appropriate in the cash subsystem section where issues of income could be better explored. In concluding the problem checklist, it was found that where cash crops are grown, they are not transported, but sold directly from the farm to local people, with no shortage of customers. The most serious problems experienced by farmers are wind damage and desiccation, heat stress, soil erosion, poor soil fertility, and drought.

Further investigation into the causes of shortages of farm-produced food reveals that a complex interplay of factors is responsible. Initially, it was supposed that there might be a direct correlation between the number of people per hectare of an individual household's farm land and food supply problems, given that all respondents are affected by drought to a similar degree. This, however, was not the case. For example, repondents from farms with the equivalent of over ten people per hectare claimed to experience shortages only in 'bad years' (up to a maximum of three out of the last ten years), while others with the equivalent of less than one person per hectare reported having shortages every year.

Attention was then focused on the sources of income (for a possible connection with the purchase of farm inputs) and specifically those of farms experiencing food shortages only in 'bad years' (i.e. the exceptions to the rule). The data in this respect did not differ significantly from the total survey sample. For example, of the farms experiencing shortages of farm-produced food only in 'bad years', 33.3 percent receive income exclusively from the formal sector employment, 11.1 percent from pension only, and 8.3 percent from a combination of informal employment and pensions. The figures for the total survey sample are 34.4 percent, 13.3 percent and 6.66 percent respectively.

It was only when an attempt was made to look at possible combinations of these data sets that patterns began to emerge. There is a definite relationship between the number of people per hectare, combined sources of permanent income, and shortages of farm-produced food. Many farms with a low number of people per hectare and irregular income or income from pension only, have food shortages only in 'bad years'. The same can be said for farms with a high number of people per hectare and permanent income from two sources (see Table 4.9 for relationship between farm size, source of income, and food shortages).

**Table 4.9** Farm-Produced Food Shortages

| RELATIVE FARM SIZE, PEOPLE PER HECTARE | SOURCE OF INCOME | FOOD SHORTAGE EVERY YEAR (%) | FOOD SHORTAGE IN MOST YEARS (MORE THAN 3/10) (%) | FOOD SHORTAGE IN BAD YEARS (UP TO 3/10) (%) |
|---|---|---|---|---|
| LARGE, 0-5 | no income | 0 | 0 | 0 |
| | irregular, informal | 5.5 | 0 | 0 |
| | irregular, formal | 3.3 | 1.1 | 2.2 |
| | informal | 1.1 | 0 | 2.2 |
| | formal | 10 | 3.3 | 3.3 |
| | pension only | 3.3 | 1.1 | 3.3 |
| | formal and pension | 4.4 | 0 | 4.4 |
| | informal and pension | 3.3 | 0 | 1.1 |
| | informal, formal and pension | 1.1 | 0 | 0 |
| | formal and informal | 0 | 0 | 4.4 |
| MEDIUM, 5.1-10 | no income | 0 | 0 | 0 |
| | irregular, informal | 2.2 | 0 | 1.1 |
| | irregular, formal | 0 | 0 | 0 |
| | informal | 1.1 | 0 | 0 |
| | formal | 4.4 | 0 | 2.2 |
| | pension only | 1.1 | 0 | 0 |
| | formal and pension | 2.2 | 2.2 | 0 |
| | informal and pension | 0 | 0 | 0 |
| | informal, formal and pension | 0 | 0 | 0 |
| | formal and informal | 0 | 0 | 0 |
| SMALL, >10 | no income | 4.4 | 0 | 0 |
| | irregular, informal | 1.1 | 1.1 | 0 |
| | irregular, formal | 0 | 0 | 1.1 |
| | informal | 0 | 0 | 0 |
| | formal | 4.4 | 0 | 1.1 |
| | pension only | 2.2 | 1.1 | 1.1 |
| | formal and pension | 1.1 | 0 | 2.2 |
| | informal and pension | 0 | 0 | 1.1 |
| | informal, formal and pension | 0 | 0 | 0 |
| | formal and informal | 2.2 | 0 | 0 |
| TOTAL | | 58.8 | 10 | 31.1 |

The pattern that emerged, then, was that a low number of people per hectare combined with low/irregular income resulted in a food shortage in 'bad years', a high number of people per hectare and regular income resulted in a food shortage in 'bad years', and a high number of people per hectare and low/irregular income resulted in a food shortage every year (see Table 4.9). Examples of the above are: a farm with an equivalent 0.2 people per hectare and income exclusively from a pension which has shortages of farm-produced food for two out of ten years; a farm with an equivalent 30 people per hectare and an income exclusively from a pension which has had a food shortage for the last five years; and a farm with an equivalent 70 people per hectare and income from permanent formal sector employment as well as a pension which has had farm-produced food shortages over the last two years. The farm with the highest equivalent number of people per hectare (375) (i.e. 15 people and 0.04 hectares of individually-held land) receives income from temporary informal sector and temporary formal sector employment, and has a food shortage every year. Even though this example is supportive of the above trend, factors such as a threshold number of people per hectare above which sustainable on-farm food supply is not possible could be explored here. Such factors may have an influence over and above the sources of income. Also, cash expenditures such as food and school fees should be considered.

Although the above correlation was true for the majority of the farms surveyed, there were still many exceptions and other causal factors had to be sought. To obtain further clues as to the reasons behind shortages of farm-produced food, it was decided to include in the equation the factors mentioned by farmers as most limiting to farm production, such as cash for farm inputs (especially manure) and shortages of land and labour. The labour shortage is particularly important in view of the high labour requirements of maize monocropping and the distance to the household's 'other land'. Viewing the number of people per hectare in a different light, two issues emerge. Firstly, with a very high number of people per hectare, there may be insufficient land for adequate food production; and secondly with a very low number of people per hectare, there may be insufficient labour input to secure yields (incorporated in this is ground preparation, pest control, time of planting, and area planted). An example of the latter is a farm with an equivalent 0.58 people per hectare, worked by only one female household member full time, with a shortage of farm-produced food every year. These are precisely the problems that agroforestry attempts to address. As stated in an earlier chapter, agroforestry has the potential to maximise returns to the scarce factor of production, through savings in capital, land and labour inputs.

These land and labour shortages in the project area are offset by income, livestock ownership and access to good quality grazing land. Secure income from the formal sector (although it was not possible to gauge the proportion of the wage/salary package actually reaching the household) increases the standard of living of respondents and affords the ability to purchase farm inputs (with a surplus for school fees and other expenses). Consequently, a high number of people per hectare can be supported in most years (Table 4.9). Also, the households surveyed with relatively high incomes often prefer to buy rather than grow the family's staple food requirements, and purchases make up for shortfalls in on-farm food production. The relationship between income and land cultivation is therefore complex. On the one hand, cash income is essential to purchase farm inputs for monocropping, while on the other, such income may be sufficient to buy food. In the latter case, farm-produced food no longer determines food security. The tendency towards purchasing staple foods would seem to explain why some relatively high income families have shortages of farm-produced food every year - such shortages may be voluntarily imposed (i.e. through a shift to purchasing staples), and not imposed by a lack of funds for farm inputs.

Access to good quality grazing land also plays a role. Those respondents with such access are able to keep more/healthier livestock (a source of wealth) and livestock in good condition are not as susceptible to drought and disease as those surviving on degraded pasture. Livestock ownership and access to good grazing land are therefore able to offset low crop production, with goats and cattle being sold in times of need.

Demographic pressure on the land should not be viewed solely in terms of the number of people per hectare, but rather in terms of all the resources available per unit of land (e.g. plant cover, soil nutrients, fuelwood availability), and how these resources have been managed. A farm with a low number of people per hectare may still come under demographic pressure if the land is utilised in an unsustainable manner and/or available resources are inherently few or severely depleted. The local and temporal influences on the balance between people and their environment remains poorly researched, in spite of its importance, and it is often assumed that only large numbers of people exert pressure on natural resources. For example, an environment utilised in an unsustainable manner over a long period of time, irrespective of the number of its occupants, will become resource-poor, and large numbers of people are not required to exert pressure on such an environment. Two people living on one hectare of land can, within a few years, exert severe pressure on this land through unsustainable resource utilisation, diminishing their chances of producing sufficient food.

It has been shown, therefore, that the number of people per hectare on a farm can have an influence on both land and labour availability. Concurrently, the type and security of employment may override the influence of the number of people per hectare to different degrees, while determining the ability of the farmer to maintain or increase his or her food production through contributions from other family members (cash for manure being the most frequently cited barrier to increased crop production). Also shown here was the fact that relatively high income may have a negative effect on food production. Added to this, the number of people per hectare of farm land influences the pressure on resources with the subsequent damage to the ecological and social environments only partially ameliorated by income and ingenuity. If a threshold number of people per hectare is exceeded, the land may become degraded to such an extent that vast investment in terms of both capital and labour is required to restore productivity. Access to a permanent source of income is critical in such cases if support from external agencies (e.g. NGOs) is not available. Underlying all these aspects is the environmental context of the farm itself, with influences on farm productivity such as soil type and nutrient status, rainfall availability, slope, ground cover, ambient temperature, and proximity to water sources.

With all these factors brought to light by the investigation into food supply problems, it has become clear that no single factor can explain shortages of farm-produced food. Once again, as discussed in the chapter on sustainable rural development and agroforestry, the importance of considering social, economic and ecological aspects in problem identification and solution must be emphasised. Looking individually at the number of people per hectare, sources of income, and labour, it is obvious that each in isolation is unable to explain food supply. Combinations of factors are the key to this explanation. As seen above, these data sets interact with other factors in a complex set of relations which recommends to the researcher that each case or household be investigated separately, rather than forced into an overall set or trend. An idea of the factors influencing all the farms in this survey was only possible by looking at the exceptions to the intuitive rule (e.g. why did the number of people per hectare not explain food shortages in all cases). For sustainable development to become a reality in the study area, such interrelationships and cross-tabulations are a necessity and generalisation should be avoided at all costs. Moving on from crop production, livestock production is now considered.

There is no variation in livestock feeding practices; all households studied graze their cattle on open land with the natural grazing consisting of both sweet and sour grasses. Large areas of Ngongoni grass (*Aristida junciformis*) (sour, and of poor nutritional value) are utilised for grazing. Goats are either allowed to roam freely or are tethered to a tree, around which the ground becomes denuded of all growth (as does the tree). There is a shortage of maize for chicken feed.

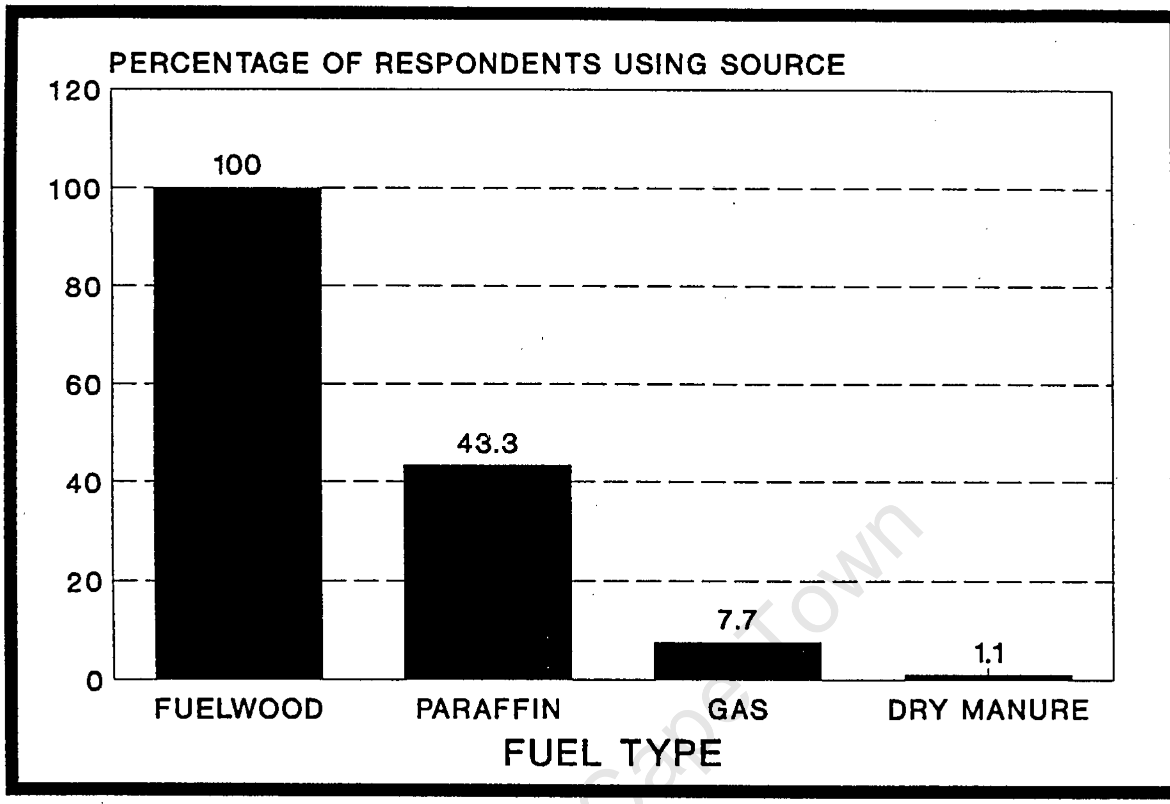
The problem checklist for livestock production enterprises was very useful here, and like that utilised for crops, it highlighted numerous problems. Symptoms of poor production are: the low rate of liveweight gain, seasonal weight loss (during winter), low milk production and high mortality from diseases (particularly black-quarter and heart-water). Resource constraints mentioned are the lack of grazing land and the poor nutritional quality of feed material. Other livestock management factors are: lack of shade, inadequate veterinary services (once a year), degradation of grazing land and soil erosion (gully, sheet, rill, slump).

Symptoms of overgrazing are in evidence everywhere, with denuded areas falling victim to degradation by wind and water. Deep erosion scars are visible throughout the study area, especially on steep slopes, but also on level areas adjacent to hillslopes (presumably, the speed of runoff from slopes increases the chances of erosion on nearby overgrazed land). There are no problems with marketing livestock where this is essential. Again, it was found during the survey that marketing questions could be more appropriately included in the cash subsystem for comparative analysis. Issues surrounding the energy subsystem are dealt with in the section which follows.

#### *4.3.4 Energy Subsystem*

With the lack of electrical power provision in the study area, all cooking and heating is done utilising fuelwood, paraffin and gas. Figure 4.6 compares the fuel sources utilised by survey respondents.

Figure 4.6 Fuel Sources




All households surveyed use fuelwood, 53.3 percent exclusively. It is used in conjunction with paraffin, gas and dry manure to various degrees by the other 46.7 percent of respondents. For example, 36.6 percent of households interviewed use fuelwood and paraffin, the latter used in a 'primus stove' when 'time is short' (e.g. morning tea). Only one respondent used mostly paraffin. Gas is the most expensive fuel and is consequently limited to very few households (7.7 percent).

Twenty respondents (22.2 percent) buy fuelwood and 14 (15.5 percent) have enough on the farm, usually in the form of indigenous forest trees. The amount of money spent on fuelwood per year by the 20 respondents who buy it ranges from R31 to R1680 and is governed by source, availability and transport problems. An example is a respondent who buys fuelwood from farms near Melmoth when he has a shortage on the farm. The cost is R140 for a medium-sized 'bakkie' load which can last up to six months. Resources are sometimes pooled to hire a truck for household fuelwood deliveries. Paraffin costs approximately R1 per litre and gas approximately R45 to refill a twenty-litre cylinder.

Fuelwood is collected from indigenous forests (some communal, others held by individuals under tribal tenure, and one on a private white-owned farm), distances to the source ranging from one to nine hours return walk with an average of three to five hours. One interviewee hires a tractor for R100 and drives it the eight hours to the forest to collect wood which lasts approximately one and a half months. Two respondents collect wood from a forest on private land and face being arrested if caught. Other sources of fuelwood are commercial plantations outside the study area (e.g. at Langgewacht Farm near Makasaneni) where permits are required for collection.

The cost of purchased fuel, diminishing fuelwood supplies and the time required for fuelwood collection are the main problems experienced by households in supplying their fuel needs. One farmer cautioned that the replacement of forests with sugar cane on a large scale is depleting the fuelwood resource. Over one third of respondents (36.6 percent) mentioned a fuelwood shortage and 17.7 percent anticipate future problems in meeting fuel needs.

Planting of trees for fuel is very rare in the project area and only one respondent has done this (gum trees). Reasons cited by others for not planting fuelwood trees are: lack of knowledge on indigenous tree cultivation (particularly uGagane (*Dichrostachys cinerea*) and *Acacia* species), shortage of cash for seedlings, and lack of space for trees. Great potential exists in the study area for the planting of hardy fuelwood species on farm boundaries. These could fulfil a double function, acting simultaneously as windbreaks, a subject investigated in the next section.

### *4.3.5 Shelter Subsystem*

This farm production subsystem encompasses: building, fencing, shade and wind shelter. The questions in the questionnaire under this heading enquire as to the present state of these factors, tree species utilised in their provision, and the degree of wind damage. Farmers' suggestions were sought in all questions.

Most households (74.4 percent) buy all the wood they need for building. It is expensive, there is often a shortage, and transport is very costly. Sources of building poles for the study area include: Melmoth, Nkwenkwe, individuals with indigenous forest on their land, and nearby farms (plantations). Twenty households (22.2 percent) utilise indigenous forests, one exclusively, the favoured species being umThomboti (*Spirostachys africana*) which produces relatively straight poles (but has a gum which irritates the skin and can cause blindness, and so needs to be 'fixed' by fire before felling can commence), uGagane (*Dichrostachys cinerea*), umKhaya (*Acacia nigriscens*) and umNgqumo (*Olea africana*). Others use a combination, usually indigenous for walls, fences and kraals (strong, resistant to pests and rot), and gum for roofing frames (uniformly straight). Plate 4.6 shows a dwelling under construction with umThomboti upright poles, umNqumo filler sections and gum roofing poles. The walls are being packed with stones and plastered with mud.

Plate 4.6 Dwelling under Construction

The degree of fencing on farms varies from complete to non-existent. The complete farm is fenced in only 11 percent of cases, while 37.7 percent have complete fences around homesteads, fields or gardens. Over 43 percent of farms have no fencing around homesteads or fields. *Dichrostachys cinerea*, a species also utilised as fuelwood, provides the uprights for most of the fencing and with close spacing forms complete kraal walls (uprights only). Materials combined with this indigenous wood are: thorn-laden twigs, wire, barbed-wire, and coiled razor-wire. Live fences also occur with hedges being popular. One respondent used sisal (*Agave sisalana*) as part of a fence. Not all fencing requirements are currently being met, with many respondents hoping to complete fences or repair damaged/fallen fencing when resources permit.

Respondents on 61 farms (67.7 percent) felt they lacked sufficient shade trees, the shortage occurring most severely around the homestead (i.e. for people), with a few interviewees mentioning a shortage for livestock. This shortage is highlighted by the fact that 15.5 percent of homesteads studied have no shade trees at all. Most people prefer fruit trees such as the Orange, Naartjie, Mango, umDoni (*Syzigium cordatum*), Marula, Peach, and Avocado Pear, but other choices include the Pine and Wattle (for their additional building potential), umSilinga (*Melia azedarach*), and a large number of indigenous forest species (see list in Appendix C).

Wind damage is considered a problem by 83 respondents (92.2 percent). Wind destroys maize, desiccates crops and blows the roofs off dwellings. Many of those interviewed do not think that wind can be prevented in any way, but 14 (15.5 percent) have tried to plant windbreaks; three of these tried pine or gum which later died. Other windbreaks are comprised of umSilinga (*Melia azedarach*), umSinsi (*Erythrina lysistemon*), umThomboti (*Spirostachys africana*), uBoquo (*Barringtonia racemosa*), *Bougainvillaea spp.*, and the pepper tree, *Schinus molle.* It is clear that many more windbreaks are required in the study area and their establishment should be a priority for local development initiatives. The discussion now turns towards the raw materials subsystem.



### *4.3.6 Raw Materials Subsystem*

Under this heading, the consumption of raw materials and their supply problems are outlined. The subject is divided into two sections: cottage industries requiring plant materials, and on-farm production for social obligations.

Cottage industries include: the manufacture of mats, brooms, beer spoons and containers (for which 'incema' reeds (*Juncus kraussii*) are utilised); biscuit baking; and the shredding and drying of sisal for thatching. As mentioned under the cash subsystem heading, there are shortages of raw materials for cottage industries and these act as severe constraints to income generation in the informal economic sector (the most direct contributor to the household economy). This factor deserves serious consideration by development practitioners if the local economy is to be boosted.

Regarding production for social obligations, almost all respondents buy gifts when required, with only two giving produce from the fields and two giving no gifts at all. Cattle are used for bridewealth (lobola).

The next section deals in more detail with water and tree resources. Water supply problems are considered and the farmers' response to the inclusion of trees on the farm as a possible solution to certain problems or method of increasing production is discussed. The section ends with the response gained from questions pertaining specifically to agroforestry.

### *4.3.7 Other Resource Management Practices, Needs and Potentials*

The first resource considered under this heading is water. Watersheds are more often than not overgrazed and/or eroded (see Plate 4.7). Gully, sheet, slump and rill erosion are common, particularly on steep slopes, but also on gentle slopes leading to major rivers (most noticeably along frequently used water-collection routes). Potential solutions may include hedge and bund establishment in eroded areas and the demarcation of footpaths parallel to and crossing slope contours.

**Plate 4.7** Erosion in the Nhlube River Catchment

Over 83 percent of households surveyed reported a year-round water shortage, with just under nine percent experiencing a seasonal shortage (mostly from boreholes) in winter. This is true for both human and animal components of the farming system. A mere seven households (7.7 percent) have enough clean water (five springs, one river, one borehole). The shortage is particularly severe in the Mfule River valley where there are no boreholes or springs and the river is low. Other rivers reportedly producing insufficient water for human consumption during the time of the survey include the Nhlube and Ntonto Rivers, where alternative sources are not available. One respondent blamed the *Eucalyptus* plantation on the crest of a hill opposite his homestead for drying up the nearby stream.

Attention is now given to the tree resource. As evidenced from questionnaire responses, trees are often not seen as possible solutions to farm problems (especially wind damage or soil erosion), or for that matter as being able to develop the potential of the farm. Many respondents after being prompted agree, however, that trees can solve some problems. Possibilities raised through discussion with farmers were wind prevention and the provision of fruit and shade. Reasons for not planting trees are the same as those cited earlier in the interview: shortage of cash for seedlings, shortage of seed, lack of knowledge on how to plant trees, shortage of space, and previous unsuccessful attempts. One simple reason for not liking indigenous trees is a lack of knowledge on how to grow them, especially *Acacia* species, where many people maintain that they have 'never seen any seed'. Trees with dense foliage are disliked because they harbour snakes, and at least one person is scared to visit the nearby indigenous forest for this reason.

The final subject examined under this heading is agroforestry in general. The respondents were asked here whether they knew anything about mixing crops and trees and/or livestock to improve yields, what they thought of the idea, and if they would be interested in a demonstration.

Only four respondents are currently practising agroforestry (as defined in this thesis). The first one encountered was a banana/maize and banana/amadombe system on a steep slope in Ndabazentshangu (see Case Study 1 later in this chapter). The reason for the existence of this system was explained in terms of the necessity to clear an area around banana trees to ensure survival, the respondent explained: 'if there wasn't maize around the banana, I would be too lazy to clear around the trees, this way I am forced to clear when the maize is harvested'. A second agroforestry system in the same area (but on a valley floor) was planted with advice from Mr. S.K. Dube (KwaZulu Department of Agriculture) and consists of oranges, brinjal, amadombe ('better by itself'), beetroot, and maize ('better in agroforestry'). This system is surviving well, but prone to waterlogging. A farmer near St. Paul's Mission is mixing bananas and maize. He belongs to a local farmers' organisation named Inthuthuko and was told about agroforestry at one of their conferences. The same man has mixed maize and sugar cane and will be trying mixed cropping with amadombe and beans. He also has an impressive pepper tree windbreak. In Qubuka, a banana/maize system is managed by an elderly couple who stated that the maize yields better between bananas and the bananas prevent wind damage. One woman in the Nomponjwana area used to mix bananas and maize, but stopped for lack of time, saying that she will do so in the future and maintaining that she 'gets the best maize that way' and that it is her own idea. Another farmer, this time in the Nhlube area, used to mix bananas and maize, but stopped for the same reason - lack of time. He mentioned that maize does better with the bananas.

