THE POTENTIAL OF AGROFORESTRY IN THE CONSERVATION OF HIGH VALUE INDIGENOUS TREES: A CASE STUDY OF UMZIMVUBU DISTRICT, EASTERN CAPE.

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DEDICATION

This work dedicated to Messrs. Toshihiro Shima and Seiichi Mishima,

and to

my beloved wife Anne Florence Asiko and children Marion Akinyi, Fabian Omondi and Stephen Ochieng "Stevo".

ABSTRACT

South Africa is not well endowed with indigenous forests which are now known to be degraded and declining at unknown rates. This constitutes a direct threat to quality of life of the resource-poor rural households who directly depend on them and to ecological integrity. It is also recognised that the declining tree resources, particularly the high value indigenous tree species, are increasingly threatened by a number of growing subsistence demands. This emphasised the need to cultivate and conserve high-value tree species such as *Englerophytum natalense, Ptaeroxylon obliquum* and *Millettia grandis* on-farm in Umzimvubu District. Agroforestry is recognised as a viable option for optimising land productivity, reducing pressure on the indigenous forests, ensuring a sustainable supply of desired tree products and services and improving the quality of life of the resource-poor rural households. This Thesis examines whether agroforestry in Umzimvubu District and similar areas of South Africa has the potential for addressing these needs. It recognises that for successful initiation, implementation and adoption, agroforestry should be considered at two levels, namely, household and institutional. Responses based on structured questionnaires were obtained at these levels. Questionnaires were used to determine whether the households and institutions were aware of, and responding to, the need to intensify and diversify on-farm production, ease pressure on indigenous forest, improve income opportunities and problem solving capacities to address agroforestry related issues. An ecological inventory of *E. natalense, P. obliquum* and *M. grandis* was carried out to provide a sound basis for integrating high-value species into appropriate agroforestry systems and to facilitate the preparation of future management guidelines for these resources in Mt. Thesiger Forest Reserve. The study: i) confirms that most high value indigenous tree species merit integration into subsistence farming systems through agroforestry, ii) appreciates that some rural households have been unknowingly practising agroforestry, iii) recognises that agroforestry is implied in South Africa's White Paper on Sustainable Forest Development of 1997, but notes that similar emphasis has not been adopted or incorporated in the National Forestry Action Programme of 1997, and iv) notes that challenges to promoting agroforestry research and development in the South African context of the institutions and resource-poor rural households are many, but can be resolved. The study concludes that agroforestry stands to benefit many resource-poor rural households and enhance environmental resilience in South Africa in the next millennium.

PREFACE

The research described in this Thesis was conducted in Umzimvubu District (Port St. Johns), Eastern Cape Province of South Africa. This was done under the supervision of Prof. Michael J. Lawes of the School of Botany and Zoology, University of Natal. Furthermore, the research was conducted jointly under the auspices of the School of Environment and Development and the Forest Biodiversity Programme.

The research in the Potential of Agroforestry in the Conservation of High Value Indigenous Trees represent the original work of the author. It has not been previously submitted in any form for any degree or diploma to any other University. Where the use of the work of others has been made, it is duly acknowledged in the text.

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LIST OF ABBREVIATIONS AND ACRONYMS

AFRENA	Agroforestry Research Networks for Africa
ANAFE	African Network for Agroforestry Education
ARC	Agricultural Research Council
CBOs	Community Based Organisations
CFP	Community Forestry Programme
CSIR	Council for Scientific and Industrial Research
DA	Department of Agriculture
DWAF	Department of Water Affairs and Forestry
ECP	Eastern Cape Province of the Republic of South Africa
EDA	Environment and Development Agency
FAO	Food and Agriculture Organisation
FSG	Farmers Support Group
ICRAF	International Centre for Research in Agroforestry
IITA	International Institute of Tropical Agriculture
INR	Institute of Natural Resources
ISNAR	International Service for National Agricultural Research
JICA	Japan International Cooperation Agency
KEFRI	Kenya Forestry Research Institute
MFAP	Master Farmer and Apprenticeship Programme
MTFR	Mt. Thesiger Forest Reserve
NFAP	National Forest Action Programme
NGOs	Non-governmental Organisations
RDP	Reconstruction and Development Programme
SADC	Southern Africa Development Community
SDI	Spatial Development Initiatives
UNEP	United Nations Environment Programme
WCED	World Commission on Environment and Development
WWF	World Wide Fund for Nature