Four respondents have seen agroforestry demonstrations (two at Nkwalini, one at Nhlangwini, one at Bhonkolo Reserve) and like the idea.

A very positive response to agroforestry ideas was received, with 75.5 percent of respondents interested in a demonstration for reasons of space saving, simultaneous production of a number of fruits and vegetables, wood provision, soil improvement, green manure supply, fodder provision and improving the general health of the farm. It must be emphasised that these are reasons cited by the farmers themselves after asking them why they are interested in tree/crop/livestock combinations. One young female respondent stated that it was 'common knowledge' that mixing trees and crops improves the productivity of the soil with the tree leaves having a fertilising effect, but she did not know how to implement such a system. When asked why those in favour of agroforestry had not yet adopted the practice, the response highlighted a lack of experience with mixing trees and crops/livestock, and the expense incurred in agroforestry establishment. The competitive aspect of trees (shade, water, roots) is the primary reason why seven respondents (7.7 percent) do not think mixing trees and crops and/or livestock is viable and are not interested in the idea. A further five farmers (5.5

percent) do not think agroforestry will succeed because of the intense heat, water shortage and soil properties on farms. One farmer was concerned about space for a tractor during ploughing. All these problems could be minimised or overcome through careful selection of tree/shrub species, tree/crop/livestock combinations, layouts, and management procedures.

An agroforestry introduction/management problem emerged during an interview in Nozika (near Ndabazentshangu). Mr. Dube from the Kwazulu Department of Agriculture was supposed to have sent someone to take a soil sample from a respondent's farm after the respondent was told that the soil was not suited to the trees which were to be planted, but no-one came. Besides the lack of farmer support, this case highlights the fact that agroforestry facilitators are choosing tree species first, and subsequently looking for suitable planting sites. To increase the chances of successful agroforestry introduction, each site (including its ecological, social and economic context) should instead be taken as a separate case and used as the starting point (i.e. choose species suited to individual sites, not sites suited to predetermined species).

While analysing those respondents practising agroforestry and comparing them to the rest of the survey sample, one clear correlation emerged. All those who practise agroforestry have farms much larger than the mean size of 0.9 hectares. In fact, an estimated farm size of 25 hectares is common to three of the four cases, the fourth being approximately five hectares in size. This supports the widely held view among farmers that agroforestry requires large land areas, and hints at an unwillingness on the part of respondents to give up land allocated to maize production for agroforestry. The risk factor is too great in the farmers' eyes, and for this reason agroforestry demonstrations are essential if its practice is to be considered as a viable option by farmers at all. As Erskine (1989) and Arnold (1987 in Cook and Grut 1989) suggest, where there is a land shortage and this land is required to produce food, the avoidance of periodical risk takes a back seat to immediate food production and the introduction of long-term tree crops may not be appropriate. Erskine (1989) adds that agroforestry can help those who receive the major portion of their income from off-farm employment, to maintain land unsuitable for crop production or grazing (e.g. steep slopes). To this can be added, farmers with a land surplus (due to a labour shortage), as potential agroforestry adopters.

Looking at the drought situation in the study area with its attendant meagre crop yields, it can be argued that the potential for agroforestry introduction (using drought-resistant species) exists even on small farms. On small farms, it may be possible to introduce boundary plantings which occupy a minimum of space, the land given over to such plantings being otherwise unproductive. In the long-term view, respondents' classification of 'bad years' (60 percent of respondents reported food shortages for more than three out of ten years) would justify the relatively long maturation period of trees/shrubs as compared to that of annual crops, particularly if sustainable production is to be a goal of rural development in KwaBiyela.

The space aspect must be weighed up in terms of large areas of unproductive land with no woody plant component versus small areas of productive land with a woody plant component. In fact, if trees and crops are mixed, there is a saving of space compared to the existing separation of these components (space is used more efficiently) and the 'lack of space' (individually-held land area as opposed to overall space) answer is partly the result of a shortage of information available to farmers on the subject of agroforestry.

## 4.4 Summary of Indicative Findings

This aspect of the survey will be discussed in more detail in a separate chapter dealing with recommendations for agroforestry introduction in the study area. The general ideas that will apply here as they relate to the functions, locations, arrangements, management, component species, and scale of agroforestry interventions are outlined below.

The functions of agroforestry components should include the provision of food, fodder, green manure, fuelwood, and building material; soil improvement; wind and erosion control; and fencing.

Suitable locations for these components are near the homestead, and homestead and field boundaries.

Possible component arrangements include: living fences, wind-breaks, home gardens, microcatchments, dispersed trees in crop and grazing land, contour strips, alley cropping, and gully stabilisers.

Agroforestry components may require management inputs such as the protection of seedlings from livestock, weeding, selective watering where possible, harvesting, lopping, pollarding, and root/branch pruning.

Component species including indigenous fuelwood, fruit, fodder, shade and medicinal trees; exotic fruit and shade trees; and indigenous and exotic vegetables require further investigation as possible agroforestry components.

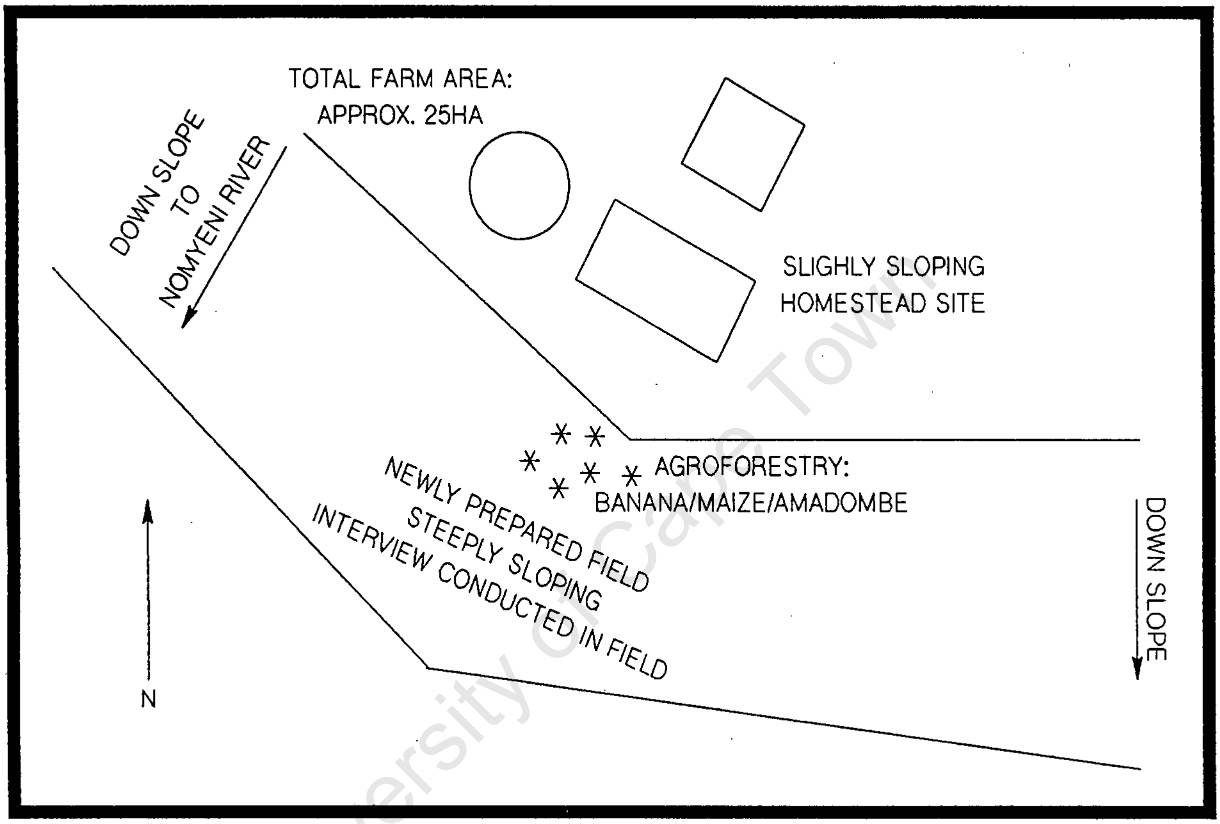
The scale of initial agroforestry component introduction should be small, occur at the homestead/single field level, and be farm-specific.

In order to integrate the above results at farm level and provide a more complete picture of life in KwaBiyela, five case studies, taken from the survey, are now considered.

## 4.5 Case Studies

### *4.5.1 Farm with Agroforestry Component, Biyela Uplands. Steep Mountain and Hill Slopes and Valleys Physiographic Region.*

**Figure 4.7** Plan View of Farm Layout




This farm in Ndabazentshangu is 'owned' (tribal tenure) by Elizabeth Zulu. The homestead, which consists of three buildings (two modern oblong, one traditional rondavel) on a hilltop, is located on gently sloping land, while cultivation takes place on the adjacent steep slopes. The Nomyeni River flows along the base of the two cultivated slopes which each have a different orientation forming a wide 'V' shape. Maize, bananas and amadombe are grown in association. Two women were hoeing the steeply sloping land and the interview was conducted with Elizabeth Zulu in a freshly-prepared field. She is one of the four respondents who practise agroforestry.

**Plate 4.8** Elizabeth Zulu's Farm with an Agroforestry Component, Biyela Uplands

The family has been cultivating this portion of land since before living memory. Dryland agriculture has been practised throughout this period with little change. The farm is large (approximately 25 hectares) and the family has access to no 'other land'. Only two female family members work the farm full time with no part-time workers and no labour being hired. An equivalent of 0.16 people per hectare live on the farm.

The Nomyeni River is the sole water source and is located on the farm boundary. Although the watershed is eroded, the water is clean and the supply adequate for household needs, according to the respondent. Trees are scattered throughout the farm. An indigenous agroforestry system is in operation on the sloping land and consists of maize and amadombe planted between banana trees (see Plate 4.9). The reason for this mix of species cited by the respondent was the necessity for clearing around the base of the banana trees, the hoeing of the ground and harvesting of maize forcing her to undertake this chore for which she would otherwise be 'too lazy'. Crop residues fertilise the banana trees. Mango and naartjie trees have been planted on the homestead boundaries, while avocado, guava and peach trees occur on the slope down to the river, mostly on field boundaries. To increase production the farm requires more labour and cash for manure.

**Plate 4.9** The Farm's Agroforestry Component

Building materials, food and school fees are the main household expenditures. There are two sources of income: a pension, and biscuits baked by the respondent and sold by her children at school. One problem encountered by the respondent with the latter is a lack of a market for the biscuits, another is intimidation of the small children by older schoolchildren who force them to hand over the biscuits without remuneration. Biscuit baking is the only cottage industry. Cash income is low and no luxury goods are owned. When gifts are required for special occasions, pumpkins are harvested from the fields or beer is brewed. Savings/investment enterprises are non-existent.

Elizabeth Zulu reported that the household has experienced shortages in farm-produced food for the past four years. Maize, beans, pumpkins, amadombe and sweet potatoes are affected and food is bought when shortages occur. The causes of crop production problems identified by the respondent include: shortage of labour, implements and cash for inputs; soil erosion (sheet and rill); pests such as locusts, beetles (especially on tomatoes) and moles (affecting sweet potatoes); inadequate rainfall and poor infiltration of rainfall; high temperatures; wind desiccation and damage; and infertile soil. Chickens are the only type of livestock owned by the respondent. They are fed on maize, but there is a shortage of feed and they do not breed well.

Moving to energy supply, the only source of energy for the household is fuelwood. Fuel sources are gum and wattle trees, the wood being collected from a neighbour's farm two hours away. Fuelwood costs R1 for a pile which lasts three days. It is deemed expensive and there is no shortage at the source. The respondent does not anticipate any future problems regarding farm fuel supply (except for possible price increases). When asked why the household had not planted any fuelwood trees, the reply was 'a lack of cash for seedlings'.

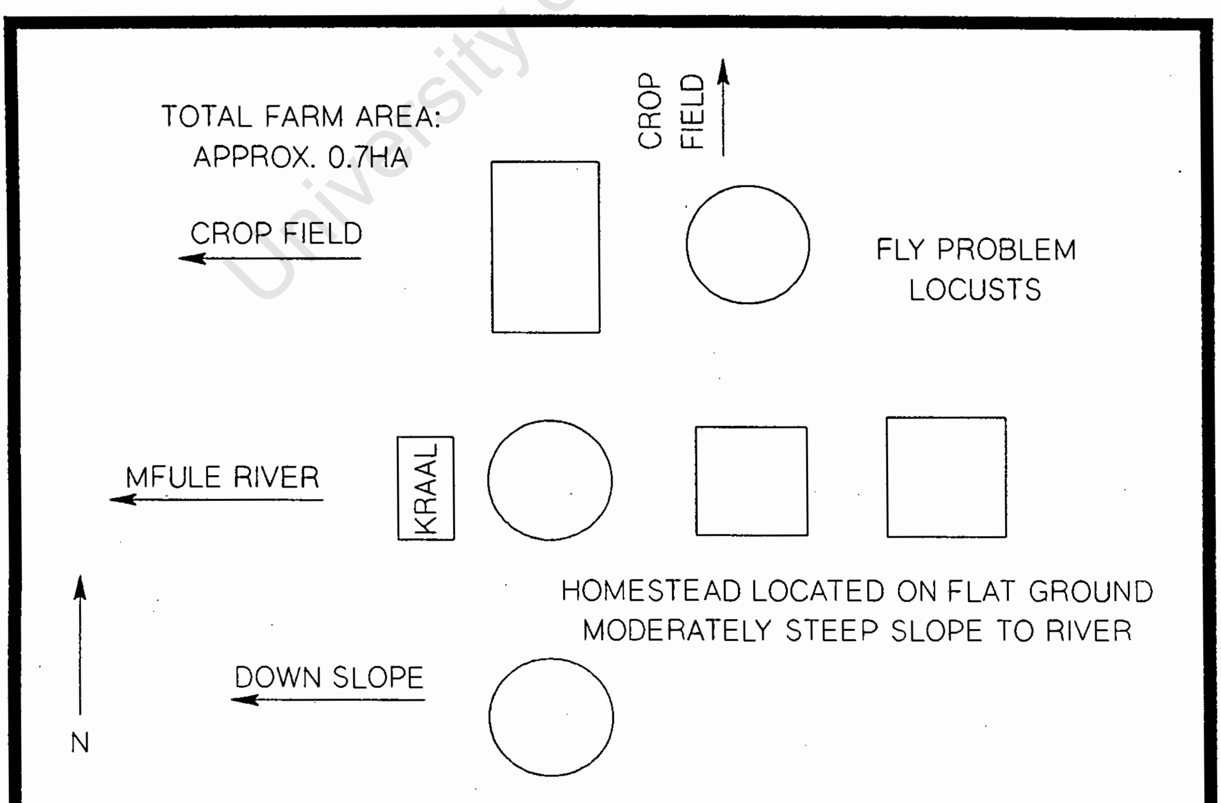
Building poles are bought from a neighbour at R1.50 per pole. A shortage sometimes occurs. The trip (on foot) to collect poles takes four hours return. There are no fences on the farm. Shade trees have not been planted and the respondent would like wattle trees for this purpose (one reason cited was that they could also provide building poles). Indigenous species are not liked as they 'cause the soil to be infertile' (this refers to non-leguminous species). Wind desiccates the crops and blows the fruits off trees. No windbreaks have been planted.

The respondent does not think that wind can be prevented on her farm as it is located on a slope (homestead on hilltop), but is interested in tree planting to reduce soil erosion. Elizabeth Zulu prefers the agroforestry part of her farm as 'it produces more fruits and vegetables at the same time' and no extra labour is required.

This is therefore an example of a farm with a large land area, but a severe labour shortage which limits production. Agroforestry is preferred in place of monocropping, but occurs on a small scale, being limited by a shortage of cash for seedlings and farming implements. The lack of vegetative cover on steep, exposed crop fields is the cause of much soil erosion. As is typical of the Biyela Uplands, wind damage and desiccation are major problems requiring immediate solution.

#### *4.5.2 Farm in Biyela Lowlands Physiographic Region.*

**Figure 4.8** Plan View of Farm Layout



Situated in Mphemvu on a rise overlooking a bend in the Mfule River, this farm is 'owned' by Kheti Mkhize. The homestead is located on a slight to moderate slope and consists of six buildings (three oblong, three rondavels) with a kraal in front. Maize is planted in two fields, one on the steepest land below the homestead and one alongside the homestead on flat ground.

**Plate 4.10** Kheti Mkhize's Farm in the Biyela Lowlands

Dryland cropping concentrating on maize has been practised on this land since before living memory and no changes were reported to have occurred. The respondent mentioned that the land has steadily become less fertile and many trees have been felled. The area occupied by the farm is approximately 0.7 hectares with the family having access to a 'privately owned' (tribal tenure) field of about the same size nearby. This 'other land' was used for maize cultivation, but has been left unutilised for the past four years due to drought. Six people are resident on the farm and the number of people per hectare is therefore 4.28. Three people (two female, one male) work the farm full-time and two males provide part-time labour for cultivation/weeding on month ends. Both a tractor and oxen are hired for ground preparation, the tractor costing R40 per day for three days and the oxen R60 for the three days.

The Mfule River is the sole water source and erosion is evident in the watershed. The respondent reported that the water in the river is dirty and the supply is inadequate for household needs. In mid 1992 the farmer paid R20 to the school for a community project to install a pump to draw water from the Mhlatuze River to the Nhlube River, but nothing has happened since that time. The Nhlube River is a tributary of the Mfule located within 15 minutes walk from the homestead. Regarding tree resources, one umNgqawe (*Acacia nilotica*) grows near one dwelling in the homestead, while uGagane (*Dichrostachys cinerea*) and umKhaya (*Acacia burkei*) occur close to the river. The household owns seven cattle, five goats, and chickens. Increased farm production is limited by a lack of cash to purchase manure.

Food, clothing and school fees account for the major farm expenditures, school fees costing R63 per annum for each of the three children. Income is derived from three sources: a pension, and two sons, one of whom works for Huletts in Empangeni, and the other at a shop (Mountain View) on the road between Ndundulu and Empangeni. The total farm income (from on- and off-farm sources) is insufficient to raise the family above subsistence level. Goats represent the only form of investment. They are sold according to need, each one fetching R200.

It was reported that the last three years have seen a shortage of farm-produced staple foods. The respondent stated that there is no maize in storage, forcing purchases of maize meal. Crop production problems are caused by: soil erosion (rill), plant diseases and pests (locusts), insufficient rainfall, high temperature stress, wind damage, and wind desiccation. The land area was reported to be sufficient and the soil relatively fertile. Livestock graze on natural vegetation and there is enough grazing which is of good nutritional quality, according to the farmer. The respondent maintained that the grazing land was not eroded and the cattle grow well, but produce little milk. Drought-related stresses are the primary cause of livestock mortality.

Fuelwood provides energy for cooking and heating and there is enough on the farm for current needs. The farmer does not anticipate fuelwood supply problems for the future, the ready supply negating the need for fuelwood tree planting.

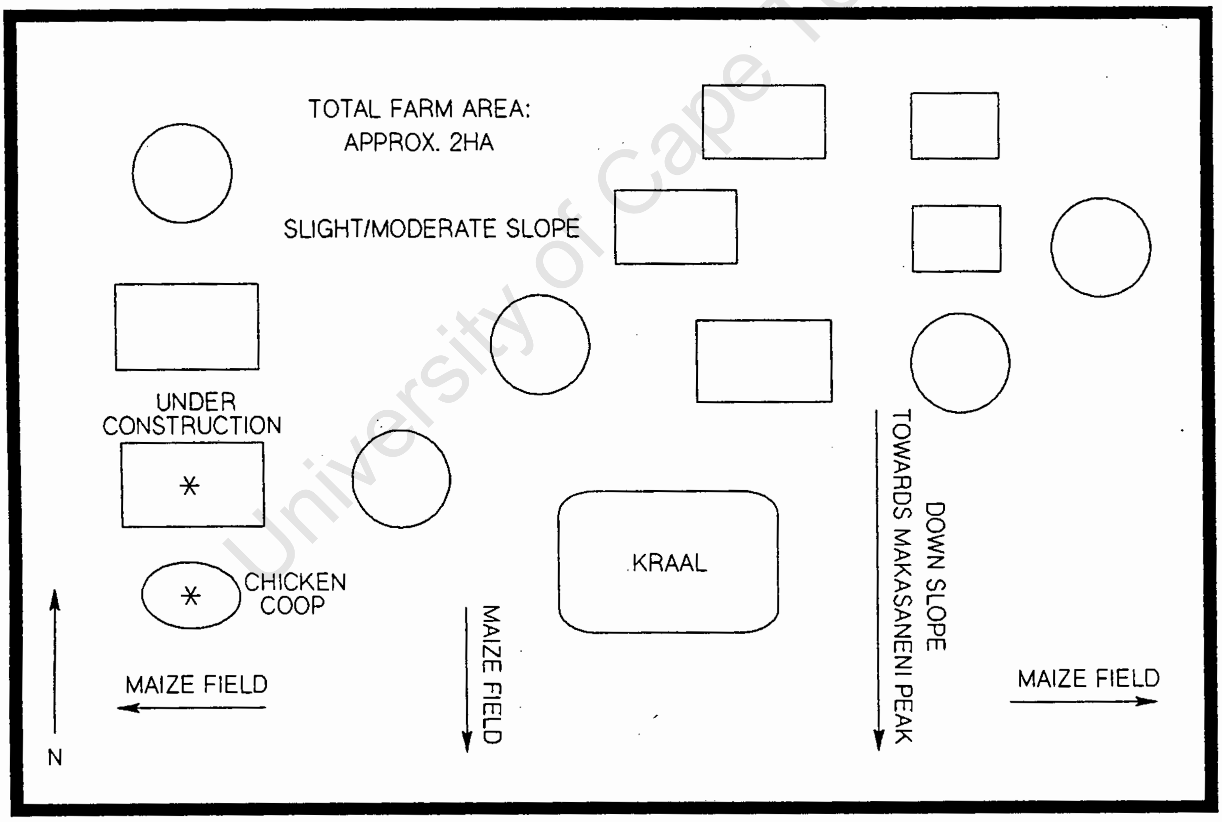
For construction purposes, umThomboti (*Spirostachys africana*) poles are collected from the nearby indigenous forest on community land. If the household has money, wattle poles are purchased from Melmoth at R2.50 each. There is one section of fencing near the road. The farm has sufficient shade trees for both people and livestock. Wind damage is a major problem. The respondent thinks that trees near the fields would help prevent this. She once tried gum trees, but they were eaten by cattle. UmSilinga (*Melia azedarach*) were also planted, but died from the drought.

Kheti Mkhize recognises that trees are useful in reducing wind damage. She has tried to plant windbreaks, but the (exotic) trees have died. The existing indigenous trees help prevent erosion on the slopes to the Mfule River according to the respondent, but she reported that she does not know how to plant such species. The respondent has not seen agroforestry in practice and she would like a demonstration to see what advantages the practice holds in her situation.

Typical of the Biyela Lowlands, the household's fuelwood needs are met by indigenous forest, and the soil is relatively fertile at present (as compared to the Biyela Uplands). However, deforestation and decreasing soil fertility (from lack of inputs), are becoming serious problems. This farm differs from other lowland farms surveyed, in that it experiences problems with wind damage and desiccation due to its location on a valley-edge rise. It is an example where the farmer is aware of a problem (i.e. wind damage) and its solution, but lacks knowledge on indigenous tree cultivation. Access to an agroforestry support program is therefore essential, if only for informative purposes (possible agroforestry component species exist in the indigenous forest on the family's land).

### *4.5.3 Farm in Hlabatini, Makasaneni Plateau, Biyela Uplands.*

**Figure 4.9** Plan View of Farm Layout






Velaphi Sibiya 'owns' this farm in Hlabatini, his wife, Khululiwe, was the respondent during the interview. The large homestead consists of eleven buildings (six oblong, five rondavels) with one (oblong) under construction, and a kraal in front. It is located on a slight to moderate slope and looks out over the cultivated land with Makasaneni Peak in the distance across a valley. Maize is grown in front and to both sides of the homestead.

**Plate 4.11** Velaphi Sibiya's Farm on the Makasaneni Plateau, Showing Unfinished Dwelling

The family has been farming this land for more than 90 years, cultivating maize, beans and other vegetables in a dryland system. The farm is approximately two hectares in size. In addition, two small vegetable gardens totalling about 0.5 hectares are 'owned' by the family and are located on the floor of the valley opposite the homestead. This is typical of farms in the Makasaneni area, with the level, more fertile valley floors being highly valued. The family has always used manure, the land being inherently infertile and covered with Ngongoni grass (*Aristida junciformis*) prior to cultivation. Seventeen people (ten female, seven male) work the farm full-time with two males and two females acting as part-time labour. An equivalent

9.2 people per hectare are resident on the farm. In a pattern common to farms surveyed on the Makasaneni plateau and mountain ridge, a spring located a reported one-and-a-half hours away from the homestead (return) supplies water for human consumption, while the livestock drink from the Hlambanyati River. The watershed was reported to be in good condition and the supply of water from the spring, although insufficient, is apparently clean. The farmer stated that a borehole in the area would help alleviate water shortages. A peach tree on the homestead boundary provides fruit and one umSilinga (*Melia azedarach*) grows on a field boundary. The landscape around the farm is devoid of trees, consisting of an almost pure stand of Ngongoni grass (*Aristida junciformis*). The household owns four cattle, seven goats and chickens. Goats and cattle are slaughtered during traditional ceremonies (for the ancestors). A shortage of cash for manure limits increased production.

The main cash expenditures as reported by Mrs. Sibiya are food (maize and beans) and school fees (R200 for all of the respondents six children). The respondent's husband is paid a pension. One of her sons works for the NPA (Natal Provincial Administration) in Durban, the other in the Richards Bay steel industry. Cash income is low and no luxury goods are owned, the family surviving at subsistence level. Shortages of farm-produced food are reported to have occurred over the past two years. Maize and beans are in short supply all year, forcing the family to purchase staple foods. The causes of crop production problems emphasised by the respondent are lack of rainfall, high temperatures and wind desiccation and damage. Others included: a shortage of cash for inputs, soil erosion, pests (e.g. caterpillars on cabbages and tomatoes), theft of produce, and the inherently low fertility of the soil. It was reported that the livestock graze on Ngongoni grass (*Aristida junciformis*), they lose weight in winter, produce little milk, and many have died from the drought. The respondent classified the quality of grazing as good. Therefore, the primary food production problem is a lack of nutrient inputs and other environmental problems (e.g. drought, wind damage) rather than a shortage of land or labour.

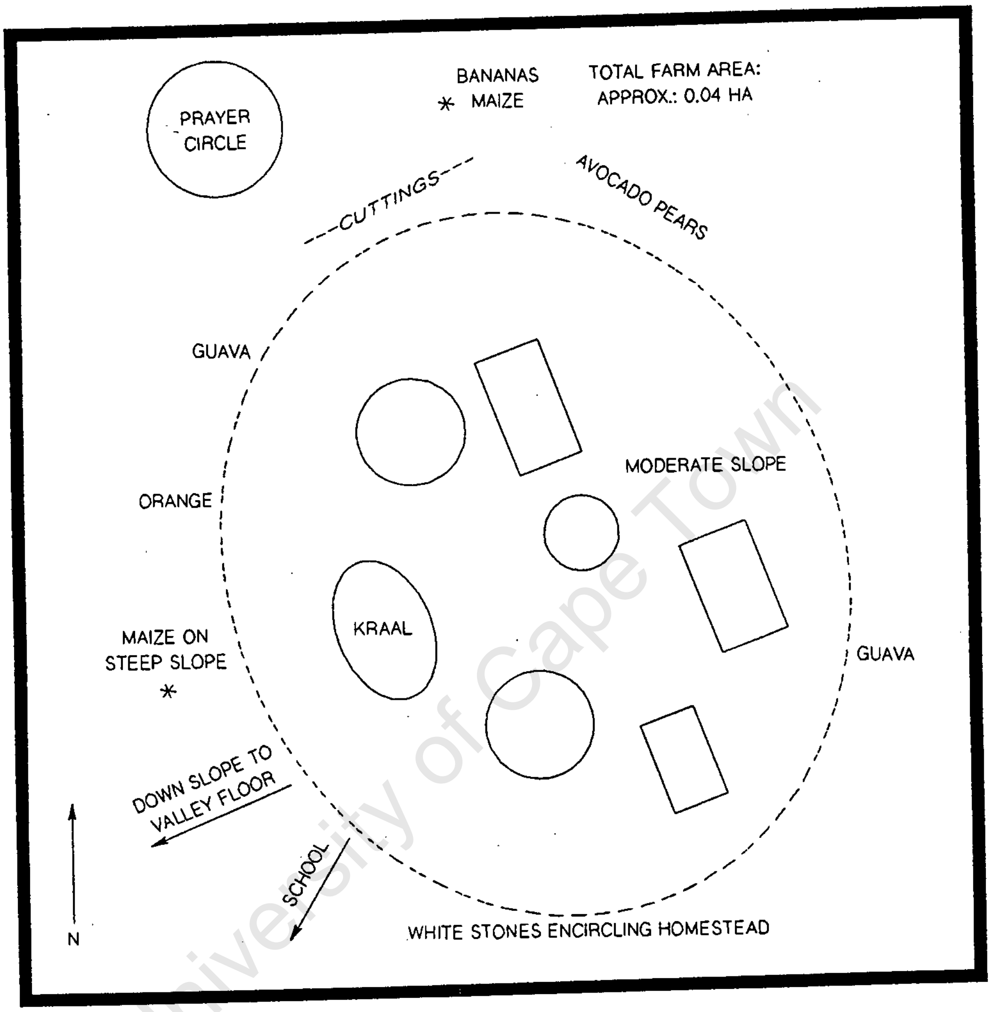
Fuelwood, paraffin and gas supply energy to the household. Gas and paraffin are used for tea and when there is a shortage of time (e.g. for the children before school). UGagane (*Dichrostachys cinerea*) and wattle fuelwood is utilised for general cooking and heating. Fuelwood is collected, free of charge, from an indigenous forest, the return trip lasting six hours, and no fuelwood is purchased. Mrs. Sibiya maintained that no problems are encountered in supplying the household's fuel needs and anticipates no problems in this regard for the future. Therefore, no fuelwood trees have been planted.

Building poles are purchased from Melmoth and at R4 each are considered to be expensive. A truck or tractor is hired by the family to transport the poles at a cost of R200 or more. Indigenous wood (umThomboti (*Spirostachys africana*) and umKhaya (*Acacia nigriscens*)) is used in the construction of dwelling walls, with wattle poles providing the roofing frame. The vegetable gardens in the valley are fenced, but no fencing exists on the farm itself. The respondent requires shade trees. She said that she had tried to plant umSilinga trees (*Melia azedarach*), but they did not grow. The drought was blamed for this. Wind damage is a problem, but the farmer does not know what she can do to prevent its occurrence.

When questioned about whether trees on the farm might solve some of the problems experienced, the respondent agreed that trees might stop the wind problem. She has not heard about agroforestry, but is very interested in the concept and thinks that she would like to try it. Khululiwe Sibiya believes that 'much food would be obtained' in an agroforestry system, and requires information on species selection and cultivation in this regard.

*4.5.4 Farm on Makasaneni Mountain Ridge, Biyela Uplands.*

**Figure 4.10** Plan View of Farm Layout






Jothami Ndludla has been farming this land on the Makasaneni mountain ridge for over 60 years. His very neat homestead consists of six buildings (three oblong, three rondavels) with a kraal in front. The entire homestead is encircled by white painted stones and separated and to one side (outside the ring of stones) is a prayer circle also encircled by white painted stones where communal religious ceremonies are performed. Maize, beans and bananas have been grown since cultivation began on this approximately 0.6 hectare portion of land. The household has a field of approximately 0.04 hectares on the valley floor and another smaller field in the adjacent valley. Maize and amadombe are planted on this 'other land', and according to the respondent, they do better there than on the farm where the land has become infertile.

Seven people (four male, three female) work the farm full-time and oxen are hired for ploughing at the rate of R50 for two days. A spring provides water for human consumption and the livestock (four cattle) drink from the Ngondlwana River. It was reported that the water supply is inadequate for the needs of the household and the watershed is eroded. Banana, sweet banana, avocado, orange and guava trees mark the boundary of the homestead. Three large avocado trees are set to one side and although growing on the respondent's land, they belong to his neighbour who planted them. Cattle are utilised for ceremonies and chickens provide meat. To increase farm production the farmer maintained that he requires land, labour and cash for manure.

Food, school fees (R53 per annum for the single child), and manure are the primary farm expenditures. The respondent draws a pension and his daughter works as a teacher in Nhlube/Nomponjwana. These are the only sources of income for the household and this income is used mainly for subsistence. If there is a severe shortage of cash, cattle are sold.

Shortages of farm-produced food occur every year, with maize and beans being the worst affected. Food is stored if possible, but often needs to be bought. The main causes of food production problems are: a land shortage, low soil fertility, soil erosion, and lack of rainfall. Other problems are: a shortage of cash for inputs, insect pests, high temperature stress, wind damage, and wind desiccation.

The cattle graze on natural vegetation. The farmer highlighted a number of problems with livestock production. These include diseases, lack of grazing, eroded grazing land, lack of shade, low milk production, weight loss in winter, and a low reproduction rate. He also mentioned the lack of veterinary services, with a vet visiting the area only once a year.

Fuelwood supplies the household's energy needs. Fuelwood is not produced on the farm, but is collected from Langgewacht farm outside the study area. A permit is required and collection is then free. The time required to collect fuelwood is about three hours return and, according to the respondent, there is sometimes a shortage. The respondent mentioned that the women of the household collect the wood and transport it on their heads. He thinks that there will be a problem regarding fuelwood supply in the future and would like to plant trees. Mr. Ndludla visited the Ndundulu Rural Service Centre a month previous to this interview, but said that seedlings were unavailable to him. Although the staff there promised to obtain seedlings for him, they did not say when the seedlings were expected.

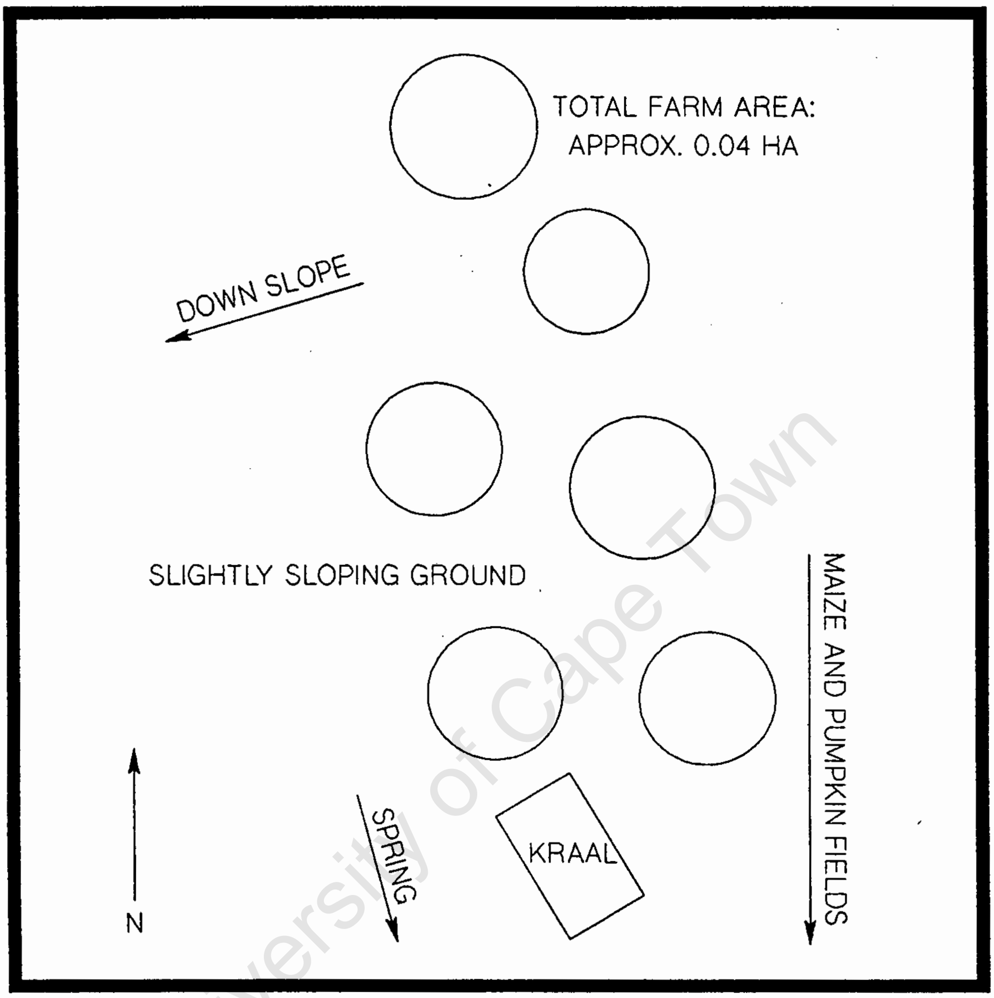
Building poles are bought by the respondent from a nearby farm. At a reported R140 per 'bakkie' load plus an extra R120 for transport, they are expensive. The farm has no fences. The respondent would like shade trees, a favourite being umBombe (*Ficus natalensis*). One of these trees has been planted, but is still young. Wind damage is a problem on this farm and the respondent planted some small trees (unidentified cuttings) in November 1992 to act as a future windbreak.

Jothami Ndludla agrees that trees would help prevent wind damage and soil erosion. He has not heard about agroforestry and is very interested in a demonstration.

The above is an example where the farmer recognises the future need for fuelwood, as well as the value of multipurpose trees, and has sought advise in this regard from the only source in the area (Ndundulu RSC), but has met with little support. Tree planting is deemed important by the farmer, despite a land shortage. This highlights a problem in farmer support and agroforestry development in the study area, and emphasises the need for a co-ordinated agroforestry development programme.

*4.5.5 Farm in the Mpumbulu Upland Physiographic Region, Biyela Uplands.*

**Figure 4.11** Plan View of Farm Layout






Themba Shandu moved to this location with his family and began farming here in 1991. The recently constructed homestead comprises six buildings, all traditional rondavels and a kraal. Maize and pumpkins have been planted in a small field and the respondent reported that the soil is fertile in this part of Ogqabhiyeni. Total farm area is approximately 0.04 hectares and seven people (four male, three female) work the farm full-time. Three sons sleep on the premises and sometimes help with farm chores. No labour is hired.

**Plate 4.12 Themba Shandu's Farm in the Biyela Uplands**

There are no water sources on the farm and water for human consumption is drawn from a nearby spring. The watershed is in fairly good condition, but the water is dirty and the respondent does not think anything can be done to improve the situation. The cattle drink from the Mpumbulu River. One small umSilinga (*Melia azedarach*) represents the only woody vegetation on the farm. The household owns six cattle and a few chickens. Increased production is limited by a severe land shortage with the farm having to support the equivalent of 375 people per hectare.

Primary cash expenditures are food, clothing and school fees (R200 per annum for five children). Themba Shandu works part-time for local people (cultivation and building) and three of his sons work on a temporary basis in Empangeni. No cottage industries are practised on this farm. Income from both informal and formal economic sector sources is therefore uncertain and at present is utilised to meet basic needs.

Shortages of farm-produced food have been experienced since arrival at the site, maize being most affected. Food has to be bought to overcome the shortage. The causes of crop production problems are: a shortage of land and cash for inputs, soil erosion (sheet), inadequate rainfall, high temperatures, wind damage and desiccation, lack of nutrient inputs, and poor soil workability. Livestock production problems are caused by seasonal weight loss, low milk production, and high mortality from drought. According to the respondent, there is no livestock disease problem and sufficient grazing is available on communal land, although it is of poor quality and the land is eroded.

The household utilises fuelwood for all its energy needs, substituting this with paraffin when a shortage occurs. No fuelwood is produced on-farm and it is collected, free of charge, from an indigenous forest. Plenty of wood is available, but the distance to the source is a major problem - it is a seven hour trip to the forest and back, including collection. The farmer recognises that the future will bring fuelwood shortages, but has not planted any fuelwood trees for the reported lack of space.

Building pole needs are supplied by the indigenous forest as well as a retailer in Melmoth. Poles bought in Melmoth cost R5 each and this is perceived by the respondent to be very costly. Indigenous species utilised include umNgqumo (*Olea africana*) and umThomboti (*Spirostachys africana*). Fences have not been erected. There is a total lack of shade trees, the farmer recognising a need, but unsure of what species to plant. Wind damage is a serious problem, but the respondent does not think anything can be done to prevent this.

The farmer maintains that there is no room on the farm for trees and although agreeing that wind might be prevented with trees, he sees no cure to the problem given the perceived lack of space. This is therefore an example where trees are seen as separate units which utilise space, rather than potentially active components of an integrated farming system. Themba Shandu has not heard about agroforestry practices and is interested in a demonstration.

## 4.6 Conclusion

Many of the problems encountered by respondents result from the farmers' functional context (i.e. a combination of political, social, ecological, and economic factors). The study area is located in a former 'homeland', with the attendant problems of artificial population concentration and poor development resource assignment. It is mountainous (necessitating cultivation on steep slopes and promoting soil erosion under monocropping) and drought-prone, with inherently low soil fertility, a poorly developed infrastructure, and few farmer support services. This situation forces farming inputs (e.g. soil nutrients, land, labour) which are of variable supply when combined with factors such as land holdings and migrant labour; and are often beyond the reach of respondents. Consequently, food shortages have been shown to be the result of the intersection of factors such as the number of people per hectare, household income, and resource allocation.



Common findings include land, labour, and capital shortages, combined with depleting natural resources. All respondents have food shortages and only seven have access to a clean, adequate water supply. Soil nutrient status is generally poor, and almost all those interviewed reported a shortage of cash to purchase manure or fertilisers as the most serious barrier to increased farm production. In addition, soil erosion is prevalent and severe gully erosion is evident in upland areas. With the exception of a few farms in the Biyela Lowlands, all households experience problems with wind damage and desiccation. Regarding financial assets, cash income is low and often dependent on family members employed in urban areas, with the local informal economic sector suffering from a lack of resources. Savings and investment enterprises are therefore negligible: only eight respondents have savings, and accumulated livestock wealth has been devastated by drought. In the Biyela Uplands (the largest section of the study area), fuelwood and poles for construction purposes are expensive and of diminishing supply, while the distance travelled to sources of free supplies (i.e. indigenous forests) is increasing due to deforestation. Raw materials for cottage industries (e.g. 'incema' reeds for mat, broom, beer spoon, and container manufacture) are scarce.

Of crucial importance is the ability of agroforestry practices to address many of the problems encountered by survey respondents, and the overwhelmingly positive response of local farmers towards agroforestry possibilities is encouraging.

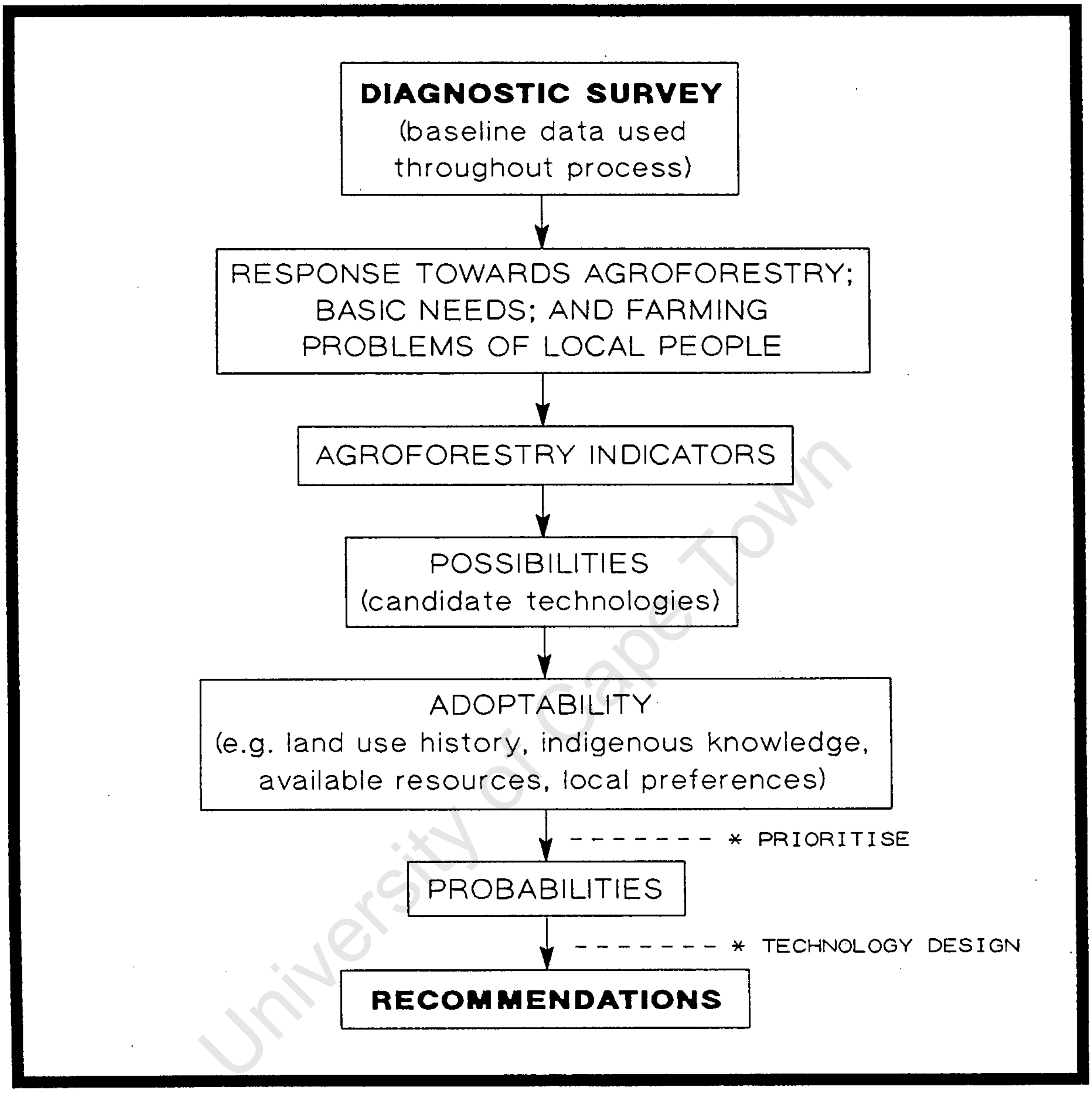
This concludes the results of the diagnostic survey. The incorporation of these results into practical agroforestry implementation guidelines is now discussed with a view to problem solving.

# CHAPTER FIVE

# RECOMMENDATIONS

This chapter utilises the information gleaned during the diagnostic survey to make recommendations regarding agroforestry development in KwaBiyela. It is divided into four sections. The first of these outlines the current state of agroforestry development in the study area. Following this is a section listing fieldwork results and observations which show that agroforestry as a practice is worthwhile pursuing as a potential contributor to sustainable rural development in KwaBiyela; and uses these to suggest a range of possible practices. The third section discusses the need for adoptable agroforestry technologies, and through this discussion narrows down the possibilities to three viable options (probabilities). These options are then considered in detail. Finally, general development needs and potentials in the study area are considered. The process through which recommendations will be made is illustrated in Figure 5.1. Emphasis is placed on the practical application of the sustainable development ideology adopted in an earlier chapter, while the chapter's focus progresses from the general to the farm-specific scale.

Figure 5.1 Process Employed in Recommending Agroforestry and Related Technologies for Introduction into the Study Area




## 5.1 Current State of Agroforestry Development in KwaBiyela

Survey results show that agroforestry (as defined in this thesis) is practised by a minority of the resident population of the study area. Although trees occur on all farms surveyed, in most cases they are not consciously utilised to increase farm productivity through positive interactions with crops and/or livestock. Many respondents are, however, aware of the beneficial effects of trees in the farming environment. To summarise the information obtained from the diagnostic survey: only four repondents (4.4 percent) are practising agroforestry; another four have seen demonstrations and approve of the practice; 68 respondents (75.5 percent) are interested in agroforestry demonstrations; and twelve respondents (13.3 percent) are doubtful as to the viability of such systems in the project area. Outside of the survey population, four out of the six farmers practising agroforestry with support from the Institute of Natural Resources were visited (the other two were not contactable).

From the above, it is clear that the majority of the local population surveyed is positive towards agroforestry implementation in KwaBiyela, but for various reasons, such as a lack of expertise in tree planting, and shortage of cash for seedlings, a woody component has not been introduced into local farming systems.