CHAPTER 1:

INTRODUCTION TO THE GLOBAL, NATIONAL AND LOCAL AGROFORESTRY PERSPECTIVES

1.1 Development and Environment Paradigms

There is an increasing awareness and recognition of the importance of forests and trees for human well-being, economic development and environmental resilience. Their sustainable management through an interdisciplinary and inter-sectoral approach is recognised as vital to achieving sustainable development. Sustainable development and environmental issues have become prominent paradigms in recent years. The sustainable development paradigm has evolved to capture and address global, national and local attention in relation to; sustainable agriculture and rural development, forest management, conservation of biological diversity, soil and water resources management and regulation of the world's climate (WCED 1987; Cawe and Mckenzie 1989; UNEP 1994; Unasylva 1997; DWAF 1997; World Bank 1997). Similarly, there is a growing concern at the global, national and local levels, that the floral environment, (i.e. indigenous or natural forests and woodlands) which once provided a rich and wide range of "*high value*" indigenous tree species (UNEP 1994; Wass 1995; Simula 1997, Shumba and Baker 1998), is degrading and declining rapidly as the *"quality of life"* (Republic of South Africa 1995) deteriorates. Deforestation, which refers to the *long-term removal of forest* (Freedman 1995), trees and other plant associations, from their natural site or environment by natural processes or deliberate human influences, is one of the most common forms of environmental degradation (Sharma 1992; Jepma 1995).

The most common reasons for deforestation are: i) to gain physical access to land for agriculture and settlement, ii) social and economic needs, iii) insecure land tenure systems, and iv) anthropogenic conversions (Jepma 1995). Sanchez (1996) notes that 60% of the current deforestation is caused by small-scale farmers for agriculture and settlement. Forest decline is mainly caused by pollution with the impacts being more pronounced in developed countries (Freedman 1995). It is characterised by progressive, often rapid, deterioration in vigour of one or several tree species caused by etyology. The decline often results in a gradual dieback of branches and eventual death. Concern over pollution in South Africa is increasingly becoming an issue, particularly in the Mpumalanga Highveld coal burning regions (Ngobese and Cook 1997). Besides deforestation, the degrading impact of soil erosion on the floral environment in the tropics is significant, particularly in South Africa (Department of Agriculture 1995; Critchley and Netshikovhela 1998).

The potential of agroforestry in the conservation of high value indigenous tree species in Port St. Johns or Umzimvubu District of Eastern Cape Province, South Africa (hereafter referred to as "Umzimvubu District") is analysed, described and presented in the context of ecological, socio-economic and institutional factors. The perception and articulation of these factors are important to ensure sustained development of agroforestry in the area and region. A detailed description of the Umzimvubu District is presented in Chapter 2. The factors constraining or providing opportunities for successfully initiating, implementing and sustaining agroforestry in the South African context at the household and institutional level, are presented in Chapters 3 and 4, respectively. The description, attributes and agroforestry potential of *Englerophytum natalense* (Sond.) Heine & J.H Hemsl.), *Ptaeroxylon obliquum* (Thunb.) Radlk and *Millettia grandis* (E. Meyer) Skeel. is presented in Chapter 5. Chapter 6 gives the state of abundance and size-class distribution of *E. natalense, P. obliquum* and *M. grandis* in Umzimvubu District, in Mt. Thesiger Forest Reserve (MTFR). The data on *M. grandis* is drawn from a case study in the area (Obiri 1997). Conclusions and recommendations are drawn in Chapter 7.

1.2 Conservation Status of the Floral Environment

One of the most important concepts underpinning this thesis is "conservation". Elliott (1996) explored how paradigms of forest conservation and utilisation could have evolved over time. He concludes, "conservation means different things to different people, hence it is subject to a wide variety of interpretation". The Macmillian Dictionary of Environment (Allanby 1993) defines conservation as " the planning, production, management and sustainable use of natural resources to ensure their wide use within the natural ecosystem". In this study conservation is viewed simply as the planning, cultivation (production), management and sustainable use of, particularly indigenous trees and associated plants within the natural ecosystem, agricultural landscape and human settlement.