The sole indigenous agroforestry practice encountered was a banana/maize or banana/amadombe system. The advantages of this system as stated by respondents are: a saving in the labour input required to clear around the bases of banana trees through the cultivation of maize amongst the trees, and the microclimatic effects of banana trees in preventing wind damage and slowing evapotranspiration in the maize crop. Both result in increased and more stable yields. The staple crop of maize responds well to both indigenous and introduced agroforestry systems. The maize component in the system introduced by Mr. Dube of the Kwazulu Department of Agriculture yielded better in the agroforestry system as compared to a monocrop, while the amadombe crop reportedly did better as a single crop stand.

The four INR-supported agroforesters visited with Mr. A. Zondi (INR Agroforester) were Mr. Z. Ngema in Ohawule, Mr. M. Nxumalo in Mfule (whose wife was present), Mr. C. Gumede in Bhonkolo (system managed by his wife), and Mr. E. Dube in Ndundulu (absent at time of visit).

Mr. Ngema cultivates maize, sweet potatoes, sweet banana, Leucaena trees (*Leucaena leucocephala*) (planted 12 November 1992 for soil improvement), Vetiver grass (since 10 November 1992 as a windbreak, to prevent soil erosion, and as a mole repellent), 'incema' reeds (*Juncus kraussii*) (for weaving), Assegaibosch (*Curtisia dentata*) (for muti as part of the ethnobotany programme) and Tagasaste (*Chamaecytisis palmensis*). The maize and sweet banana form an indigenous agroforestry system (as practised by four survey respondents), while Leucaena, Tagasaste, Assegaibosch and Vetiver grass have been introduced with support from the INR, and planted in rows. All these species are grown on slightly sloping land using manure and 2:3:4 fertilizer. The Tagasaste die when a certain height (approximately 50cm) is reached (possible soil structure constraint), but all other crops and trees are growing well. Mr. Ngema's farm is very productive and the maize seen here was the tallest and healthiest in the study area (Plate 5.1), but his land is irrigated from a stream which has been dammed and is therefore an exception to the norm. The results obtained on this farm cannot be widely expected in the study area, as very few farms have access to such a supply of water. None of the households surveyed irrigated their land.

**Plate 5.1** Maize on Mr. Ngema's Farm

Mr. Nxumalo's farm in the Mfule River valley (Biyela lowlands) has been ravaged by drought. Leucaena and Tagasaste were planted in a level field here for soil improvement and fodder provision on 26 November 1992, and all but a few small (approximately 10cm high) Leucaena seedlings covered by a layer of dry grass, have died. Orange trees are surviving well and are hand-watered from the river. Two *Strychnos spinosa* (Spiney Monkey-Orange) trees on the field boundary are also surviving the drought.

Agroforestry introduced onto Mr Gumede's farm in Bhonkolo has so far been a success. His wife (who cultivates the field and is therefore, in effect, the agroforester) showed us the farm. Leucaena, Tagasaste and Pigeon Pea (*Cajanus cajan*) seedlings were planted on the boundaries of a level vegetable garden on 5 November 1992 to act as windbreaks and improve soil fertility. All are growing well, but there is a marked decrease in growth rate amongst the Leucaena the closer they are planted to a large *Acacia robusta* tree. The vegetable garden produces maize, spinach, melons, tomatoes, green peppers and chillies (Plates 5.2 and 5.3).

**Plate 5.2** *Leucaena leucocephala* Planted on a Vegetable Garden Boundary

Plate 5.3 Mrs. Gumede and the Pigeon Pea Seedlings Planted in 1992

The last INR-supported agroforester visited was Mr. E. Dube in Ndundulu who was absent during the visit. Tagasaste, Leucaena and Pigeon Pea were planted in November 1992 for fodder provision and soil improvement on the boundaries of a steeply sloping field. The seedlings had not been well tended and were overgrown with weeds.

The two INR-supported agroforesters not visited were Mrs. R. Mbatha in Makasaneni who is growing Tagasaste and Leucaena, and

Mrs. J. Mchunu in Ndundulu who has Pigeon Pea, Leucaena and Tagasaste trees. Both farmers were hoping to produce animal fodder and improve soil fertility with the introduction of a tree component into the farming system.

As of July 1994, Mr. A. Zondi reports that four of the original six agroforestry plots are progressing well. The situation on Mr. Nxumalo's farm has not changed, but he is still interested in practising agroforestry after the drought has eased. Mrs. Mchunu has left the project. Two members of the Nxumalo family have recently joined the INR agroforestry project, bringing the number of participating farmers back up to six. A new community garden incorporating an agroforestry component was established late in 1993, but was later destroyed by flooding. The Head of Agroforestry at the INR, Ms. M. Peden, hopes to incorporate another existing community garden into the INR agroforestry project. Seedlings (seed in the case of Pigeon Pea) are given out free of charge to agroforestry project participants with whom agreements have been drawn up, and are offered for sale to the general public (Morag Peden, INR, pers. comm.). Mr. Zondi (pers. comm.) emphasises the continuous demand for seedlings and seed from the Ndundulu Rural Service Centre for fruit, windbreaks, hedges and shade. He distinguishes between 'agroforestry', 'fruit', and 'indigenous' species. The agroforestry species are Leucaena, Tagasaste and Pigeon Pea, while fruit trees (the most popular) include orange, naartjie, banana, litchie, mango, avocado pear, peach and plum. Indigenous species offered are: *Warburgia salutaris*, *Kigelia africana*, *Acacia albida*, *Acacia xanthophloea*, *Albizia adianthifolia*, *Trichilia emetica*, *Sclerocarya birrea* (Marula), *Eckebergia capensis*, *Ocotea bullata*, and cycads. According to Mr. Zondi, of the indigenous trees, cycads, Albizia, Trichilia, Marula, and the Fever Tree (*Acacia xanthophloea*) are the most sought after.

The INR Biyela agroforestry programme is showing promising results at this preliminary stage, utilising exotic species on six trial plots and possibly once again in a community garden.

Information on indigenous practices is also being collected (e.g. indigenous fodder species such as *Syzigium cordatum* (M. Peden, On-Farm Trials, Visits to Participant Farmers, July 1992)). At present, however, indigenous agroforestry systems are promoted only indirectly (if at all), primarily by the availability of low-cost seedlings. At least one local farmers' organisation, Inthuthuko, is promoting indigenous agroforestry practices and intercropping, within a farming systems approach.

This brief overview of agroforestry practices encountered while conducting fieldwork in the study area shows that agroforestry development in KwaBiyela is in its infancy. The sections which follow look at the applicability of agroforestry to the study area and suitable mechanisms for its future development where appropriate.

## 5.2 Agroforestry Indicators

As stated in an earlier chapter, agroforestry is not always an appropriate land use system, and its capacity for problem solving in any geographical area rests entirely on the existing local social, economic and ecological context. The task set for this thesis was to investigate the applicability of agroforestry to problem solving in KwaBiyela using local people as the primary source of information. If agroforestry was deemed appropriate in the local context, suggestions would be made regarding practices and adoption based on the results of a diagnostic survey. From the results obtained from the survey, it is maintained that agroforestry is indeed an appropriate response to rural development problems in the study area. The factors supporting this will now be listed as possible starting points for agroforestry introduction, support and dissemination.

1) Maize monocropping is unsuccessful under present circumstances and there is a need for an alternative system.

2) Shortages of food, fuel, farm inputs (e.g. manure), land, and labour occur throughout the project area.

3) Problems mentioned by respondents occur in the food, energy, shelter, and raw material farm production subsystems. Food production problems include: wind damage and desiccation, heat stress, soil erosion, inadequate and poor infiltration of rainfall, decreasing soil fertility, lack of soil nutrient inputs, lack of grazing land, poor nutritional quality of grazing, and overgrazing.
Energy provision problems are the cost of purchased fuel, a shortage of fuelwood, and the time required for fuelwood collection.
In the shelter subsystem, the cost, shortage and transport of building wood are constraints, while there is a need for fencing, shade and windbreaks.

The raw material subsystem experiences a shortage of 'incema' reeds for weaving.

4) Agroforestry ideas received a positive response from the majority of respondents for reasons of space saving, simultaneous production of fruits and vegetables, wood provision (fuel and timber), soil improvement, green manure supply, and fodder provision.

5) Reasons for negative responses to agroforestry such as competition between trees and crops, heat, water shortages and soil properties, can be overcome by careful selection of systems and component species.

6) The indigenous agroforestry system encountered (banana/maize, banana/amadombe) is successful in certain areas, but is probably not transferable to drier parts of the study area (e.g. Biyela lowlands) without irrigation.

7) The INR agroforestry initiatives are in their early stages, but show promise in the Biyela uplands.

8) People in the study area plant trees in specific locations to fulfil a variety of functions (e.g. on boundaries as windbreaks, near homesteads for the provision of fruit and shade).

9) Certain species are preferred for particular productive and service roles (see list in Appendix C).

10) Many respondents would like to plant trees to fulfil the above roles, but lack expertise in tree planting (especially indigenous trees) and/or cash for seedlings.

11) Indigenous fuelwood species are in great demand.

12) Trees from Ndundulu RSC (at a nominal charge) are in increasing demand for fruit, windbreaks, hedges and shade.

13) Some respondents are aware of the benefits of mixing trees and crops.

14) The fertilising effects of legumes are recognised in maize/bean systems.

15) Mixed cropping is practised for lack of space.

16) The shelter functions of trees (e.g. as windbreaks) are, at present, utilised for homesteads only, in the majority of cases, and can be easily extended to crop stands.

17) The economic value of umThomboti trees (*Spirostachys africana*) and 'incema' reeds (*Juncus kraussi*) is recognised by respondents.

18) One respondent has constructed a microcatchment for growing 'incema' reeds.

Using the above core of knowledge as a foundation for the construction of an agroforestry development programme framework, a number of possibilities for agroforestry practices emerge. These, as detailed by Rocheleau, Weber and Field-Juma (1988:73-222), include:

a) Dispersed fruit trees in cropland.
b) Contour vegetation strips.
c) Alley cropping.
d) Trees in home gardens
e) Agroforestry in erosion control earthworks.
f) Gully and waterway stabilisation with trees and shrubs.
g) Microcatchments for water management.
h) Living fences.
i) Borderline and boundary plantings.
j) Windbreaks.
k) Trees and shrubs along waterways.
l) Trees and shrubs along roads and paths.
m) Trees and shrubs around houses and in public places.
n) Dispersed trees in pastures and rangeland.

This list covers virtually all the agroforestry practices known to exist. A discussion covering the adoption of such practices will utilise contextual information from the study area, combining this with the agroforestry indicators and the perceived needs of farmers, to arrive at a selection of technologies deemed to be adoptable by the local population.

## 5.3 Adoptability

Raintree (1983, 1987) uses three criteria to assess agroforestry interventions: productivity, sustainability and adoptability. These have become the three pillars on which agroforestry has to rest if it is to make any contribution to sustainable rural development. 'No matter how technically elegant or environmentally sound an agroforestry design may be, nothing practical is achieved unless it is adopted by its intended users' (Raintree 1987:3). A development intervention can therefore only make an impact if it combines well with the social, economic and ecological context of the target population. To reiterate a point made earlier, the focus of rural development must be the people who are to benefit, not the benefits themselves. Therefore, it is important, where possible, to support local initiatives and encourage their spread, rather than introduce externally devised systems, thus increasing the chances of adoptability and social, economic and ecological success. Richards (1985:150) argues for ''sideways extension' - formal sector assistance in spreading the best local agricultural innovations'.

Rogers and Shoemaker (1971 in Raintree 1983) show that technologies are more adoptable if they are perceived by target populations as advantageous over existing systems, are compatible with local social systems, are technically uncomplex, and are trialable and observable. Raintree (1983) incorporates these ideas into a series of three strategies for 'adoption-oriented agroforestry research and development' (p177). For the first strategy, Raintree (1983) points to the often overlooked necessity of gaining an understanding of indigenous agroforestry systems before introducing 'modern' ones, proposing 'incremental improvements' to existing systems as satisfying Rogers and Shoemaker's (1971 in Raintree 1983) points of comparison. The second strategy is to 'adopt a problem-solving or 'diagnostic' approach to design' (Raintree 1983:177) (i.e. utilise the ICRAF's Diagnosis and Design methodology). Raintree (1983) identifies two priorities for agroforestry interventions: 'to develop latent *potentials* within the [existing] system' and 'to address its inherent weaknesses and solve existing *problems*', and promotes 'technologies to solve *perceived problems* and address perceived needs' as 'more adoptable' (p178). The third strategy deals with economic issues, and specifically the opportunity costs of land and labour. 'To arrive at truly adoptable designs, however, we must go beyond qualitative functional specifications to quantify and evaluate the relative economic advantage of different agroforestry and non-agroforestry alternatives' (ibid.:178). The implication here is that unless an intervention has an economic advantage (i.e. is able to provide greater income-earning opportunities than the existing system), it will not be adopted. Adoptability of agroforestry interventions is improved if the land utilised has a low opportunity cost and labour requirements are kept to a minimum, so decreasing the risk perceived by the farmer.

It can be seen, therefore, that understanding the mechanism of agroforestry adoption to recognise how and why people are likely to adopt the practice, is more important than devising complex systems for introduction. An investigation into current agroforestry and tree planting activities in the study area and the reasons behind them, has supplied a foundation on which to develop ideas surrounding agroforestry intervention, support and dissemination.

This thesis has concentrated on discovering the trees and crops that local people *want* to plant and are *planting* at present, in various *locations* and *combinations*, for fulfilling particular *functions* in the agricultural environment, as starting points for agroforestry development in the study area. This was deemed preferable to compiling lists of trees (unfamiliar to local people) suitable for fulfilling certain functions, for subsequent introduction onto selected farms. It is believed that the above approach parallels that at the forefront of rural development research and practice (i.e. the 'bottom-up' approach). In this way, indigenous knowledge forms the basis for all recommendations, and is balanced by external technological inputs applicable to the study area and its people.

The possibilities listed above are therefore limited or modified by interrelating social, economic and environmental factors which are peculiar to each household (e.g. labour availability, slope aspect and angle, land area). The *probabilities* for agroforestry system component introduction or dissemination are therefore different for each household. Using the information received from the survey, however, it is possible to gain a general idea of which agroforestry components are most likely to be adoptable over a wide range of households within KwaBiyela. 'Fine-tuning' of components at farm level will, of course, be essential. Since the discussion centres mainly on agroforestry components, and not self-contained systems for introduction, a wide range of possibilities exists as to their combinations as they relate to access to resources (social, economic and ecological).

Considering the focus of this thesis on the increase of farm productivity as the route to agroforestry development in the study area, the factors stated by survey respondents as constraining farm productivity must be given prominence. These factors are: a shortage of cash for inputs (92.2 percent of respondents), a land shortage (23.3 percent of respondents), and a shortage of farm labour (20 percent of respondents). In recommending agroforestry practices for introduction into the study area, emphasis will necessarily be placed on the fertilising effects of trees and shrubs, increasing productivity on small areas of land, and minimising system management requirements. In all cases, the ideas on adoptability discussed in this section will be combined with the goals of increasing farm productivity and solving problems (e.g. wind damage and soil erosion) encountered in the rural environment. Priority will be given to addressing local needs, existing indigenous agricultural systems, species and practices that people are familiar with, and the promotion of indigenous species (adapted to the local ecological context). If the above list of possibilities for problem-solving is filtered through the argument dealing with adoptability, a small number of probabilities for agroforestry development emerge. These agroforestry technologies, considered to be most adoptable in KwaBiyela, will now be examined in detail.

## 5.4 Most Adoptable Agroforestry Interventions

### *5.4.1 Dissemination of the Indigenous Banana/Maize System*

The indigenous banana/maize agroforestry system has a long history in the study area, having been practised for at least 40 years (farmers, pers. comm.), but is not widely known. It consists of banana trees arranged in a rough grid shape interplanted with maize, and is a small-scale operation. Only three of the 90 survey respondents (3.3 percent) are managing such a system, while a further two (2.2 percent) have done so in the past, but have stopped for lack of time and hope to continue in the future.

Where the system occurs (Ndabazentshangu, Nozika, St. Paul's Mission, Qubuka, among surveyed farms) it is successful. Banana trees are planted elsewhere, but as single-species stands. According to practising local farmers, the system is beneficial for both components. Maize yields are greatly improved and the maize responds well to the sheltering effect of the banana trees which prevent wind damage and desiccation. The banana trees, in turn, benefit from improved care (clearance around the base) and maize residues dug into the soil, as well as any nutrient inputs applied to the maize. Under study area conditions in the uplands and adjacent dissected slopes, banana seedlings (taken from basal shoots of mature trees) produce fruit after four years (Mr. L. Ziqubu, farmer, pers. comm.).



The system increases the productivity of the land and utilises labour efficiently. Opportunity costs to land, labour and capital are negligible, considering the returns obtained. Land area occupied is approximately the same as that for separate maize and banana fields if the same area of maize crop is planted, due to the spacing of trees required (shade effect). The system does not, therefore, save space, but the benefits to farm production from complementary relationships between maize and banana components justifies the mix, increasing the efficiency of the space utilised. Space could be saved if the system was enlarged, with improved maize production in a reduced area of the farm freeing land for other purposes (e.g. vegetable gardens, fuelwood and fodder production). Its present small average size of below 150 square metres means that it supplements farm production on a small scale, rather than impacting the entire maize crop.

In the study area, only two direct catalysts for the dissemination of this agroforestry system were encountered: indigenous knowledge (ideas passed down through generations) and Inthuthuko (a local farmers organisation), both having very localised effects at present. The reasons why this agroforestry practice has not spread throughout the project area point the way towards a programme of dissemination, and are now outlined.

Their reported capacity for harbouring snakes precludes a minority of farmers from planting banana trees, and this should not be seen as a major barrier to adoption. Ecological constraints mean that the system is not suited to the dryer Biyela lowlands and dry upland plateaux where edaphic and climatic factors may stunt the growth of bananas. A lack of cash for seedlings and expertise in tree planting are more widespread reasons stated by survey respondents. Both have been overcome to some extent at the Ndundulu Rural Service Centre (RSC) where banana seedlings are available at a nominal charge (free of charge to INR Project participants), while planting advice is freely available, but it is not certain how many people in the study area are aware of this service. Also, the initial labour input required for planting trees may be prohibitive in some cases, especially where the able-bodied members of the family are absent from the household (e.g. seeking formal employment in urban areas). The problem of initial labour requirements (management of established systems requires less labour input than that of a maize monocrop) might be overcome by a focus in some cases on community gardens, which are already proving successful in the study area (Agrippa Zondi, pers. comm.).

Another obstacle to adoption may be the perceived competition of banana trees with crops. Farmers assume a degree of risk with every innovation, and the risk of devoting land (which could be planted to maize) to banana trees must be *perceived* by the farmer as worthwhile. Farmers must therefore be made aware of the benefits of mixing bananas and maize as seen on three respondents' farms. Additional farmers' organisations such as Inthuthuko, promoting farmer experimentation with different combinations of crops and trees (of great benefit since each farm is unique in its access to resources), could encourage the spread of banana/maize systems (as well as other practices), and this would be facilitated by the availability of free seedlings and advice (e.g. from Ndundulu RSC) at meetings. Visits by groups of farmers to individual farms where the system is successful would promote its dissemination and perhaps reinforce successful traditional practices long since forgotten.

A management aspect that needs to be investigated is the life-expectancy or sustainability of the system and the need for replacing large trees with seedlings on an ongoing basis to maintain maize productivity. On at least one farm, large banana trees are regarded as a hindrance to overall production and will be removed with no intention of replacement. A staggered rotation of mature trees with seedlings (e.g. replacing 20 percent of mature trees with seedlings every seven years) may solve the problem, but would require greater labour and time inputs, even if timed for the off-peak labour season. Banana trees planted on maize field boundaries or in an alley system with proper spacing (e.g. to allow plough passage) may prove easier to manage over the long term. In addition, simple microcatchments (e.g. trees planted in shallow pits) would improve water availability to trees, decrease runoff and increase yields.

The indigenous banana/maize agroforestry system is regarded here as the most adoptable, primarily because it already exists on local farms and has proven to be successful under local conditions. It could also act as a model for similar agroforestry systems utilising other species (e.g. dispersed Acacia trees in cropland). Recommendations made in subsequent sections will rely on trial periods to determine their success, and it is to these practices that the focus now shifts.

### *5.4.2 Boundary Plantings as Windbreaks and Living Fences*

Wind damage to crops and dwellings was cited as a problem by over 92 percent of survey respondents. Semi-permeable boundary plantings can significantly reduce wind speed, decreasing the risk of wind damage and desiccation of crops (Rocheleau, Weber and Field-Juma 1988). Planted windbreaks can take a variety of forms, consisting solely of trees or shrubs, or combinations of both in predetermined patterns. They differ from living fences in that they need not be located on boundaries, but with the emphasis here on boundary plantings, it has been decided to group the two components together as fulfilling interchangeable roles. The only difference between windbreaks and living fences for the purposes of these recommendations is that the former are purposely located as close as possible to a 90 degree angle to the direction of the prevailing wind (prevailing wind from south-west sector for KwaBiyela (Loxton, Venn and Associates 1985)). Windbreaks can therefore form part of living fences (and vice versa), and living fences can also be used to protect windbreaks consisting of vulnerable species, from livestock. Living fences represent an alternative to costly wire fences, with a lack of capital as the only reason for the majority of survey respondents being unable to fence their land and protect it from encroachment by grazing animals and other unwanted visitors.

Since the majority of farms visited in the study area are less than one hectare in size, even a single row of low trees or shrubs can have a significant effect on wind speed, and complex multi-level windbreaks (which utilise large land areas and require considerable labour input) are not required, not to mention inappropriate in KwaBiyela. In all cases there will be a degree of competition between trees/shrubs and crops, but increased yields and other benefits would negate the effects of this competition. The degree of competition can be reduced by selecting woody plant species with deep rooting systems and phenologies in harmony with adjacent crops.

With an emphasis on adoptability, it has been decided to study current practices in the study area and to utilise these as starting points on which to build recommendations. In this respect, boundaries (homestead, field, farm) are promoted for the location of woody plant species as they are already favoured by local farmers for planting trees or protecting (i.e. not removing) those which were self-seeded.

Survey results show that at present, windbreaks are only used to protect dwellings. They consist of a single row of trees (e.g. pine, gum, pepper) or individual trees and shrubs (e.g. *Melia azedarach*, *Erythrina lysistemon*, *Spirostachys africana*, *Bougainvillaea spp.*) located on homestead boundaries. These trees and shrubs are not utilised to improve crop productivity, but do provide building material and shade for family members. Two sections of living fences, one consisting of *Agave sisalana* (sisal) and the other of bamboo (*Bambusa spp.*) were also encountered, while a *Barringtonia racemosa* (uBoquo) hedge has been planted near the homestead of one respondent. The proposal put forward here is that the principle of protecting dwellings with woody plant species can be extended to other parts of the farm; specifically, to field boundaries.

Multipurpose species selection would ensure that windbreaks and living fences supply products such as fuelwood, nutrient inputs, fodder, and building materials, while simultaneously ameliorating the local environment. This would not only increase overall farm production, but would save the farmer money by reducing the need for purchased inputs. Legumes, with their capacity for fixing nitrogen are most suitable for improving soil quality. Decreasing soil fertility is a problem on most farms in the study area, and the shortage of cash for purchasing manure and/or artificial fertilisers is the single most important obstacle to increased farm production on over 92 percent of the farms surveyed. Indigenous species are both adapted to the local environment and familiar to local people, enhancing the chances of adoptability and survival. For these reasons, the emphasis will fall on windbreaks and live fences utilising indigenous, multipurpose, leguminous species.

Candidate leguminous tree species include: *Acacia albida, A. burkei, A. karroo, A. nilotica, A. nigriscens, A. robusta, A. sieberana* (although toxic to livestock (Vahrmeijer 1981)), *Dichrostachys cinerea, Albizia adianthifolia, Erythrina lysistemon*, and *Scothia brachypetala*. Of these, Ndundulu RSC has *Acacia albida, A. sieberana* and *Albizia adianthifolia* seedlings available to farmers.