A recent poster by World Conservation Monitoring Centre (WCMC) global analysis of the conservation status shows the distribution of *"protected areas"* of the tropical moist forests by region as; Africa 7.3%, Asia 10.5% and Latin America 15.1%. This suggests the need, particularly in Africa to: i) understand the reasons for the poor status, ii) focus on sustainable land use management systems which are capable of diversifying and intensifying production activities at rural household level, and iii) strengthen the institutional capacities of the organisations and individuals responsible for planning, implementing and evaluating community oriented forest/tree conservation programmes. (Sharma 1992; Scott 1996; WCMC *undated*).

Deforestation is recognised as a major cause of the floral environment decline (Sanchez 1996), particularly the high value indigenous tree species. However, recent empirical evidence indicates a significant slowing in the rates of deforestation in the 1990's (Fairhead and Leach 1997; FAO 1997a; 1997b). There is also increasing evidence that diversifying and intensifying land use management systems is making significant contributions to arresting soil erosion and gradually increasing the number of trees in the rural landscape. According to FAO (1997b), deforestation in the floral environment has reduced from 15.5 million ha in 1980 - 1990 to 13.7 million ha in 1990 - 1995, in the developing countries. Although this is a relatively small proportion, it is still substantial (de Montalembert 1998). It calls for concerted efforts in conservation, so as to realise both socio-economic and environmental needs. The views supporting the decreasing trend include: i) imprecise and significantly exaggerated estimates of the past forest cover in West Africa during the twentieth century (Fairhead and Leach 1997); ii) that rapid population growth, instead served to promote soil erosion control and steadily increased the number of trees in farmlands in densely populated areas, as land per capita declines, for example, in Kakamega, Kisii and Muranga Districts, and in the semi-arid areas of Machakos District in Kenya (Mortimore 1991; Tiffen *et al.* 1993). Remarkable efforts in individual tree planting and small woodlots at farm and village level have also resulted in increased tree cover in the hilly areas of Nepal and Haiti (Chambers 1997) and in Asia (de Montalembert 1998); and iii) enhanced public awareness and sensitivity, compliance with relevant local, national and international environmental policies, laws and conventions. Nevertheless each situation will vary from one area or country to another. Critchley (1998), concedes "perhaps it is right to say that population growth does not necessarily mean, greater degradation and sometimes actually improves conservation status. Above all, land users especially the rural poor, should not be looked upon simply as a problem, but as part of the potential answer". Critchley further states that "the greatest untapped conservation resources in Africa are human endeavour and ingenuity". This departure suggests a positive move towards; i) easing pressure on the over-exploited indigenous forests and woodlands, ii) enhancing environmental resilience, and iii) an appreciation of an often obscured contribution of farmers in managing their agricultural landscapes.

It is noteworthy that endeavour and ingenuity are the key to practical development and adoption of sustainable land use management systems, particularly agroforestry. The integration of high value indigenous plants within agroforestry systems provide the opportunity for their conservation and sustainable use. The "resource-poor farmers" (Department of Agriculture 1995) in the rural areas of the developing countries, including South Africa could benefit from their cultural, economic and environmental importance in this way. In essence, endeavour and ingenuity are the main drawback to the development of agroforestry in Umzimvubu District. Constraints due to this concern are not limited to the resources-poor farmers in the rural areas, but also affect other stakeholders in the area and region. However, this does not suggest the absence of willingness to be involved, but more of a real: i) lack of awareness, ii) misconception of agroforestry concepts and practices, iii) absence of appropriate information, and iv) inflexible and often transitory institutional setups and functions (Koen 1991; Taylor 1991; Cooper and Swart 1992; Langford 1994; Underwood 1995; van Zyl *et al.* 1996; Bembridge 1997).