*Acacia albida* is a well-known, fast-growing, multipurpose legume used in agroforestry systems (e.g. dispersed trees in cropland and pastures, home gardens, windbreaks) throughout Africa (e.g. Niger, Kenya, Cameroon) to improve soil quality and provide animal fodder, fuelwood, and shade (Rocheleau, Weber and Field-Juma 1988). It grows naturally in northern Natal, but was not encountered on survey respondents' farms. Elsewhere in Africa it is combined with maize as it loses its leaves in summer (maize growing season) and therefore does not compete with the maize for sunlight (Rocheleau, Weber and Field-Juma 1988), while the leaf fall fertilizes the maize crop. Trials are needed to determine if the same is true for the project area. Under favourable conditions this tree may grow to seven metres in three years (Palmer and Pitman 1972). As with all Acacias, the seeds require soaking in boiling water before they can germinate (Eliovson 1984). *Acacia burkei* (umKaya) is a shade tree on a number of respondents' farms, occasionally providing fuelwood. The same is true for *A. sieberana* (umKhamba). *Acacia karroo* (umNgu) is another fast-growing species, and is utilised in the study area for shade and medicinal purposes. Its long thorns protect it from grazing animals, making it a practical choice for living fences when young. This tree, along with most Acacias, loses its leaves in winter (Eliovson 1984) and is therefore suited to planting alongside winter crops such as peas, cabbages, onions and carrots. *Acacia nilotica* (umNgqawe) is a preferred fuelwood species in the study area. Although slow-growing, it can become invasive in riverine environments (Rocheleau, Weber and Field-Juma 1988). With the current overutilisation of tree resources in KwaBiyela (noted during fieldwork), this invasiveness may not be problematic. Because of its dense form, it is the most suited of the indigenous Acacias to windbreaks, living fences and erosion control, and can be managed as a shrub, reducing competition with crops. *Acacia nigriscens* (umKhaya) provides survey repondents with building poles and sticks, as well as shade in summer, while *Acacia robusta* (umNgamanzi) reportedly yields fuelwood of excellent quality, and is second choice only to *Dichrostachys cinerea* in this regard.

*Dichrostachys cinerea* (uGagane) is the most sought-after fuelwood species in the study area, reportedly burning cleanly and efficiently, and is collected from the indigenous forest for this purpose. It also supplies poles and sticks for construction and fencing. A deciduous species, *D. cinerea* is slow-growing and requires protection from browsing livestock when young, but is nevertheless suitable for planting on boundaries with its deep rooting system (Rocheleau, Weber and Field-Juma 1988). *Albizia adianthifolia* (uSolo) is a legume utilised for fuelwood provision and medicinal purposes by survey respondents. It may not, however, be suitable for field boundary planting (especially small fields) as it is likely to have the same surface rooting system as related species (e.g. *A. lebbeck*) and would compete with nearby crops for nutrients, although being useful for erosion control (Rocheleau, Weber and Field-Juma 1988). The species should be subjected to further investigation in this regard. *Erythrina lysistemon* (umSinsi) is favoured by survey respondents for its shade-giving, medicinal and ornamental qualities, while it reduces wind speed around dwellings. Like most of the Acacias, it loses its leaves in winter (Eliovson

1984), making it suitable for planting alongside winter crops. *Schotia brachypetala* (umGxamo) is a shade tree on respondents' farms which drops most of its leaves during the maize growing season (Eliovson 1984). For this reason it can be combined with maize along with *Acacia albida* where it would not compete severely for sunlight, the leaf fall improving soil fertility.

Indigenous legumes can therefore perform a number of functions simultaneously in the farming environment. Windbreaks and living fences can be composed of species which provide fuelwood, shade and medicine, while fertilizing the soil and reducing soil erosion from wind and water. The mature shape of most Acacias (umbrella-like) does not lend itself to wind speed reduction, but species such as *Acacia nilotica* can be managed in a dense shrub form to fulfil this role. If the boundary plantings are to be left to grow without additional management, their phenologies must be in harmony with adjacent crops. In the study area, many fields are utilised to produce summer and winter crops in rotation, and the planting of shade giving species on field boundaries may not be appropriate. Although, depending on local circumstances, it may be argued that the woody component has a beneficial effect on adjacent crops proportionally greater than the loss experienced from shading and other competitive effects, the farmer's perception in this regard must be determined. If the farmer perceives the space taken up by mature trees as excessive, planting will not take place. As with all farming innovations, the benefits must outweigh the risks in the farmer's perception if it is to be adopted. The space occupied by boundary plantings must consequently be minimised. This can be achieved through the utilisation of shrubs rather than trees, or by spacing trees and planting low-growing species in between the trees.

This thesis recommends *Acacia albida* (particularly suited to the sandy soils of the Biyela lowlands) and *Schotia brachypetala* as tree components on maize field boundaries. If spaced apart they could be interplanted with *Dichrostachys cinerea*, *Acacia nilotica* and/or *Agave sisalana* (also used for weaving and thatching in KwaBiyela) to form an effective windbreak and living fence. *Acacia albida* is recommended as it is a fast-growing legume which drops its leaves (a source of nitrogen) during the maize season (Rocheleau, Weber and Field-Juma 1988), contributing nutrients to the crop at the most beneficial period. It is also a possible source of fodder, and for this reason needs protection from livestock when young (e.g. sisal hedge). *Acacia burkei* and *A. robusta* could be planted as boundary markers (e.g. at corners of fields) to act as fuelwood producers and contributors to soil nutrients. *Acacia karroo* is suited to the formation of vegetable garden fences (due to its long thorns which also protect it from browsing livestock) and windbreaks, along with *Erythrina lysistemon* which drops its leaves in winter (Eliovson 1984) and casts a dappled shade in summer. Trials of exotic legumes (e.g. *Leuceana leucocephala*) are being conducted by the Institute of Natural Resources on six selected farms and possibly once again on a community garden (a previous trail was destroyed by flooding) to test adaptability and yield under local conditions.

Although legumes are able to fix nitrogen and are therefore particularly useful for improving soil fertility, a number of other woody plant species could be (and are) used in windbreaks and living fences. Of these, the indigenous *Spirostachys africana* (umThomboti) is the most promising. It is already used by survey respondents as windbreaks for dwellings and is sought after for the construction of dwellings and for shade. One respondent sells *S. africana* poles for construction and the timber has value in the furniture industry. This tree has a narrow, upright form and if planted on east-west boundaries, would not compete with crops for sunlight. In nature it grows in dense groups and could therefore be planted as dense stands, but should still be interplanted with a shrub or grass layer to reduce ground-level wind speed. However, it is not certain how these trees affect crop species (e.g. rooting system, possible toxicity), and this aspect requires further study before they can be combined with crops.

Other indigenous species useful for boundary plantings are *Ficus natalensis* and *Phoenix reclinata*. *Phoenix reclinata*, a palm tree found growing mainly in the Makasaneni and Dlomodlomo sections of the study area is a useful low-growing windbreak for boundary planting, but *Ficus natalensis* may occupy excessive land area on small farms when mature and has a significant shading effect.

The pepper tree *Schinus molle* is another promising species suitable for windbreaks (as seen on one survey respondent's farm) and should also receive attention for possible crop/tree combinations, but must be investigated in terms of a surface rooting system (as found in other *Schinus* species) (pers. observation), toxicity, and invasiveness (Moll, Moll and Crass Strebel 1989). Hedges composed of *Barringtonia racemosa* and *Bougainvillaea spp.* are presently planted for their ornamental value, but have potential as windbreaks for small vegetable gardens. *Melia azedarach* is self-seeding and found on many farms in the study area, but is invasive, has a surface rooting system (pers. observation), and drops toxic berries (Vahrmeijer 1981). Gum trees (*Eucalyptus spp.*) are not recommended (especially for small farms) due to their high water consumption. One respondent complained that a nearby stream had been dried up by a hilltop gum plantation. Pine trees (*Pinus spp.*) do provide effective windbreaks for homesteads (as seen on one farm), but the effects of their leaf-fall on soil quality and texture may make them unsuitable for field boundary plantings. They are, however, utilised as windbreaks on commercial fruit farms near the project area, but these are irrigated and fertilized. This is another topic requiring research. The planting of potentially large trees with a bare lower trunk section in uniform stands is not recommended for field boundaries in the study area, as air currents between such trees can have a scouring effect on the soil surface, increasing erosion (Rocheleau, Weber and Field-Juma 1988). The Black Wattle (*Acacia mearnsii*) is another exotic species which should be investigated for agroforestry purposes, although it is potentially invasive. Gum, Pine and Black Wattle trees are utilised by survey respondents primarily for timber and building poles (e.g. dwelling roofing poles), as well as fuelwood.

The diagnostic survey results show that fruit trees are the most sought after species in the study area. In fact, in one case the importance of trees was recognised only in terms of fruit production. The more visible benefits of fruit production may override the importance of trees for soil improvement and the farmers' perception in this regard seems to support this. Consequently, fruit tree components may prove more adoptable than legume components in some cases, although their potential as fencing and windbreaks is limited and most fruits are susceptible to removal or damage by wind. Also, the roles that certain legumes can play as fuel and building wood producers, as well as shade provision,are well recognised by farmers and enhance their chances of adoption. Nevertheless, fruit trees are still more attractive options to farmers than other species and should be a focus of agroforestry development in KwaBiyela. Fruit trees planted on boundaries will reduce wind speed to some degree, provided that they are semi-permeable to wind from ground level. The Guava (*Psidium guajava*) has become naturalised in the study area and can form effective windbreaks and living fences (it is used as a hedge on one farm), but must be used with caution since its surface rooting system (Rocheleau, Weber and Field-Juma 1988) may compete with adjacent crops. The beneficial attributes of *Psidium guajava* in terms of agroforestry are emphasised by Dekker (1991), who recommends the species for agroforestry development. These attributes include: easy cultivation, good growth rate in marginal soils, production of fruit rich in vitamin C, medicinal properties, useful timber, fire resistance, and the fact that it does not compete with indigenous grazing grass species; among others. The Kei Apple (*Dovyalis caffra*), an indigenous species, although useful for living fences, windbreaks and fruit production, also has a surface rooting system, making it unsuitable for small farms, and is slow-growing (Rocheleau, Weber and Field-Juma 1988).

Indigenous species favoured by survey respondents for their fruit (and shade) include *Syzigium cordatum* (umDone) and the Marula, *Sclerocarya birrea* (umGano), also used for fuelwood. *Sclerocarya birrea* is utilised in living fences elsewhere in Africa (Rocheleau, Weber and Field-Juma 1988), and may be suited to this purpose in the study area. Snyders, Machiné and Fourie (1991) show that this species has great commercial value and can be successfully integrated with cattle farming, with benefits to both components of the system as well as the ecology. *Syzigium cordatum* (umDone) is a potential source of animal fodder (M. Peden, On-Farm Trials, Visits to Participant Farmers, July 1992) and should be investigated for possible boundary planting. *Strychnos spinosa* (umHlale) is another indigenous fruit species which is mainly utilised for fuelwood and medicinal purposes in the study area. Its dense, thorny form makes it suitable for living fences/windbreaks, and it should receive attention from researchers (as regards possible negative effects on adjacent plants) for this purpose. The main advantages of indigenous fruit species are that they are adapted to the local environment, and require little maintenance.

Exotic fruit species planted by survey respondents include: peach, orange, naartjie, avocado pear, banana, sweet-banana, guava, mango, pawpaw, lemon and apple trees. Wind blows the fruit off the citrus, peach and apple species (farmers, pers. comm.), making windbreaks essential, and effectively excluding these trees from utilisation in crop windbreaks. The Lemon (*Citrus limon*) and Pawpaw (*Carica papaya*), like the abovementioned Guava (*Psidium guajava*), although fast-growing, have surface rooting systems (Rocheleau, Weber and Field-Juma 1988) and may compete for nutrients with adjacent crops. The most suitable exotic fruit species for boundary plantings are the Banana and Sweet-Banana (*Musa spp.*), the Avocado Pear (*Persea americana*), and the Mango (*Mangifera indica*). Banana trees are already utilised on a minority of farms in the study area as windbreaks for dwellings, and this function could be extended to crop field boundaries in areas of sufficient rainfall. The indigenous banana/maize agroforestry system utilises the wind speed reducing capacity of the trees to good effect. The Avocado Pear is an evergreen, fast-growing tree suitable for living fences in some cases (Rocheleau, Weber and Field-Juma 1988), and is planted on homestead boundaries in the study area. The fruit has a commercial value and is sold by farmers at roadside stalls. If the Avocado Pear can be managed as a small tree or shrub by local farmers, it may be suitable for living fences/windbreaks for crops in KwaBiyela, but otherwise should be planted only as individual boundary markers due to its shading effect. The Mango is planted by survey respondents in the same locations as the Avocado Pear, and its fruit is also sold by farmers. This tree is known to improve soil fertility (Rocheleau, Weber and Field-Juma 1988) and would therefore be a beneficial component in field boundary plantings. Its effect on adjacent crops would, however need to be investigated under local conditions.

The key to the implementation of boundary plantings in KwaBiyela is the spread of information on, for example, the benefits of mixing trees and crops, the cultivation of indigenous species, and the availability of seedlings at a nominal charge. Agents for the spread of such information could be INR fieldworkers already known to farmers in the study area, and local farmers' organisations. Planting material (i.e. seeds and cuttings) is available from indigenous forest on community land and trees already growing on farms. The introduction of exotic species (e.g. exotic fruit trees, *Leucaena leucocephala*) is more costly for both extension workers and farmers, involving transport of seedlings (available at a nominal charge from Ndundulu RSC) to individual farms, but the current demand for seedlings (especially fruit trees) from Ndundulu RSC seems to negate this effect. There does, however, seem to be a reluctance among local farmers to plant unfamiliar species (Morag Peden, INR, pers. comm.). This is another reason why resources should be directed towards the promotion of familiar, indigenous species for agroforestry development in the study area.

Survey respondents expressed a need for demonstrations before they would try agroforestry practices. For this reason, community gardens are promoted here as possible demonstration sites, linking in with the establishment of community gardens by Mr. A. Zondi, Agroforester for the INR. The planting of indigenous woody species in these community gardens (e.g. on boundaries) must be encouraged. Given the relatively long maturation period of tree components (as compared to crops) and the time required for the establishment of fully operational agroforestry systems, it would be advantageous if the planting of such species in community gardens could act as an incentive for individual farmers to do the same, rather than them waiting for the establishment of such fully operational systems. Information on tree/shrub cultivation, the advantages of agroforestry, and the availability of seedlings, cuttings or seeds, should therefore be available at community garden sites. Commercial, fuel and building functions must be stressed to improve chances of adoptability.

Multipurpose windbreaks and living fences are viable agroforestry options in the study area, representing an extension of current practices and the utilisation of species familiar to local farmers. Potential benefits in the local farming environment are manifested in all farm production subsystems, while conservation problems (e.g. soil erosion, depletion of indigenous forest) are simultaneously addressed. However, information on the phenology, yields and rooting systems of indigenous woody plant species is severely lacking and is a major constraint to future agroforestry development in the region. These factors govern planting densities and management requirements, and must receive greater attention than at present, with the current focus on exotic species which may not be adapted to local conditions over extended periods (e.g. drought response, soil structure). Also required are trials utilising a range of indigenous tree/crop combinations to study adaptability for boundary plantings.

On steeply-sloping exposed land, especially if the slope faces into the wind, a single windbreak may not be effective. In such cases, low shrubs interspersed with crops may be more effective at slowing wind speed around crops. It is possible to create microclimates for maize and other crops using such a method, but the break-up of, for example, a maize field, into a patchwork of shrubs and crops would hinder ploughing and harvesting. Rows of shrubs or low trees may be more appropriate and could form an extension of a boundary planting, repeating it across the field. This would constitute 'alley-cropping', an agroforestry practice which would require more labour input than monocropping under study area conditions (e.g. hedge management), and for this reason may not be as readily adoptable as boundary plantings. A solution to this problem could be the delimitation of small maize gardens bounded by shrubs or trees (i.e. relative advantage of small productive field versus large unproductive field). In effect this represents an extension of the 'home garden' principle into the maize field. Trees and/or shrubs in home gardens (Rocheleau, Weber and Field-Juma 1988) is regarded as the next most adoptable agroforestry practice, and will now be outlined.

### *5.4.3 Home Garden Technologies*

A home garden is defined here as a plot of land recognised as an extension of the homestead site on which concentrated cultivation occurs, mainly for food production, but also for products such as fuelwood and raw materials for craft industries.

In the study area at present, the roles of home gardens are, in most cases, kept distinct. They are utilised either to grow vegetables, or to grow fruit, not a combination of the two, and both types may be found on a single farm. Fruit trees (e.g. orange, peach, banana, avocado pear) are most often located on, or within, homestead boundaries, while vegetable plots (e.g. planted to amadombe, izindlubu beans and sweet-potatoes) occur adjacent to the homestead site. This recommendation seeks a combination of fruit and/or leguminous trees with vegetable crops. In the study area, the introduction of trees or shrubs into vegetable gardens, or vegetable cultivation below/adjacent to existing trees and/or shrubs is encouraged for the solution of a number of reported farming problems (e.g. decreasing soil fertility, soil erosion, poor infiltration of rainfall, weeds, pests).

Possible benefits to farmers include: increased food availability; cash from the sale of produce; cash savings from a reduction in purchased food (Rocheleau, Weber and Field-Juma 1988); fuelwood production; fodder provision; microclimatic amelioration; more efficient utilisation of land, labour, and natural resources; and convenience.

Leaf-fall from the woody component acts as a mulch layer, suppressing weeds, reducing evaporation, increasing the fertility and friability of the soil, and preventing the baking of the soil surface to a solid layer which increases rainwater runoff and erosion (as witnessed in the study area). These effects are advantageous for food crops as well as in microcatchments designed for the production of 'incema' reeds for weaving. Leguminous crops (e.g. beans) and trees (e.g. Acacias) are especially well suited to soil improvement and should be included wherever possible. Knowledge of the advantages of leguminous crops (e.g. beans) grown in association with other crops such as maize exists in the study area, and could form a basis for the introduction of a leguminous woody component into the farming environment. Labour-time efficiency is maximised by the concentration of production in one area of the farm close to the homestead, and space is saved by combining mutually beneficial species.



Recommendations made in this chapter should not be taken in isolation of one another. Rather, opportunities for combining species and practices from different agroforestry components should be sought and utilised wherever possible to maximise sustainability and productivity. For example, the tree component of a home garden can be arranged to act as a windbreak for the homestead. In fact, presently existing homestead windbreaks can form the basis for home gardens. A windbreak/living fence can also be established to protect the home garden from livestock. Browsing by livestock and antelope is a serious impediment to tree cultivation in the study area, particularly palatable thornless exotic species (farmers, pers. comm.). Possible solutions to this problem are offered by Von Carlowitz and Wolf (1991), and include *Euphorbia tirucalli* latex, sisal (*Agave sisalana*) fibres, Kapok tree (*Ceiba pentandra*) fibres, and fluffed-up sheep's wool. All of these materials were found to be effective in reducing browsing under artificially increased livestock stocking levels when applied (latex) or attached (fibres and wool) to seedlings. Importantly, sisal is cultivated in the study area (pers. observation), while various *Euphorbia* species, including *E. tirucalli* (a common live-fencing material), are indigenous to the region (Coates Palgrave 1984). Both of these should be subjected to research for selective browsing prevention under local conditions.

A tree, shrub, or grass component significantly reduces erosion on sloping cropland. As discussed in the previous recommendation, the effects of trees and shrubs on the microclimate can be beneficial to crops, and the same holds true for home gardens. With careful selection of species (see previous section), wind speed and temperature can be positively influenced while competition is kept to a minimum and soil erosion reduced.

Water utilisation is optimised by combining farm components. This is particularly true in KwaBiyela where valuable fruit trees (e.g. Peach) are hand-watered and any adjacent crop could benefit from this practice. Also, water loss through evaporation is minimised through microclimate amelioration.

A primary aim of this recommendation is to diversify production on a given area of land in order to spread the risk of failure among as many components of the farming enterprise as possible. This ensures that even under, for example, drought conditions, the land guarantees some production, be it food, timber, fuelwood, weaving material, or green manure.

As with the previous recommendation, the emphasis falls on utilising current knowledge and practices in the study area as a basis for the introduction of agroforestry. The abovementioned combination of practices can be achieved with a number of currently cultivated crops and trees in arrangements suited to individual household needs. Possible component species present on local farms include exotic fruit trees such as the Orange, Peach, Banana, Avocado Pear, and Mango; indigenous fruit trees such as the Marula (*Sclerocarya birrea*) and umDoni (*Syzigium cordatum*); leguminous species like indigenous Acacias; crop plants such as maize, sorghum, sugar cane, amadombe, izindlubu beans, ihlobo nuts, ibhece melons, pumpkins, tomatoes, cabbages, and chillies; and craftwork plants like *Juncus kraussii* ('incema') and *Agave sisalana* (sisal).

The various *Grewia* species indigenous to the region are multipurpose shrubs suitable for the understorey of a multistorey agroforestry system. An example is *Grewia flava* producing raisin-like sweet fruits from October to March, as well as fibre for basketry and weaving, and fodder for livestock. It is used for medicinal purposes, and to produce alcoholic drinks (Palmer and Pitman 1972). Other *Grewia* species which should undergo trials in the study area are *G. caffra* (producing fruit from February to July), *G. bicolor* (producing fruit from March to June), *G. villosa* (producing fruit from April to May), and *G. occidentalis* (producing fruit from January to May, and easily grown from seed or cuttings) (Palmer and Pitman 1972).

*Amaranthus hybrides*, the 'spinach tree' is adapted to maize-growing areas and may be appropriate to KwaBiyela. It is a fast-growing shrub, and its leaves, with a protein value equivalent to milk, can be harvested eight times a year and within two months of planting (trials conducted in the Orange Free State). Related processing and packaging industries are being developed in the Orange Free State (*Cape Times*, 2/2/93). Trials of this species and related hybrids should be conducted in the study area with a view to increased food production and possible local industry development. Its value lies mainly in food production, but in home gardens, it could act as a windbreak for other vegetables, and could be intercropped with maize.

*Melia azedarach* (umSilinga), a self-seeding, fast-growing, exotic species is a shade, ornamental and windbreak tree in the homesteads of many survey respondents. Although heavily invasive and possessing a strong surface rooting system, its poisonous berries dropped in summer have potential for pesticide production (Rocheleau, Weber and Field-Juma 1988). It could, therefore, fulfil a useful function in crop production and home-industry development if this potential is realised. Lemon grass (*Cymbopogon citratus*) is a natural insecticide and fungicide (*Earthfile*, BBC World Service Television 4/8/93) which may be suited to the study area and should be investigated for adaptability.

The combination of trees and crops in sustainable agroforestry systems is deemed adoptable in the study area as both components already exist on local farms, and survey respondents are positive about the potential benefits of this combination. Again, as with previous recommendations, the key factor in achieving this innovation is the availability of information and support to farmers, and the establishment of demonstration plots, particularly in community gardens.

These recommendations include only those agroforestry practices which are most adoptable in KwaBiyela, based on the results of the diagnostic survey. The focus has been on the individual farm as the centre of innovation for agroforestry development and community gardens as demonstration sites (for a balance between economic and ecological benefits). Potential does exist, however, for agroforestry on communal land in general (e.g. dispersed trees on grazing land, stabilised terraces on steep slopes, gully stabilisation using trees). Although of great ecological benefit (e.g. reducing soil erosion), community land agroforestry is more difficult to introduce, as it requires that each individual's access to the resource be determined, and a corresponding labour, time and capital input be decided upon (i.e. each individual's contribution to system establishment), before agroforestry component establishment can take place. Each individual's entitlement to the products and/or services of system components must also be determined, and should be related to his/her contributions in terms of labour, time and capital outlay. In short, community land agroforestry establishment is often a more complex process (with attendant potential for conflict) and this thesis recommends the establishment of agroforestry system components on individual farms (and in community gardens) initially, as a foundation for future agroforestry development in the region.

There is a definite need to integrate the idea of tree/shrub cultivation with that of problem-solving. At present, they exist as two separate, non-interacting spheres of thought among farmers in the study area. Coupled with this is the integration of the separate mindsets of tree/shrub planting and food crop cultivation.

In general, the challenge lies in spreading information about the potential benefits of trees and/or shrubs in the local farming environment. The patterns, combinations and locations in which these species are planted are not as important as the idea that they can solve many farming problems and contribute to increased, and sustainable, farm production. Farmers can choose where and why they want to plant trees and/or shrubs, basing their choices on the information (about suitable species and their cultivation, species availability, practices and management requirements) available to them. Of key importance is to make this information available to farmers, and not only to those with favourable access to resources such as water. Farmer advice centres employing local people and located throughout the project area (e.g. near 'tea rooms' and bus stops), where, for example, farmers could bring soil samples and be shown suitable species, could play a valuable role in this regard.

Other barriers to overcome in order to facilitate agroforestry development in KwaBiyela are the establishment of farmer support organisations or networks, and the conducting of relevant research, particularly on indigenous species for agroforestry. Potential centres for agroforestry innovation and dissemination, in addition to the individual farm (as mentioned above) include community gardens, schools, clinics, and the Ndundulu Rural Service Centre. To use a metaphor from an earlier chapter, the bricks and mortar of sustainable rural development are available in KwaBiyela, what remains is to foster the conditions under which these elements can be combined in the local context, to facilitate development that is sustainable.

## 5.5 General Development Needs and Potentials

Early in this thesis, a case was made for local people as the starting point for problem-solving in rural development. This entailed a balance between indigenous knowledge and modern innovations using local resources to solve local problems wherever possible. The agroforestry recommendations outlined in this chapter represent an attempt to put these ideas into practice in a sustainable manner. During the research for this project, and in addition to the basic recommendations, a number of general development needs and potentials within KwaBiyela have emerged. Many of these can be incorporated into an agroforestry development programme, while all are relevant to the KwaBiyela farmer. This section briefly explores these issues, relating them to possible rural development innovations for the study area.

### *5.5.1 Funding*

One precondition for the promotion of rural development in the study area (and elsewhere) is the availability of funding for the introduction of innovations and the support of local initiatives. In this regard, the 1991/2 Annual Report of the Department of Economic Affairs of the Kwazulu Government points to sectoral imbalances in the loan portfolio of the Development Bank of South Africa for that year between the various development programmes for which funding was allocated. For example, the Agricultural Development Programme received only 0.62 percent of loan finance, while the Urban Development Programme received over 25 percent of that finance. The same report points out that 'a particular cause for concern is that rural communities appear to receive very little [of the] development funds being channelled towards their upliftment and this situation will have to be reversed in future' (Kwazulu Government Service 1992:12). Funding for rural development, and particularly, access to available funding for local projects in Kwazulu/Natal, clearly require urgent attention if significant rural development is to occur. Looking at new projects in the Policy Speach of the Department of Economic Affairs for the 1993/4 financial year (Kwazulu Government Service 1993), the absence of agroforestry initiatives was noted. However, there was a commitment to rural development as evidenced by the proposal for the formulation of a White Paper on Rural Development in Kwazulu during the same period. It is not known what the future path of government funding for rural development under the new constitution entails, but the governement's Reconstruction and Development Programme (ANC 1994) points to substantial increases in rural development spending. This is a situation which has positive implications for rural development in the study area, and South Africa in general.

### *5.5.2 Water Provision*

A primary health requirement in KwaBiyela is an adequate, clean water supply. As shown in the diagnostic survey results, only seven of the 90 respondents have access to sufficient clean water fit for human consumption, and a year-round water shortage is experienced by over 83 percent of surveyed households. Only eleven boreholes have been drilled in the project area (Roy Dandala, Rural Development Facilitator, INR, pers. comm.) and there is clearly a need for more boreholes using low cost, low maintenance hand or wind pumps. Although vast potential exists in the study area for boreholes, a major obstacle in this regard is the high cost of borehole drilling.

Since the majority of households surveyed receive their water from rivers and springs (six of the seven with adequate clean water fall into this category), the key to improved clean water delivery may lie in improved water source management. Examples include the capping and protecting of springs, and farm and riverside plantings to reduce erosion and subsequent silting up of watercourses.

Reduced surface infiltration (and hence crop utilisation) and the corresponding increased runoff of rainfall due to the baked and compacted soil surface can be counteracted through the construction by farmers of microcatchments in which crops and/or trees can be planted. Farmers in the project area currently plough along contours, and this practice could probably be extended/modified to include microcatchment establishment on steep slopes (e.g. small terraces edged with shrubs and/or grasses).

The average wind speed for Melmoth, the nearest meteorological station to the study area, of 13.4 km per hour (Loxton, Venn and Associates 1985), as well as the wind damage problem described by survey respondents, shows that wind-powered pumps for water delivery are viable for KwaBiyela. In fact, one respondent suggested that such pumps could help alleviate water shortages in KwaBiyela. Research into the design, locations, maintenance and funding of wind-driven water pumps (as well as their association with boreholes) is a crucial first step in alleviating water shortages in many parts of the study area.

Moving to water consumption in KwaBiyela, a situation exists where water is converted into capital (e.g. by gum plantations), but the reverse is not true, with very little being invested in water provision systems. In effect, the formal economic sector (e.g. paper production companies) is 'exporting water' (John Richards, *Earthwise*, Radio South Africa, 2/5/93) from KwaBiyela, albeit with the full support of local people. This thesis urges that scarce resources such as water be managed to provide maximum benefit to the local population. Although producing financial rewards over the long term, the detrimental effects of schemes such as single-purpose plantation establishment in terms of environmental degradation (e.g. soil erosion after harvesting) and water recycling (e.g. water consumption of gum trees) show that this development path is unsustainable in the study area context.

### *5.5.3 Food Production*

The emphasis thoughout the recommendations has been on indigenous species as being most suited to dryland farming (practised by all survey respondents) in KwaBiyela. One major advantage of utilising indigenous species in farming enterprises is the production of a stable yield under all conditions (particularly in marginal environments), rather than a higher yield under optimum conditions. With the cultivation of 'indigenous' (i.e. non-hybrid) species (e.g. amadombe, izindlubu, ihlobo) in KwaBiyela and the promotion here of indigenous fruit tree species (e.g. *Sclerocarya birrea* and *Syzigium cordatum*) as agroforestry system components, great potential exists for the development, through selective breeding, of high yielding, low maintenance indigenous food species.

Work being done by Veld Products Research in Botswana on species including *Sclerocarya birrea*, *Vangueria infausta*, *Strychnos* species, *Richinodendron rautantenii* and *Grewia flava* (most of these indigenous to the study area and utilised by local people) for the development of superior cultivars from fruit trees/shrubs with economic potential (Frank W. Taylor, Veld Products Research, pers. comm.) is directly applicable to KwaBiyela. Co-operation between organisations such as Veld Products Research, the Vegetable and Ornamental Plant Institute of the Agricultural Research Council in Pretoria (researching indigenous vegetable crops like *Amaranthus* and Cow Pea), and the INR should be established and maintained as an essential contribution to agroforestry and general agricultural development in KwaBiyela. Of prime importance for the future of agroforestry development in the region is the maintenance of (recently established) links between local researchers and facilitators, and the International Council for Research in Agroforestry (ICRAF) in Nairobi, Kenya. This effectively places the study area into the context of an international network of agroforestry research, and provides a forum for the exchange of information and innovation between individuals and organisations.

A technological innovation in farming practice suited to the unpredictable climatic conditions and poor soil fertility of most of KwaBiyela is a method known as sub-hydroponic agriculture, recently introduced into South Africa by Mr. W. Fourie of Tyger Valley north of Cape Town, but widely used in Israel and Europe (*The Argus* 21/1/94). In sub-hydroponic agriculture, each vegetable plant is grown in a separate plastic bag filled with a soil and manure mix. The method is low-cost, labour intensive, water utilisation is kept to a minimum, and the weed problem is overcome. The soil mixture (which could incorporate green manure from on-farm trees in the study area) is replaced after three seasons. With each crop plant in a separate bag containing all its nutrient requirements, food crops can be grown anywhere, while being spaced and orientated during growth for maximum yield (e.g. shaded during drought, exposed to receive rainwater). Mr. Fourie has grown successful bean, lettuce and cabbage crops using this method, employing local people, and encouraging them to set up their own farms. Research in Israel shows that six people could be supported on one hectare of ground set aside for sub-hydroponic agriculture (*The Argus* 21/1/94).

Survey respondents mentioned insect pests as a serious food production problem. The high cost and health risks associated with chemical pesticides have meant that international pest control research is now focussing on biological pest control methods. Some of these methods should receive attention in KwaBiyela. The International Institute of Biological Control in Berkshire, England, is the centre of an international network, receiving biological control agents for quarantine, researching their pest specificity, and distributing them to regions experiencing pest problems (Dr. J. Waage, Director, International Institute of Biological Control, 'Pest Wars', *Horizon*, BBC World Service Television, 20/9/93). One such control agent is a fungus specific to the locust, the single most important pest species in KwaBiyela, reaching alarming numbers in some parts (as witnessed during fieldwork). The large numbers and mobility of locust swarms relegate their natural enemies to a spectator status, while chemical pesticides are often ineffective and expensive. The abovementioned fungus is easily distributed in spore form, is environmentally benign, and should be tested under study area conditions. Another sphere of research at the International Institute of Biological Control is in the spread of natural pest predators among crops (e.g. beetles, wasps, spiders, mites). This is achieved either directly (e.g. introduction of sachets of predatory mites developed by Bunting Biological Control Ltd. to rid tomatoes of thrips and whitefly) or indirectly (e.g. establishment of hedge banks by Dr. S. Wratten, Department of Biology, University of Southhampton in crop fields to provide a haven for predators and allow them access to pest species) ('Pest Wars', *Horizon*, BBC World Service Television 20/9/93) . Both practices are applicable to the study area, and the conducting of related research must be encouraged in KwaBiyela.

### *5.5.4 Energy supply*

Rapid depletion of resources such as fuelwood forces innovation in the direction of more efficient energy supply and consumption.

Emphasis falls here on food preparation as the primary consumer of heat energy in KwaBiyela. Paraffin and gas are currently luxury energy sources in the study area, too expensive to be used for everyday cooking and only available to those households with relatively favourable access to capital resources. Fuelwood therefore remains the primary source of heat energy, purchased and often transported long distances at great cost to those in areas with little or no tree cover. The multipurpose agroforestry systems recommended in this chapter are an attempt to address the current fuelwood shortage, and should be seen as a transitional solution, in anticipation of the utilisation of more efficient and environmentally benign sources of energy such as sunlight and wind, both abundant in the study area.

To be sustainable, any energy supply programme in KwaBiyela must concentrate on utilising renewable resources. Fuelwood plantings are an appropriate response, but may not be sustainable with the current rate of population growth. Electrification (from lines existing outside study area boundaries, purposely built wind- and water-powered generators, or solar panels), is the ultimate solution to the energy supply problem in KwaBiyela, but has limited potential at present due to the high cost of electrical appliances (e.g. electric stoves) and low incomes of the local population which are unable to support an electricity supply service. Also, the dispersed settlement pattern of the study area makes electricity supply to each household expensive to implement. Nevertheless, study area residents should have the option of an electricity supply and it is a necessary requirement for long term rural development in KwaBiyela. Feasibility studies should therefore be conducted throughout the study area. The potential for electricity generation using solar panels is highlighted by Gandar (1990) who states that the electricity needs of Natal/Kwazulu (now Kwazulu/Natal) could be supplied by solar energy installations covering only 0.1% of its surface.

Reduced fuelwood utilisation is possible through the design and operation of efficient wood-burning stoves (National Academy of

Sciences 1980). The benefits of stoves over the open fires used in the study area include improved heat transfer from the fire to cooking utensils, and smoke reduction. In order to introduce such stoves into KwaBiyela, they must be cheap and easily transportable. A more simple alternative might be a hood that fits over a pit dug into the ground, concentrating the heat from the fire below and providing a platform for cooking utensils. Against this recommendation stand the social (i.e. gathering place) and lighting functions of indoor fires mentioned by Gandar (1984).

In support of the argument for the utilisation of local resources to solve local problems, two clean, freely available energy sources require further attention in KwaBiyela: sunlight and wind. The current high cost of solar panels rules these out for the short term, but the direct use of concentrated heat from sunlight shows increasing potential. An example of the practical application of this principle is the solar cooker designed by Mr. E. Paetzold of Cape Town (*The Argus* 26/4/93; pers. comm.). Essentially a large bowl lined with foil and fitted with a centrally mounted cooking grid, the solar cooker can be angled to receive maximum sunlight, concentrating heat on the grid. A major drawback is the cost of manufacture on a small scale (R1000-R1500 each, if manufactured individually by Mr. Paetzold), but this would be significantly reduced on a larger production line (Ernst Paetzold, pers. comm.), pointing the way towards small business development and employment generation possibilities in the study area. Gandar (1984) found that the majority of fires in Kwazulu are made indoors and in the mornings or evenings, drawing attention to this as a key problem regarding the introduction of solar cookers. However, if fuelwood alternatives are available, such practices may alter in response. In more than one instance during the diagnostic survey, outdoor fires in bright sunlight were observed, as were the extreme concentrations of smoke from indoor fires during the day. For these reasons, it is maintained that the introduction of low-cost solar cookers may yet prove to be successful.

As mentioned earlier, wind-powered generators are a possibility for KwaBiyela, but the cost of appliances such as electric stoves, is prohibitive. The utilisation of the wind resource in wind-powered water pumps is more viable under present economic conditions in the study area.

### *5.5.5 Economic linkages*

Plantations supported by paper production companies represent the sole cash earner on many farms in the study area, but they are a long-term investment, land 'owners' are not permitted to utilise trees to be harvested, and at least one such plantation has been sabotaged by burning. Loxton, Venn and Associates (1985) recommended plantation establishment on steep slopes and land unsuitable for agriculture. However, local farmers are often forced to produce food on steeply sloping land (being unable to afford purchased foodstuffs), even if it is 'unsuitable', and other methods of economic production for sloping land in the project area context require research. A compromise needs to be sought, and one such compromise is the establishment of multipurpose woodlots incorporating indigenous species to strengthen local tree-based economic flows (e.g. fruit, fuelwood, timber, medicinal, and craft material production), rather than single-purpose plantations which increase dependency.

An innovation which has made Cuba self-sufficient in paper is the production of paper pulp, from the fibre by-products ('begas') of the sugar industry (*Azimuths Programme No. 8*, UNDP 1994). Sugar cane is grown in KwaBiyela, and the region has a vast sugar production infrastructure. Potential exists, therefore, for the development of a local paper production industry based on sugar cane. The advantages of sugar cane over tree plantations are its fast growth rate (a number of crops can be harvested in the time it takes for *Eucalyptus* trees to mature), the fact that it can be intercropped, as well as two raw materials being produced simultaneously - sugar cane and fibre for paper pulp. Also, the demands on the local ecology (e.g. water consumption, species diversity reduction) are greatly reduced and the crop is more easily transported. Sugar cane is surviving well in dryland systems in KwaBiyela only where rainfall accumulates (e.g. valley floors), and is well suited to cultivation in microcatchments, along with 'incema' reeds (*Juncus kraussii*).

The primary aim of economic development in the study area should be the development and support of existing and potential local economic linkages. Applying the innovations considered above, it is possible to integrate water, food and energy provision programmes with sustainable local economic development.

## 5.6 Conclusion

To conclude these recommendations, emphasis must again be placed on the vast potentials existing in KwaBiyela for its development on a sustainable basis. Both the agroforestry recommendations, and the general development needs and potentials, show how indigenous knowledge, practice and resources can be combined with modern technologies in a way that is beneficial to the local population and their environment. The greatest challenge facing development practitioners is the implementation of these innovations.

# CHAPTER SIX

# CONCLUSION

The structure of this thesis has reflected its primary objective - the practical application of the theory of sustainable development through the medium of agroforestry. It has been argued that to achieve this goal, it is necessary to adopt a problem-oriented, integrated and multidisciplinary approach, based on participation with local people and the application of indigenous knowledge and resources at the local scale; combined with the consideration of political, social and economic formations at the regional and national scales.

Of prime importance has been the goal of applying these aspects to a rural, resource-poor area of South Africa. The study area, being located in a part of northern KwaZulu/Natal, is representative of regions where relevant (i.e. focussed on local people) research and development (especially that applying the principles of sustainable rural development) is severely lacking. In these areas, local people are usually the last to be informed of the methods to be used for 'their development'. This thesis has supported the view that under certain conditions the goal of sustainable rural development is by no means unattainable in the study area, and consequently in many comparable parts of southern Africa.



## 6.1 Review

In support of the above approach, and coupled with an exploration of the theory of sustainable development, a sequence of four stages of the Agroforestry Diagnosis and Design methodology (Raintree 1987) was followed. The prediagnostic stage collated physical, economic and demographic information through a literature search. This was followed by the diagnostic stage which included the conducting of a questionnaire survey designed specifically to identify agroforestry potentials and opportunities; combined with personal observations, visits to INR agroforesters, and the compilation of a photographic record. In the design and evaluation stage, recommendations were made regarding suitable agroforestry technologies, while the final, planning stage discussed strategies for agroforestry component introduction and development. In conjunction with this process, relevant information on sustainable rural development and related technologies was obtained from a variety of sources, and utilised in support of suggestions regarding general development needs and potentials in the study area. The outcome of the Diagnosis and Design methodology will now be recapitulated, beginning with the diagnostic stage. This will serve to consolidate the findings of the primary research and the recommendations. In addition, the simultaneous application of the ideas contained in Chapter Two will assist in reinforcing the links between the ideology adopted by this thesis and its practical manifestation.

The diagnostic survey results have served four main functions. Firstly, the nature, success and sustainability of farm production systems in the study area over time were determined. Secondly, an overview of available farm resources was provided; and thirdly, the functioning of the farm production subsystems utilising these resources was described in detail. Finally, and most importantly, throughout the exercise farming (and related) problems were exposed, and potentials for their solution through the medium of agroforestry were elucidated. To demonstrate these points, a summary of the main findings of the survey now follows.

The survey found that the majority of respondents had been farming the same land (on average less than one hectare, and often on steep slopes) all their lives, utilising a dryland monocropping system with maize as the primary crop. Continuous maize monocropping, a history of low input (due to the prohibitive costs of fertilisers, land and labour shortages), and demographic, socio-economic and environmental factors (e.g. population growth, migrant labour, and drought), have combined to produce an unsustainable low input - low output agricultural system. The related problems of overgrazing, soil erosion, and poor soil fertility occur throughout the study area, with indigenous crops and trees proving more resistant to the harsh conditions. Watersheds were found to be overgrazed and eroded (gully, sheet, slump and rill erosion being evident), and the water supply (from rivers, streams, boreholes, and tanks) in over 83 percent of surveyed households was reported to be inadequate throughout the year.

Regarding farm tree resources, the survey provided information on tree species, site and usage preferences, as well as problems related to this resource; information which was to prove invaluable in recommending agroforestry components for introduction. Trees are utilised for food, shade, fuel, windbreaks, live fences, and building material, while a distinct preference emerged for locations on boundaries (windbreaks, live fences, fuel, building material) and adjacent to dwellings (shade and fruit). Respondents often did not regard trees as possible solutions to problems such as wind damage or soil erosion, but after being prompted agreed that trees could solve many problems and increase farm production. A lack of knowledge on tree cultivation, previous unsuccessful attempts, shortage of cash for seedlings, and lack of space were cited as reasons for not planting trees on the farm.

A shortage of soil nutrient inputs proved to be the most serious barrier to increased farm production. Other factors reported were land and labour shortages, as well as shortages of cash for tractor hire, dam construction, and irrigation system installation. Available resources are therefore unable to support maize monocropping, a practice which has denuded the soil of nutrients. A suggestion put forward at this point was that development interventions should investigate methods for increasing farm production which are not capital intensive - agroforestry being one such candidate technology. It was argued that low-maintenance agroforestry systems are particularly well suited to addressing the problems inherent in the current land-use system, as they are able to maximise returns to the scarce factor of production.

On-farm labour inputs were found to be primarily female. These are the same people who collect water (taking up to half a day to complete this task) and fuelwood, construct dwellings, look after the household, and care for the children. The subsequent low labour availability for cultivation cannot support the high labour requirements of maize monocropping, and an argument was put forward for the introduction of female-centred, intensive, small-scale and conveniently located technologies for increased farm production.

Almost two thirds of surveyed households receive income from the formal economic sector concentrated in urban areas. Study area employees in this sector are mainly male, who account for almost all of the household absentees resulting from migrant labour. Income received from this source (often low and unreliable) is usually unable to offset the resulting labour shortage. The informal economic sector - in which over 25 percent of surveyed households are involved - was found to be the most direct and regular contributor to the household economy, but suffers from a lack of resources (e.g. financial aid, raw materials for cottage industries). Consequently, a high level of urban dependency exists in the study area. It is therefore apparent that the informal economic sector must be strengthened, and the local economy boosted, if a path towards sustainable development is to be initiated. Since the majority of informal sector employees are female (the same people tending the farmland and homestead), development technologies must be household-based, as well as labour, time, and capital efficient. Agroforestry was therefore promoted for its potential to support local informal sector initiatives by supplying the required raw materials and systems.

Respondents indicated staple food and school fees as their main cash expenditures, with others including building material, seedlings, manure, clothing, cattle, and tractor and oxen hire. In most cases cash income was reported as low and mainly used to meet subsistence needs. Low wages and the reduction of cattle wealth by resource depletion and drought mean that very few households have the resources required to meet unforeseen circumstances, or to improve their situation. As a result, only a small minority of respondents have savings at post offices or banks.

Food production systems fail to supply staple food requirements (maize and beans) in most of the households surveyed. The cause of these shortages was shown to be a complex interplay of the abovementioned factors such as land and labour shortages, sources of income, soil erosion, wind damage, poor soil fertility, and drought. Cattle and goats graze on the natural vegetation and experience problems such as seasonal weight loss, low milk production, and high mortality from disease (often drought-related); partly as a result of resource constraints including shortages of grazing land, soil erosion, and the poor nutritional quality of feed material. Overgrazing is common in the study area, and poor maize yields mean that there is a shortage of chicken feed. With cattle as the main indicator of family wealth, an effort is made to own as many as possible, with disastrous results for the local ecology. A comparison with a survey conducted in 1985 showed a reduction in the average head of livestock and range in number per owner since that period, the result of the effects of unsustainable resource utilisation and/or the disappearance of the 'cattle culture' through a process of modernisation. Food production systems must therefore evolve towards the efficient utilisation of available resources in response to current problems. To this end, this thesis has promoted a recycling approach to food production in the face of resource depletion.

Energy needs are supplied by fuelwood, paraffin, gas and dry manure to various degrees. Fuelwood is used by all households surveyed with over half relying exclusively on this energy source, and the others combining it with paraffin and/or gas and/or dry manure. Reported problems encountered in supplying fuel needs include: the cost of purchased fuel (all types), diminishing fuelwood supplies, and the time required for fuelwood collection (on average three to five hours).

The survey found that most households purchase wood for construction, with respondents highlighting problems with regard to the high cost of the wood and its transportation, and recurring shortages. Only a minority of farms are fenced, and it was found that the majority of respondents felt they lacked sufficient shade trees (in the homestead and for livestock). The last shelter factor to be considered was wind damage, and almost all of the households surveyed experience a wind damage problem. It is thus evident that windbreak and fence establishment is a priority for local agricultural development.

Tree-sourced products (e.g. fuelwood, building and fencing material) are therefore vital to the functioning of local society. With the survey highlighting the difficulties experienced by the study area population in ensuring the supply of such products (e.g. high cost, distance to source), a need presently exists for on-farm tree planting. The resulting tree-crop interface, it has been suggested, is best addressed by agroforestry practice.

On the subject of agroforestry implementation, the survey produced three supportive findings. Firstly, opportunities for agroforestry development exist in KwaBiyela (and probably in similar areas countrywide) utilising indigenous and exotic plant species in extensions of current dryland farming practices. Secondly, a successful indigenous agroforestry system exists in the study area. It is a banana/maize system and its advantages as stated by survey respondents are a saving in labour input (as compared to a banana monoculture), reduction of wind damage, larger and improved quality maize yields, and the fertilising effects of maize residue. Finally, the vast majority of the survey population were positive towards agroforestry practices for reasons such as space saving, wood and fodder provision, and soil improvement; and reasons given for not adopting agroforestry (e.g. lack of experience with mixing trees and crops/livestock, tree competition, heat, water shortage, lack of knowledge on tree planting and tree/crop/livestock combinations, expense incurred in agroforestry establishment) can be addressed through careful selection of plant species, combinations, layouts, and management procedures. Other findings suggested that there is a need to introduce agroforestry components with a minimum of risk to the farmer, and that a serious lack of farmer support services currently exists in the study area.