Furthermore, the value and need to cultivate high value indigenous tree species for use in agroforestry systems, have until recently been overlooked by science (Dunn 1991; Leaky and Newton 1994; Maghembe *et al.* 1998). Past initiatives have favoured the cultivation of fast growing, high yielding commercial, exotic monocultural species, particularly in the twentieth century. Therefore, concerted efforts are needed to establish how to promote the use and integration of these species into appropriate agroforestry systems (Scott 1996; van Eck *et al.* 1997). The emphasis in the context of Umzimvubu District, should initially centre on "bring to human use" (Simons, 1996), and advance to the more intricate domestication activities. In genetic terms, domestication is a continuum from the natural state to a genetically human induced advanced generation of breeding lines, through science. Industrial forestry in South Africa with pine and in Brazil with eucalypts are cases in point for genetic manipulation by humankind (Kruger 1996; DWAF 1997).

Identifying farmers' preferences for high value agroforestry trees is the first step in developing a domestication project (Weber *et al.* 1997; Maghembe *et al.* 1998). In addition, the emphasis should be on a on-farm approach, while taking cognisance of the issues of competition, complexity, sustainability and profitability of the system (Sanchez 1995). It is my expectation that through endeavour and ingenuity, domestication would be the ultimate goal for conserving high value indigenous tree species. The specific research areas should include physiology, reproductive biology, phenology, propagation and product improvement of these species. Nevertheless, the farmers must be the focus and partners in the research process.

While integrated science and practice continue to determine the active properties of some popular high value indigenous medicinal plants and other utility woods (Martin 1995; Hutchings *et al.* 1996), the same pace cannot be accorded to their cultivation or domestication. This is due to the lack of confidence in, and untested land use management systems, which can fully integrate trees, combine or moderate the positive and negative aspects of monoculture agricultural and forestry production systems and socio-economic and environmental needs within rural development imperatives (Koen 1991; Taylor 1991; Langford 1994).

The deliberate and unintentional human influences have promoted the retention or cultivation of some indigenous tree species in and around human settlements and in some farmlands, in various formations (Macdonald *et al.* 1989; Loxton, Venn and Associates 1990). Within this context, sustainable use and management of these species for their various products and services, at national, local and particularly household level, is vital and imperative to achieving sustainable development. Nevertheless, the floral environment in which they occur are under increasing pressure from adverse human influences.

1.3 Adverse Impacts of Deforestation on the Floral Environment

The processes which mitigate adverse human impacts and economic pressures on the floral environment are well known, described and documented (Jepma 1995; DWAF 1997; Shumba and Baker 1998). A case in point is the southern African ecological subregion (FAO 1997b). The subregion has a rich biodiversity and production potential. For example, South Africa is considered to be the third most biologically diverse country in the world. It has about 24,000 plant taxa and totally contains one of the world's six floral kingdoms - the Cape Floral kingdom, of which about 80% are known to be endemic. One third of South Africa's plant species are in this kingdom alone (Low and Rebelo 1996; Laird and Wynberg 1997). The annual deforestation rate in this ecological subregion is about 0.5%. This is due to expansion for arable land, shifting cultivation, settlement, mining, fuelwood and charcoal, bush and forest fires, overgrazing, invasive plants, soil erosion, and infrastructural development (Cooper and Swart 1992; Chenje and Johnson 1994; Department of Agriculture 1995; World Bank 1997; Critchley and Netshikovhela 1998). However, one should take cognisance of Fairhead and Leach's (1997) argument of past exaggerated estimates of deforestation rates, the gradual increase of the number of trees in the farmlands and the potential ecological recoveries in Kenya, Nepal and Haiti (Tiffen *et al.* 1993; Chambers 1997; de Montalembert 1998).

In addition, economic decisions are regarded as indirect causes of deforestation. They are seen as a catalyst to the processes. This is manifested as: poverty; rapid population growth; population distribution; unemployment; persistent negative perceptions; policies; and land, economic and institutional reforms. These factors are further compounded by increasing incidences of climatic stress in the recent decades (Chenje and Johnson 1994; Jepma 1995; UNEP 1996; DWAF 1997a; 1997b; FAO 1997b; Isik *et al.* 1997; Khasa and Dancik 1997; Shepherd 1997; van Eck *et al.* 1997; World Bank 1997).