Visits to four INR agroforestry program participants utilising exotic species (e.g. *Leucaena leucocephala*) as windbreaks and for soil improvement and fodder production, showed that two of these systems were progressing well (one being irrigated, the other on level ground), but one had died from drought and another was overgrown with weeds. The photographic record compiled during the survey provided an opportunity to study landscape, land use system, and population distribution in more detail after the survey, subsequently being used to illustrate current agroforestry practices and problems such as crop failure and soil erosion.

Following the discussion of survey results, five case studies were selected to show how local farming systems function and to integrate the results of the diagnostic survey (showing the interrelationships between the various farm production subsystems) in a portrayal of rural life in the study area.

The diagnostic survey has exposed the clear interconnectedness of the different farm production subsystems (cash, savings/investment, food production, energy, shelter, raw material subsystems) and the factors that influence them (e.g. the political economy). Thus the ideas contained in Chapter Two have been reinforced, while elements of the human-environment relationship in the study area have been quantified with the aid of a questionnaire, highlighting major problems requiring immediate solution. For example, the traditional ideal of maximum cattle ownership has interacted with politics in the form of the 'homeland policy' to cause overstocking and subsequent overgrazing. Overgrazing has, in turn, exposed the topsoil causing soil erosion. The resultant shortage of grazing, combined with the onset of drought, has led to substantial cattle mortality, affecting farmer investment and cash enterprises, while removing the much-needed manure input. Any manure that is available may be used as fuel in the face of a fuelwood shortage. Furthermore, the migrant labour system, another outcome of the South African political economy, has reduced local labour and capital availability. Simultaneously, the drought, reduction in soil fertility, and soil erosion have damaged crops. Farm production has therefore declined, forcing the purchase of staple foods with a decreasing, often urban-sourced and unreliable income, further deepening the poverty of the study area population. Furthermore, shortages of fuelwood and building materials due to deforestation necessitate the purchase of these requirements, while a shortage of cottage industry raw materials reduces income-earning opportunities. Any willingness to address food and capital shortages through, for example, agroforestry practices, is hampered by factors such as a lack of knowledge on methods of tree cultivation, as well as the absence of infrastructure and institutional support. The situation described above indicates that people in the study area currently have little control over their situation. A need therefore exists to empower the population in relevant decision-making processes.

The combination of a diagnostic survey, personal observations and visits to INR agroforesters therefore supplied information on local farming practices; resource access, use, shortages and potentials; indigenous knowledge on tree utilisation; and the current state and awareness of agroforestry in the study area.

The results of the diagnostic survey have thus provided an idea of the problems faced by the residents of the study area. But it must again be emphasised that the aim of this thesis has been to contribute to problem solving. In this regard, the survey has not only supplied information on farming and related problems, but, most importantly, has exposed opportunities for their solution along sustainable lines. An attempt has therefore been made to look beyond such problems towards the utilisation of locally available resources for their solution. The unique strength of agroforestry interventions in the study area context (and in many similar contexts) is their ability to address simultaneously a multitude of farming and general development problems in an integrated manner. For example, a low-maintenance windbreak occupies a minimum of space, requires little labour input, and is cheap to establish. The same windbreak may, in addition to its shelter function which reduces crop damage from wind and increases yields; provide fuelwood, green manure, fodder and building material; reduce soil erosion; and afford income opportunities (e.g. building pole and fuelwood sales). The promotion by this thesis of the indigenous species mentioned by survey respondents has the advantage of ensuring a higher degree of component survival and farming system success. In this way the low input - low output cycle and its link to increased poverty can be broken. Keeping these advantages in mind, it must not be forgotten that agroforestry introduction requires support from a number of sources. Agroforestry development should take the form of an interactive process with contributions from local people, researchers, extension and funding agents and others if it is to progress and make a contribution to the achievement of sustainable rural development.

Continuing through the the sequence of the Agroforestry Diagnosis and Design methodology, the next stage reached was that of design and evaluation. The ex-ante evaluation aspect fell beyond the scope of this thesis, and the task of this stage therefore consisted of making recommendations concerning potentially suitable agroforestry and related technologies. To fulfil this task, a three-phase process was followed. The first phase (possibilities) consisted of the identification of appropriate technologies. Within this phase, information obtained from the survey regarding the local response to agroforestry, basic needs, farming problems, and the current utilisation of the tree resource, was integrated into a list of positive indicators for the introduction of an agroforestry programme in the study area. These indicators formed the basis for the compilation of a list of agroforestry possibilities.

In the second phase (probabilities), those technologies deemed to be most suitable with respect to the diagnostic survey results on resource access and availability were selected from the list of possibilities. Central to this phase was the recognition of the vital adoptability aspect of agroforestry interventions, where it was argued that to achieve adoptability, a farmer-centred approach must be taken, building on local initiatives. The importance of understanding indigenous agroforestry systems in the first instance, utilising a diagnostic approach to address perceived problems, and considering the economic advantages of various systems, was emphasised. Concurrent with the focus on problem solution was the objective of incorporating indigenous multipurpose species wherever possible, particularly those preferred by the local population; and an emphasis on locations chosen by survey respondents. Of particular significance was the recommendation of components which are flexible, interchangeable, and can be adapted by the farmer to suit each situation. The large number of possibilities for agroforestry interventions in the study area were subsequently filtered through the consideration of adoptability, and were narrowed down to three probabilities (i.e. the existing banana/maize system, boundary plantings, and home gardens).

In the final phase (recommendations), potential technology specifications as they relate to the functions, location, components, scale, arrangement, and management of components, were finalised (i.e. the design of the probable technologies identified in the previous stage). The outcome of this three-phase process was a selection of recommendations for the development of agroforestry activities deemed to be adoptable by the study area population in the form of a selection of system components (although consultation with farmers and on-farm trials are required to test local applicability), and open to experimentation and alteration by them with support from interested parties. Reflecting these factors, the recommendations included: the dissemination of the banana/maize system indigenous to the area, boundary plantings as windbreaks and living fences, and home garden technologies. The focus was on the promotion of self-help and self-sufficiency through available resource maximisation, and the practical application of sustainable development theory.

Recommendations were also made concerning general development needs in the study area as they relate to financial support for rural development; water provision (stressing the need for boreholes, improved water source management, microcatchments, and wind-powered water pumps; along with the dangers of single-species plantations); food production (emphasising indigenous species, sub-hydroponic agriculture, and biological pest control); energy supply (promoting renewable energy sources); and economic linkages (supporting tree-based economic flows, and the production of paper pulp from the by-products of the sugar industry).

Although the theoretical basis and context of agroforestry have been extensively discussed, the emphasis has been on its practical implementation in the study area and beyond. Agroforestry has been suggested as a viable and adoptable option for attaining sustainable livelihoods in the study area, while playing a potentially important role in achieving sustainable rural development on a regional basis.

The final stage of Agroforestry Diagnosis and Design followed in this thesis - the planning stage examining research development and extension needs - was included as part of each recommendation; and will be enlarged upon, in the general sense, in the next section, which covers agroforestry development needs in South Africa.

## 6.2 Agroforestry Development Needs in South Africa

The concept of agroforestry represents a fundamental change in the way that agriculture is viewed in South Africa (and in much of the developed world). This thesis supports agroforestry as the optimum response to unsustainable resource utilisation through monocropping and the way forward for a fully integrated, recycling, and sustainable approach to farm production.

The proceeds of the Conference on African Agroforestry with emphasis on southern Africa held in Nelspruit in August 1991 (Koen 1991) give perhaps the best indication as to the current state of agroforestry in South Africa. The conference aimed to discuss and evaluate the application, implementation and development of agroforestry (Van Daalen 1991). Some of the findings to emerge from this conference were: the current lack of progress in agroforestry implementation (Gandar 1991); the urgent need for agroforestry in rural South Africa to address environmental degradation and energy supply problems while increasing local productive capacities (Viljoen 1991); the education of the population as regards the financial and personal benefits of tree cultivation (Stratten 1991); the importance of utilising a participatory approach for agroforestry development (Taylor 1991); and the need for co-ordination amongst interested parties to formalise a national strategy agroforestry research and development (Walmsley 1991, Fenn 1991). Overall, the conference yielded a positive attitude towards the potential for agroforestry development in South Africa. The requirements for supporting this process will now be discussed in more detail.

Agroforestry development at the single-farm scale in South Africa demands interactive support from all relevant parties (e.g. local farmers, extension agents, researchers) while agroforestry's move from contributions to sustainable livelihoods towards sustainable rural development on regional and national scales in the country requires institution building, financial support, and policy restructuring; both processes occurring along the lines of the government's Reconstruction and Development Programme (ANC 1994). To this end, agroforestry development in South Africa must be approached on two levels: a basic needs level (e.g. dealing with the provision of food, fuel, shelter, and building material); and a development needs level (e.g. providing educational, infrastructural and marketing support).

At the basic needs level, there is an urgent requirement for surveys to identify the needs of the resource-poor population; the instigation of methods to ensure seedling supply; and the dissemination of information on tree planting, the cultivation of indigenous species, and agroforestry component establishment. Simultaneously, surveys need to be undertaken to discover and catalogue indigenous knowledge, practices, and experimentation as they relate to farming experience under local conditions. Attention should be drawn, here, to the issue of secure land tenure as a requirement for land improvement. Although it may be expected that people will minimise farm inputs unless they possess freehold tenure, no such barrier was encountered during the diagnostic survey and local people are improving their land (held under tribal tenure) whenever resources permit (e.g. by erecting fences, planting trees, and practising crop rotation). In South Africa at present, it is more important to secure access to resources and services for the majority of the population under a new constitution, to provide a stable context within which to work towards sustainable rural development. Small-scale farmers must be incorporated into an agroforestry development network within which all of these processes can be conducted in an integrated manner with feedback occurring at all levels, and between all parties involved.

At the development needs level, in addition to the above occurring on an ongoing basis, links must be forged between sustainable livelihood promotion and economic development along environmentally sustainable lines. For this to be realised, a number of prerequisites need to be met. One such prerequisite is the stimulation of rural-urban economic linkages through the provision of marketing opportunities and support services for small-scale farmers and related rural-based small industries. The introduction of agroforestry education and training programmes aimed at all sectors of society, from farmer to government level, and the inclusion of the subject in appropriate syllabi, is another necessity. Emphasis must be placed on the establishment of a national database to record agroforestry activities throughout the country (Underwood 1991), linking this to databases worldwide (e.g. that of the ICRAF) to permit the exchange of information. Local research and extension capacities will have to be strengthened by training and employing local people (Fenn 1991). In conjunction, incentives need to be provided for related scientific research. Agroforestry must be integrated into rural development and farming programmes and included as part of a multidisciplinary approach to rural development. An institutional framework to deal with agroforestry development should be established (Von Maydell (1987) draws attention to the lack of an institutional "niche" for agroforestry in Africa which limits the availability of resources for research and development), and the co-operation and exchange of information amongst development agencies on local, national and international scales, encouraged. Stemming from such an initiative would be the implementation of a co-ordinated national agroforestry development policy (Fenn 1991), forming part of a national agricultural or food supply development programme. Priority should be given to the practical application of farming innovations and the exchange of information between farmers and researchers. At both the basic and the development needs levels, much could be achieved simply by reducing impediments to the flow of information between interested parties (e.g. local farmers, researchers, NGOs, extension agents, and government structures).

This would involve the opening of channels of dialogue between such groups through their incorporation into an agroforestry development programme.

The introduction of commercial agroforestry-based enterprises in place of monocropping implies a challenge to the vested interests of industries and structures supporting monocropping (e.g. agribusiness, marketing structures). In addition, it requires fundamental shifts in farming practices, not to mention funding for initial establishment. This emphasises the importance of an integrated approach to agroforestry development, demanding the support of financial institutions and policy-makers.

If agroforestry remains cloistered within research organisations and enjoys consideration and discussion only amongst academics, it is unlikely to reach its full potential as a facilitator for, and stimulator of, sustainable rural development. It has to be promoted, publicised and funded on local, national and international scales to achieve its full potential. This is especially true in South Africa where very few people beyond academic circles, other than isolated small farmers, have even heard of the practice of combining trees with crop plants and/or livestock, known as agroforestry.

To give agroforestry 'public currency' and encourage financial support from the public and private sectors in this country, it will be necessary to emphasise its environmental benefits (e.g. reduction of soil erosion, agrochemical pollution, and greenhouse gases; combatting of deforestation; conservation of indigenous species), in addition to the benefits accruing to local people (e.g. food, fuel, shelter, craft materials, attaining sustainable livelihoods). This is the approach adopted internationally in gaining support for causes such as 'the saving of the rainforests', and may be the appropriate route to take in ensuring public participation in agroforestry promotion, and the acquisition of funding for agroforestry research and development.

To end this section it is necessary to go full-circle and focus attention once again on the political and social factors discussed in Chapter Two. One hindrance to the establishment of a national agroforestry development programme is the apparent slowness of the transition process in the country. With the establishment of a new bureaucracy still underway, it will be some time before development programmes are initiated. In addition, if a national agroforestry development programme is viewed as a tree, the branches of which represent the production, shelter and service roles (Raintree 1987) of agroforestry components, with the roots (i.e. networks linking participants) supplying the 'nutrients' of institutional, economic, financial and political support; this 'tree' of agroforestry development must be planted in stable ground (i.e. stable political and social formations) before it is able to grow and bear fruit. The latter is particularly relevant for the study area which is located in a region experiencing escalating politically-motivated violence during a period of structural transition. A stable social context is a crucial requirement for a future-oriented society and the current violence in the country therefore militates against the achievement of sustainable rural development.



## 6.3 Conclusion

Previous chapters have discussed the interrelationships between political, social, economic and ecological spheres and suggested that agroforestry can supply the means to integrate these spheres. It is therefore fitting that the political and social transformations underway in South Africa be accompanied by a transition towards farming practices equipped to provide for the needs of its population on a sustainable basis, while simultaneously improving the state of the biotic and abiotic environment. Attention must be drawn to the recently-initiated redistribution of previously white-owned farming land as stated in the government's Reconstruction and Development Programme (ANC

1994). Such land, having been intensively farmed, requires continuous, expensive inputs (e.g. fertilisers and pesticides) to ensure the yield of hybrid crops under monocropping systems. The limited capital resources of the people likely to settle on this land impose severe restrictions on inputs and demand the introduction of cheap, efficient agricultural methods. Agroforestry's ability to provide multiple, sustained outputs and benefits with minimum input, potentially increasing production and income, makes it a dynamic, potent, and workable option for the development of the country and its people.

This thesis concludes on the hopeful note that with peace will come opportunity. With our access to vast natural (e.g. indigenous species) and human (e.g. indigenous knowledge and practice, research capability) resources, the people of South Africa have a unique chance to grasp opportunities for sustainable rural development and consequently for the development of the country as a whole. The timely initiation of this process is critical to ensuring future prosperity. One potential contributor to this process is the practice of agroforestry.

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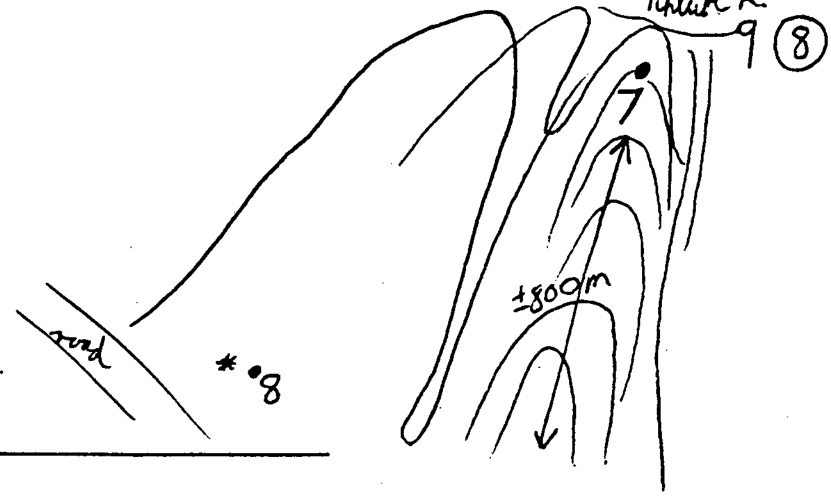
# APPENDIX A

## DIAGNOSTIC SURVEY QUESTIONNAIRE




## DIAGNOSTIC SURVEY

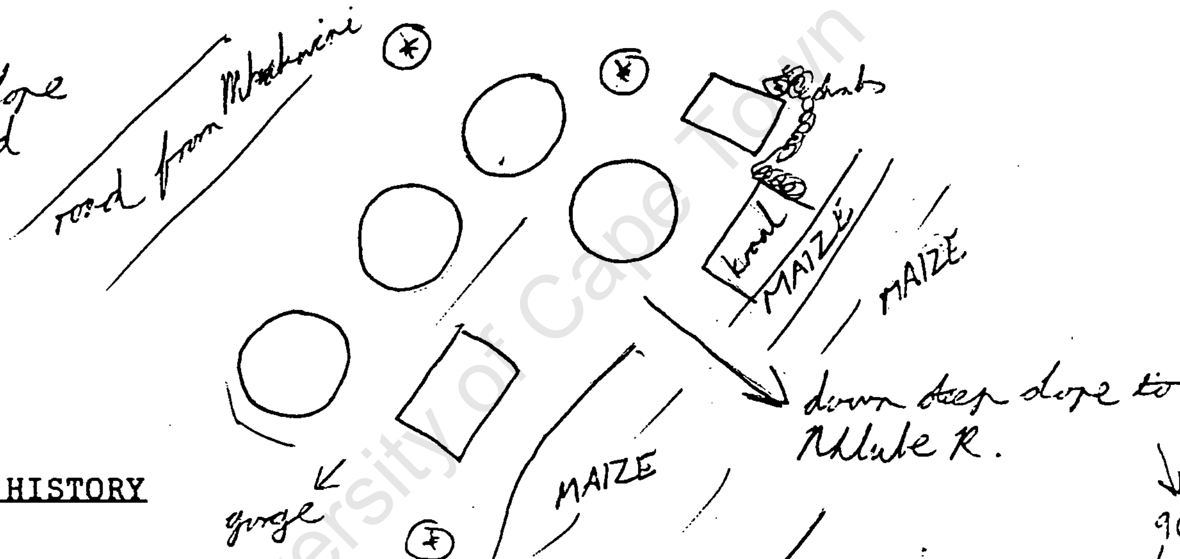
Date: 1/3/93

Location: MPHEMVU

Farmer's name KHALESAKHE MBUYISA (owner) KHANGEZILE (rep)

Notes on landscape features, general land-use pattern, location of enterprises, variations in soil type, crop stand, vegetation cover, farm infrastructure. Visual evidence of farming problems e.g. soil erosion, physical condition of farm.

photo
steep slope
near road
Woman-
reading
dress old




9① down slope across gorge on edge incised Nhlute R.

## LAND USE HISTORY

1) How long has the farmer been farming this particular land?

Already cultiv when born: 34 yrs old

2) What form of land use was practiced at the beginning of the period?

Maize - dryland

What changes in land use have occurred and why?

/

3) What was the condition of the land at the beginning of this period and what changes have occurred since (veg. & soil )

Soil was fertile, now not.

FARM RESOURCES

Land 4) Estimate approx. area of rainfed and rough grazing land on farm: bigger than (7)
- maize fields: 100 200m

5) Does the household have access to other land outside the farm? If so, note:
location: No

use (crops, grazing, fuelwood etc.):

approx. area:

terms of usage (e.g. communal, private, borrowed, rented):

Labour 6) How many people work on the farm full time? note sex and age (adult/child):

Only her

7) How many people work on the farm part time? note sex, age and time of year (for what farm operations):

2 males - family

8) Does the farm ever hire labour? For what operations, how long, and at what cost?

use tractor
tractor R200 - 1 day

9) If labour is hired, what is the source of cash for this purpose?

/

Water 10) Note water source(s) on farm:

/

11) What off-farm water sources are used? Note use (livestock, drinking, other), season of use and distance to source:

Nhlube R.

Trees 12) Note location and use of trees on farm.
Relate the use (fruit, fodder, building materials, living fences, shade, windbreak, etc.) to the location (farm boundaries, compound, woodlot, cropland, grazing land, etc.)

umThomboti, uJagane, guavas
- near home
→ on boundary

13) What off-farm tree resources are used by the household? Note use, location/distance, and terms of usage:

/

Livestock 14) What livestock does the farm have?
Note type of animal, number of each type, and the use for which the animals are raised (e.g. on-farm vs. sale of milk, meat, manure, live animals, breeding stock):

1 cow
chickens

15) <u>Most limiting factors to farm production</u>
Relative scarcity of land, labour, cash:
e.g. "If you want to increase production, which would you need more- land or labour, or cash for farm inputs, hiring labour, draught animals etc.

Cash for manure
Enough land & labour

## TROUBLE-SHOOTING FARM PRODUCTION SUBSYSTEMS

### CASH SUBSYSTEM

16) What are the main cash expenditures of the household?
    direct to adults of both sexes.
    Free response: "What else?":
    Indicate approx. rank order of main expenses.
    Check against: staple foods, minor foods and sundries, fuelwood, building materials, crop inputs, hired labour, farm equipment, livestock, veterinary services, raw materials for home industry, school fees, social expenss etc.

Food
School fees R50/child/yr x2
R30/month each for tpt



17) What are the main sources of cash for the household?
    Free response:
    Check: off-farm employment, gifts or remittances, sale of cash crops, "surplus" food crops, livestock or livestock products (milk, wool, manure etc.), cottage industry products, other sources.
    Indicate approx. rank order of main cash sources.

Husband works on commercial farm

18) Does the household always have enough cash to meet its needs? If not, which expenditures are most difficult to meet?

No
Food

19) Which of the following best characterises the role and adequacy of cash income in the household economy?

a) Cash income is low and mainly used to meet subsistence needs.

b) Cash income is more than adequate to meet subsistence needs and there is a moderate 'surplus' left over for consumption of 'luxury goods' and/or savings/investment.

c) Cash income is adequate to maintain a higher than average standard of living for the area and a substantial part of the income is or could be used for saving or investment.

20) Trouble-shoot the major cash enterprises to identify production constraints and causal factors responsible for low cash income and/or to identify potentials for improvement. (esp. if answer to 19 is "a").

Note: production and livestock enterprises are covered later, so they need not be gone into in detail here.

Focus on "cash crops" per se, on other cash generating enterprises (e.g. cottage industry), and on post-harvest problems like processing, transport and marketing. Checklist in no. 27 can be used as an aid in trouble-shooting cash crops.

SAVINGS/INVESTMENT ENTERPRISES

21) Most farm families would like to have a savings or investment enterprise either to meet unforseen expenses (e.g. medical) or to realise higher ambitions (e.g. build a new house, send children for higher education etc.).
Does this farm have any such enterprise (i.e. not part of the normal cash flow activities)? If not, why not? What prevents it?
(note: savings & investment need not be interpreted in narrow financial sense, livestock may constitute savings on the hoof while timber trees may be planted as an "investment" for the future or as a buffer against unforseen financial problems).

No, subsistence



22) Trouble-shoot existing savings/investment enterprises to identify constraints, causal factors and potentials for improvement.

/

## FOOD PRODUCTION SUBSYSTEM

23) Which of the following best characterises the general strategy of the household with respect to food supply?

a) The household aims to produce nearly all of its staple foods and usually succeeds in doing so.

b) The household would like to produce nearly all of its staple foods but often fails to do so.

c) The household aims primarily to generate sufficient cash income to purchase a substantial amount of its staple foods and relies on farm produced food only to supplement purchases.

24) Discuss with the household members to find out whether shortages of farm produced staple foods occur:

a) only in "bad years" (estimate frequency of bad years)

b) in most years (est. frequency of inadequate harvests)

c) even in "good years" (i.e. every year)

25) Which foods are affected?
Is there a seasonal pattern to food shortages?

Maize

Food shortages all year

26) How does the household cope with food production shortfalls? What strategies do they follow in meeting family food needs when harvests are inadequate?
Are there any 'insurance crops' or occasionally used 'famine foods.
How often is external famine relief necessary?

Buy

No famine foods used

Famine relief never received

27) What are the causes of food production problems?
Trouble-shoot the crop production enterprises to identify causal factors and constraints involved in the failure to meet household food production objectives.
Free response: e.g. "what are your main problems with food production?" "Are there any others you can think of?"
Supplement info. given by farmer with direct field observations.
Only then use trouble shooting checklist.

drought
erosion
high temps
low soil fertility

## TROUBLE-SHOOTING CHECKLIST FOR CROP PRODUCTION ENTERPRISES

### Resource Constraints
- lack of land
- lack of labour
- lack of draught power
- lack of cash for inputs
- inadequate knowledge or skill (be specific)
- other resource constraints

### Farm Management Constraints
- soil erosion (specify type: gully, sheet, rill, wind)
- flooding/waterlogging
- salinization
- soil toxicities
- weeds
- diseases
- insect pests
- other pests
- theft
- other hazards

### Constraints on Plant Growth

#### Inadequate moisture
- inadequate seasonal rainfall
- poor distribution of rainfall
- poor infiltration of rainfall
- low water holding capacity of soil
- inappropriate crop varieties for local rainfall regime
- other water-related constraints

#### Other climate-related factors
- temperature stress (high or low, explain)
- wind dessication of crops
- physical damage by wind, heavy rain, hail, etc.

#### Low soil fertility
- inherently low fertility of soils
- lack of nutrient return or inputs
- specific nutrient deficiencies
- low organic matter content

#### Poor soil physical conditions
- shallow soils
- poor structure/consistency
- poor drainage/aeration
- poor workability

### Marketing Problems for Cash Crops
- lack of markets
- low prices
- transport availability and cost

N/A

28) Discuss with relevant members of the household to discover livestock feeding practices. Note type of feed and source for each season of the year.

Graze on natural veg

29) Repeat step 27 for livestock enterprises:
What are the causes of livestock production problems.
Free response to e.g. "what are your main problems with livestock production?" "Can you think of any others?"

Die ∵ of drought
Pasture eroded
Mbendeni disease
Poor quality grazing - enough avail

## TROUBLE-SHOOTING CHECKLIST FOR LIVESTOCK PRODUCTION ENTERPRISES

Symptoms of Poor Production
- low rate of liveweight gain
- seasonal weight loss
- low milk production
- ✓ low reproduction rate
- high mortality (note age of animal, whether unweaned, recently weaned, or adult; identify causes of death if possible)

Resource Constraints
- lack of grazing land
- lack of land for growing fodder (cut-and-carry)
- lack of feed (specify season and feed type, e.g. grazing, browse, fodder or cut-and-carry)
- ✓ poor nutritional quality of feed materials (note season and type of feed)

Other Livestock Management Factors
- lack of non-use fencing (reasons)

- lack of shade
- inadequate vetrinary services/inputs (reasons)

- ✓ degradation of grazing land
- soil erosion (type) gully
- nutrient mining
- encroachment of unpalatable bush or herbaceous species

Marketing Problems for Livestock Enterprises
- lack of markets
- low prices
- transport availability and cost N/A

ENERGY SUBSYSTEM (direct quests. to appropriate household members, usually women).

30) What fuels are used by the household?
Note: type (firewood, charcoal, crop residues),
use (domestic, cottage industry)
and any seasonal variations.

fuelwood

31) Does the farm produce enough fuelwood to meet its requirements? If not, how are these requirements supplied (e.g. collection from off-farm sources, 'borrowing' from other farms in the area, purchase from other farms or market).

Yes

32) If fuelwood is purchased, estimate annual expenditure for this purpose.

/

33) If fuelwood is collected from off-farm sources, note sources, distance to source and collection rights and restrictions.

/

34) What problems does the household experience in supplying its fuel needs? e.g., cost of purchased fuels, time requ. for collection, diminishing fuelwood supplies in the area, use of fuels which the household considers 'inferior'.

No problems at present

35) Does the household anticipate future difficulties in meeting its fuel needs?

Maybe

36) Have they planted fuelwood trees? Why not?

No – no expertise

SHELTER SUBSYSTEM

(These questions cover a wide variety of tree-related shelter needs)

37) How does the household supply its need for building poles and saw wood? Are there any problems with the way this is currently done (e.g. diminishing supply, dist. to source, cost of purchase, etc.).

Indig forest – umThombothi pillars, umgqumo filler sections
Buy wattle poles from Melmoth, ±R5/pole – expensive

38) What 'fencing' practices, if any, are currently employed on the farm and where (e.g. boundary demarkation, livestock enclosure or exclusion, compound hedges)?
What species are used for these purposes and do they have any additional uses? Are fencing requirements currently being met (farmers' perception supplemented by team's perception).

None



39) Are there enough shade trees on the farm?
If needed, where and for what purpose would additional shade trees be planted? (e.g. on compound for human shade, in grazing land for animals, etc.).

None
Orange & mango trees liked
doesn't grow grown

40) Is wind damage or crop desiccation considered to be a problem by the household? What is the team's perception of the potential for windbreaks? What do the farmers think? Have they planted any trees for wind shelter?

Yes
Nothing done
Trees would help

RAW MATERIALS SUBSYSTEM

41) Are there any cottage industries which require trees as a source of fuel or other raw materials (e.g. timber, fibre, fruits, etc.)? Are these needs being adequately met by farm sources? What off-farm tree resources are used? Are there any present problems or problems anticipated in future? (Compare farmer and team perceptions and discuss.)

/

42) What kinds of production are undertaken to meet social obligations? (e.g. contributions or expenditures in kind or cash for social needs such as bridewealth, gifts to relatives or neighbours, political contributions, educational expenses, ceremonial occasions) Are there any problems in meeting these expenses? (Some of these may have come up under previous sections)

Buy

## OTHER RESOURCE MANAGEMENT PRACTICES, NEEDS AND POTENTIALS

Water 43) What is the general condition of the watershed on the farm or in the vicinity of the farm or relevant parts of thr upper or lower watershed of the area? What problems and potentials exist for improved watershed management? (Compare and discuss both farmers' and team perceptions.)

Gully erosion - photo
Doesn't know if anything can be done

44) Is the water supply adequate for farm needs (human, livestock)?
What problems exist? Are they seasonal in nature?
Could anything be done to improve the situation?
Does this have any bearing on agroforestry potentials?

No - all year
Borehole needed



Trees 45) Probe farmer's response to the idea that the planting or better suited trees on or in the vicinity of the farm could play a role in solving the farmer's problems or developing the potential of the farm. Ask questions like: "What kinds of trees would you plant and where?" "Why have you not planted them yet?" (probe for constraints).

Wind prev
Building material
Likes idea of cattle fodder from trees
Lack of expertise in planting trees & where to get seedlings

46) If the team has ideas at this point about the potential role of trees or agroforestry management systems in the farming system or general area, these could be discussed with the farmers to get a rough idea of the farmers' reaction.

Note: This initial response may not reflect the farmers' considered opinion of the ideas, which will only be formed after they have had a chance to see a demonstration and to experiment with the technologies themselves. Unless a very enthusiastic response is given, positive responses are less informative than negative responses at this stage of the exploration. Pay particular attention to the reasons cited by the farmers for their negative responses: these provide important clues as to how to design the technologies so as to minimise the farmers' worries and increase their chance of adoption. If the team feels that the farmers' concerns are based on misunderstanding of the proposals, elaborate and explain until the farmer has been given enough information to make an informed judgement - or better still, develop a better idea together with the farmer. Involve all relevant household members in this discussion.

Hasn't heard about AF
Would like demo

## SUMMARY OF INDICATIVE FINDINGS

It is never too soon to begin the analysis of the indicative findings. While the interview is still fresh in the minds of the team members, the team may wish to find a quiet place to sit and review the indications for potential agroforestry interventions. Such indications should be regarded as preliminary, of course. If there is sufficient information to do so, indicate preliminary answers to the following design questions:

What functions should the agroforestry systems perform? (production and service roles) Soil fertility, erosion prevention, fodder provision, wind damage prevention, building materials

At what locations on the farm or general landscape are the functions best performed? (spacial niches)

- near homestead
- on boundaries

What arrangements of trees and other plants are envisaged?

- single-row windbreaks
- mix cropping with trees

What management practices are needed to achieve the desired performance?

- windbreak maintenance - trimming etc
- pruning to reduce shading

What component species are likely to be most compatible with the above requirements?

- indigenous (drought resistant, adapted to soil conds)

At what scale should the technology be implemented to have a beneficial impact on the farm?

- small scale

# APPENDIX B

## DIAGNOSTIC SURVEY QUESTIONNAIRE
## (ZULU TRANSLATION)

Translation - Ukuhunyushwa: Lieutenant Zweliyabuya Sibonakaliso Ntombela.

Ukuhlolwa kwesimo sendawo.

Umlando ngokusetshenziswa komhlaba.

1. Umlimi usewusebenzise isikhathi esingakanani lowo mhlaba

2. Hlobo luni lokusetshenziswa komhlaba olwalwenziwa ekuqa[illegible] kwesikhathi esinikiwe?

~~3.~~ Zinguquko zini ezenzekile ekusetshenzisweni komhlaba, zenzekeleni?

~~Izikhiqizo Zendawo.~~

3. Sasinjani isimo somhlaba ngaphambi kokuqala kwesikhathi esinikiwe? Kanti futhi zinguquko zini ezenzekile kusuka ngaleso sikhathi? (izitshalo kanye nomhlaba)

Izikhiqizo zendawo.

4. Linganisa ububanzi bendawo yakho nalapho kudla khona imfuyo.

5. Ngabe obomndeni banawo omunye umhlaba ngaphandl[e] kosedu[z]e kwabo? Uma kunjalo:

Bhala:

Indawo:

Ukusetshenziswa (izitshalo, amadlelo, izinkuni nokunye).

Ubungako bendawo:

Imigomo yokuwusebenzisa (ngabe ubolekiwe noma uyakhokhelwa, ngabe ngowakho nje kuphela).

Abasebenzi.

6. Bangaki abantu abasebenza indawo yakho ngokugcwele? Balula ubulili nobudala (abadala/izingane)

7. Bangaki abasebenza okwesikhashana? Balula ubulili, ubudala kanye naleso sikhathi abasebenza ngaso. (Basebenza ngani)

8. Ngabe bakhona abaqashwa? Baqashelweni, isikhathi esingakanani kanti futhi izindleko zingakanani?

9. Uma abaqashwa bekhona, bakhokhelwa ngemali evelaphi?

~~10.~~ Amanzi

10. Balula izimboni zamanzi

11. Hlobo luni lwezimboni zamanzi ezingaphandle kwendawo yakho ezisetshenziswayo? (Awokuphuza) Balula ubude bebanga ukuyokha amanzi nendlela asetshenziswa ngayo.

~~Trees~~ - Izihlahla.

12. Balula indawo kanye nokusebenza kwazo endaweni. Ngokusetshenziswa: (izithelo, ukudla kwezinkomo, ukwakha, izingcingo, umthunzi njll.
Ngokwendawo: Emngceleni; ngaphakathi, emasimini, emadlelweni njll.

13. Ngabe zikhona izihlahla ezighamuka ngaphandle?

13. Balula umsebenzi wazo, indawo/ibanga kanye nendlela ezisetshenziswa ngayo.

<u>Imfuyo.</u>

14. Nhloboni ekhona?
Balula uhlobo lwesilwane, inani kanye nokusetshenziswa (ukudayisa ubisi, inyama, umquba nokunye okufana nokuzandisa)

15. <u>Izinkinga ezingala eziphazamisa ukukhiqiza kwakho.</u>

Ukushoda komhlaba, abasebenzi noma imali?
Uma ufuna ukuthuthuka yikuphi ongakudinga kakhulu?

IZINKINGA EZIPHAZAMISA UKUKHIQIZA KWEMGOGODLEYANA YENDAWO YAKHO.

<u>UMGOGODLEYANA WEMALI.</u>

16. Yikuphi lapho kuchitheka khona imali eningi kakhulu emndenini? Lokhu kubheke kubaba nomama.
Qgamisa uhlobo lwezindleko ezinkulu. Izinkuni, izinto zokwakha, ukudla, yimali yesikole, izindleko zomphakathi, emfungweni, izinto zokusebenza ukulima njll.

17. Imali ephilisa umndeni itholakalaphi?
Kudayiswa okulinywayo noma imfuyo ngabe imikhiqizo yayo njll.
Balula uhlobo ~~lwezindleko~~ lwezindawo lapho kutholakala khona imali.

18. Ngabe lemali yanele? Uma kungenjalo yikuphi kokwenziwayo okunzima ukuhlangabezana nakho?

19. Yikuphi okukhombisa ngokusobala ukusebenza kanye nokwenela kwemali ethola kalayo emnothweni womndeni:

(a) Imali incane ngakho isetshenziselwa izidingo zempilo,
(b) Imali iningi kunokudingekayo kangangoba enye ithenga ubuntsofontsofo bempahla enye yongiwe emabhange, enye ibekwe,

(C) Yanele ukukuphilisa izinga lempilo eliphezulu kunelijwayelekile endaweni. Bese enye inxenyana yemali ingongiwa.

20. Izinkinga ezidala ukutholakala kwemali encane. Bheka izitshalo ezidayisayo mayelana nezokuthutha nokudayisa (Bheka uhlelo).

~~21. Ngabe ninayo i~~ Ukonga/Nokongela.

21. Ngabe ninayo into nihlawumbe eniyongelayo? Mhlawumbe ukwakha indlu nokufundisa izingane kanye nokuphathelene ngempilo. Uma kungenjalo kungani? Kuyimbani?

22. Izinkinga ezibhekene nokudayisa nokonga.

23. ~~Izinkinga~~ UMGOGODLANA WOKUKHIQIZWA KOKUDLA.

Okukhombisa ngokusobala umgomo osobala futhi wokukhiqiza ukudla:

(a) Kukhiqizwa ukudla okudliwayo futhi kuyaphumelelekа

23. (b) Niyohlukeka
(c) Niyadayisa imikhiqizo yenu.

24. Ukushoda kokudla emasimini ngabe kuyenzeka?
Nini:
(a) Eminyakeni emibi (linganisa ukusheshe kwayo ukufika)
b) Eminyakeni eminingi (linganisa).
c) Minyaka yonke.

25. Yikuphi ukudla okuhlukumezayo ngokushoda?
Ngabe kukhona ukushoda kokudla ngenkathi yesikhathi sonyaka?

26. Nilwa kanjani nokukushoda? Nenzani uma ukudla kungenele (okuvuniwe).
Zikhona izitshalo zomshwalense (ezingolobaneni)?
Ngabe usizo lokudla kwangaphandle nikudinga kangakanani? Niyakuthola?

27. Yiziphi izinkinga ezidala ukuthi isivuno esihle singabi khona? (uhlelo).

28. Imfuyo idlani? Bheka uhlobo lokudla nalapho kuthalokhona ngezikhathi zonyaka.

29. Izinkinga ngokukhiqiza kwemfuyo (uhlelo).

UMGOGODLANA W'AMANDLA

30. Ukubasa:
Uhlobo lokubaswayo. (izinkuni, amalahle, pakaliny

Uhlelo lwezinkinga ngezitshalo. - CROP PRODUCTION

- ukushoda komhlaba
- " kwabasebenzi
- " kwezinto zokumelana nokomisa.
- " kwemali yezidingo.
- Ukungeneli kolwazi noma ugeqesho (qonda nggo)
- Ezinye izinkinga ngezizinda.

Izinkinga ngokuphatha.

- ukugugulekа komhlabathi
- izikhukhula/ukugewala kwamanzi
- ukugewala amakhemikhali.
- Ukuba nobuthi
- ukukhula
- izifo
- izinambuzane
- ukweba
- nokunye.

Izinkinga Ngokukhula kwezitshalo.

Ukungeneli komsokamа:
- ukushoda kwezimvula ngezikhathi zonyaka.
- ukungahleleki kahle kwamanzi endaweni.
- ukungamunceki kahle kwamanzi ngumhlabathi.
- Ukubambeka kwamanzi okungekuhle
- nezinye

Ezimphathelene nesimo sezulu,
- ukushisa kwezulu / ukuqanda (chaza).

- ukoma kwezitshalo ngenxa yomoya.
- umoya, isichotho, izimvula ezinkulu.

Izinga eliphansi lokuvunda komhlabathi.
- ukungavundi ngenxa yesimo.
- ukushoda kokudla komhlabathi.
- ukushoda kokudla komhlabathi okuthile
- ukungabi bikho kwemvundo.

Isimo esibi somhlabathi.
- umhlabathi ongashonile.
- " ongaphekile kahle.
- " ongawa ~~[illegible]~~ khululi kahle amanzi ukedele umoya
- umhlabathi ongasebenzeki kahle.

Izinkinga Ngokudayisa.

- ukushoda kwezimakethe
- intengo ephansi
- ukuba khona kanye nokubiza kwezinto zokuthutha.

Uhlelo Lwezinkinga Ngemfuyo. LIVESTOCK

Izimpawu zokukhuthaza okubi.
- ukukhulu phola kancane.
- ukonda ngezikhathi ezithile zonyaka.
- ubisi oluncane.
- zizala kabi
- Zifa kakhulu (Balula imimpka yesilwane, zibulawa yini)

Izinkinga ngezisinda.
- ukushoda kwamadlelo
- ukushoda komhlaba wokutshala ukudla kwezikomo,
- ukushoda kokudla (Balula isikhathi sonyaka, uhlobo lokudla)
- izinga eliphansi lokudla okudliwayo (Balula isizini kanye nohlobo lokudla).

Izinkinga Ngokuphatha.
- ukushoda kocingo (izizathu)
- ukushoda komthunzi
- ukungeneli kwezinto zokwelapha (izizathu)
- izinga eliphansi lemadlelo.
- ukuguguleka komhlabathi (uhlobo)
- Ukumbiwa kwezimayini,
- ukugcwala kwezihlahlana lamduku anganambitheki

Izinkinga Ngokudayisa Emhlanyweni.
- ukushoda kwezimakethe
- amanani aphansi
- ukungabi bikho kwezinto zokuthutha kanye nokubiza kwazo.

30. Ukusetshenziswa
Ngabe ukwehluka ngezikhathi zonyaka kukhona?

31. Ngabe izinkuni ezikhiqizwa endaweni yenu zenele? Uma kungenjalo kwenziwa njani (Kuthelakala kwezinye izindawo?)

32. Uma izinkuni zithengwa malini echithekayo ngonyaka ngezo?

33. Uma zithelakala ngaphandle ghona indawo, ibanga kanye namalungelo okuzitheza nemigomo yakhona.

34. Izinkinga ezibhekene nokokubasa (izindleko, isikhathi sokutheza njll).

35. Ngabe zikhona izinselo zokushoda kwamandla okumelana nezidingo zokubaswayo ngengomuso?

36. Ngabe asetshaliwe amahlathi ezinkuni? Kungani angatshaliwe? Uma ekhona nhlobani?

UMGOGODLANA WOKUKHOSELA.

37. Ngabe zikhona izinkinga ezibhekene nazo mayelana nokwakha ngezingogo? Nizithengaphi, malini?

38. Ngabe kukhona ukubiyelwa kwendawo yakho? Kukuphi? Kusetshenziswini? Ngabe kukhona okwandisile? Ngabe izidingo zokubiyw~~a~~ ziyafezwa?

39. Zikhona izihlahla zomthunzi endaweni? Uma zifuneka

39. Zifunekelani, kuphi futhi?
Mhlawumbe ezabantu noma izilwane emadlelweni

40. Ngabe umoya uyinkinga ezitshalweni?
Ngabe nithini ngokutshalwa kwezivimbi moya?
Ngabe zikhona esezitshaliwe?

UMGOGODLANA WEZINTO ZOKUSEBENZA EKWAKHENI NOKHOYINI

41. Ngabe kukhona okwakhiwayo endaweni yakho okungadinga izinto zokubasa kanye namafulude?
Ngabe lezizidingo kuyakwazeka yini ukuthi zihlangabezwe ngokukhona endaweni?

Ngabe kukhona okuvela ngaphandle kwendawo yakho okusetshenziswayo?
Ngabe zikhona izinkinga ngalokhu noma kukhona ukusola ukuthi zingase zibe khona kusasa?

42. MIKHIQIZO MINI eyenziwayo ukuze kuhlangabezwane nezidingo zomphakathi!
(ukunikela, ukupha, izipho emishadweni (ukucimela),
izindleko zesikole njll)

EZINYE IZIDINGO.

43. Izinkinga ngamanzi? Kungenziwa njani ukuze ziphele?

44. Ngabe amanzi azanele izidingo zendawo? Nkinga zini ezikhona? Ngabe ahambisana nezikhathi zonyaka?
Ngabe kukhona okungenziwa ukulungisa isimo?

145. Izihlahla zibalulekile.
Zihlahla zini ongathanda ukuzitshala?
Kungani ungakazitshali?

146. Kukhona okwaziyo ngokuxutshwa ~~ng~~ kwezihlahla kanye nezitshalo ezincane emasimini? Uma kungekho, ungahle uthande ukukukhonjiswa? Uma usukubonile ungakuthanda? Yini obona ukuthi kuwusizo ngakho? Kuyona noma kuyalungisa na?

# APPENDIX C

## TREE UTILISATION ON SURVEYED FARMS

## TREE UTILISATION ON SURVEYED FARMS

### Fuelwood

uGagane (*Dichrostachys cinerea*)
uSolo (*Albizia adianthifolia*)
umBondwe (*Combretum molle*)
umGano (*Sclerocarya birrea*)
umNGamanzi (*Acacia robusta*)
umBondo (*Combretum zeyheri*)
umHlambamanzi (*Rauwolfia caffra*)
umHlale (*Strychnos spinosa*)
umNyamathi (*Ekebergia capensis*)
umNgqawe (*Acacia nilotica*)
Gum (*Eucalyptus grandis*)
Wattle (*Acacia mearnsii*)

### Fruit

umDone (*Syzigium cordatum*)
umGano (*Sclerocarya birrea*)
umViyo (*Vangueria infausta*)
umHlale (*Strychnos spinosa*)
Peach (*Prunus persica*)
Orange (*Citrus sinesis*)
Naartjie/Tangerine (*Citrus reticulata*)
Avocado Pear (*Persea americana*)
Banana (*Musa spp.*)
Sweet Banana (*Musa spp.*)
Guava (*Psidium gaujava*)
Mango (*Mangifera indica*)
Pawpaw (*Carica papaya*)
Lemon (*Citrus limona*)
Apple (*Malus sylvestris*)

### Windbreaks

umThomboti (*Spirostachys africana*)
umSinsi (*Erythrina lysistemon*)
umSilinga (*Melia azedarach*)
Pine (*Pinus spp.*)
Gum (*Eucalyptus spp.*)
uBoquo (hedge) (*Barringtonia racemosa*)
Bougainvillaea (hedge) (*Bougainvillaea spp.*)
Pepper (*Schinus molle*)

**Building**

umThomboti (*Spirostachys africana*) (poles)
uGagane (*Dichrostachys cinerea*) (poles & sticks)
umNgqumo (*Olea africana*) (sticks)
umKhaya (*Acacia nigriscens*) (poles & sticks)
Wattle (*Acacia mearnsii*) (poles)
Gum (*Eucalyptus spp.*)(poles)
uQwalo (bamboo) (*Bambusa spp.*) (live fencing)
Sisal (*Agave sisalana*) (live fencing)

**Shade**

iMinyela (*Commiphora neglecta*)
umThomboti (*Spirostachys africana*)
umKaya (*Acacia burkei*)
umNgu (*Acacia karroo*)
umGxamo (*Schotia brachypetala*)
umBombe (*Ficus natalensis*)
umSinsi (*Erythrina lysistemon*)
umGqwabagqwaba (*Erythrina latissima*)
umDone (*Syzigium cordatum*)
uSolo (*Albizia adianthifolia*)
umSilinga (*Melia azedarach*)
umGano (*Sclerocarya birrea*)
iSundu (*Phoenix reclinata*)
umKhaya (*Acacia nigriscens*)
umKhiwane (*Ficus sycamorus*)
umNgquandane (*Diospyros spp.*)
isiFico (*Ozoroa spp.*)
iNhlokoshiyana (*Rhus lancea*)
isiQatankobe (*Pellophorum africanum*)
umVutwamnini (*Canthium inerme*)
umKhamba (*Acacia sieberana*)
Jacaranda (*Jacaranda acutifolia*)
umNhlonhlo (*Euphorbia spp.*)

**Medicine**

umHlaba (*Aloe marlothii*)
uSolo (*Albizia adianthifolia*)
umBondwe (*Combretum molle*)
umGano (*Sclerocarya birrea*)
umHlale (*Strychnos spinosa*)
umNyamathi (*Ekebergia capensis*)
umHlale (*Bridelia micrantha*)
umThomboti (*Spirostachys africana*)
umNgqumo (*Olea africana*)
umNgu (*Acacia karroo*)
umGxamo (*Schotia brachypetala*)
Guava (*Psidium gaujava*)