1.4 The Processes of Deforestation in the Floral Environment

Human activities influence deforestation processes by triggering, accelerating or exacerbating their impacts, and in turn are themselves affected. As a result, the processes of deforestation for the floral environment in Umzimvubu District include: habitat alteration, loss and fragmentation; loss of land productivity; introduction of invasive plant species; and adverse effects on the local climate. (Cawe 1992; Cooper and Swart 1992; Jepma 1995; Isik *et al.* 1997; van der Zel 1997).

Habitat alteration, loss and fragmentation of the indigenous forests and woodlands results in either reduction in their size and/or total loss of socio-economic, biological diversity and resilience importance. Examples of affected fauna and flora in Umzimvubu District are: i) insects, such as the Swallow tail *Papilio demodocus* and Orange Playboy *Virachola diodes*, butterflies; ii) birds, such as the Yellow streaked Bulbul *Phyllastrephus flavostriatus*); iii) mammals such as the Blue Duiker *Philantomba monticula*, Samango Monkey *Ceropithecus mitis* and Tree Dassie *Dendrohyrax arboreus*; and iv) trees such as *P. obliquum, Ocotea bullata* (Burch.) Baill. and *Maytenus abbottii*), (Cooper and Swart 1992; Pooley 1993; van Wyk and van Wyk 1997).

Globally about 5 to 7 million ha of arable land is lost annually through soil erosion and nutrient depletion (FAO 1991). A conservative estimate of 400 million tonnes of soil is lost annually in South Africa alone (Pickette and Hoffman 1992). Settlement and cultivation on the steep terrain in Umzimvubu District makes it highly susceptible to soil erosion. The impact is severe in the absence of appropriate land use management practices. The net effect is loss of the productive potential of agricultural, forest and woodland ecosystems (Duelli 1997).

Invasive species are either indigenous or exotic (alien). They are presently of considerable concern in the South African landscape (DWAF 1997; Versveld *et al.* 1998). Their ability to readily naturalise, infiltrate and replace indigenous vegetation threatens agricultural productivity and environmental resilience (Henderson, 1995). Examples include the Bugweed *Solanum mauritianum*, *Lantana camara* and the Peanut Butter Cassia *Cassia didymobotrya.* Alien weed control is a major programme of the Departments of Agriculture (DA) and Water and Forestry Affairs (DWAF) in South Africa (Department of Agriculture 1995; DWAF 1997). The activity has stimulated arguments for and against programmes to eradicate invasive alien plants (Macdonald *et al.* 1989; Dekker 1991; Armstrong 1992; Unsworth 1997;Versveld *et al.* 1998). Some alien plants, such as the pines, gums, wattles and assorted fruit trees are an important resource base for industrial, agricultural and economic development.

Most trees and associated plants in urban homes, industrial sites and greenspace are alien. What is required is pro-active management strategies and programmes.

The above consequences of deforestation on the flora environment are not necessarily exhaustive, but represent some of the major environmental issues in contemporary South Africa. The White Papers on: Sustainable Forest Development (DWAF 1997a) and the Conservation and Sustainable Use of South Africa's Biological Diversity (DWAF 1997b) provides the vision and basis for enhancing environmental awareness and exerting public pressure to conserve indigenous forests and woodlands. Furthermore, concerns that all forests and woodlands should be managed in such a manner as to ensure that their production function, resilience and socio-economic benefits are sustained, has stimulated the need to develop and implement comprehensive control measures. Examples include the: i) environmental impact assessment (EIA) (Wood 1995) or integrated environmental management systems (IEM) (Fuggle and Rabie 1992) as preferred in South Africa; ii) environmental management frameworks (EMF) to address environments and environmental sensitivity within the context of IEM (DEAT 1998); and iii) criteria and indicators (C&I) (DWAF 1997; FAO 1997a; Stork *et al.* 1997). It is imperative that such initiatives are enhanced within the framework of sustainable land use programmes at the national and local level.

1.5 Conservation and Value of Indigenous Forest Resources in South Africa

Natural forests and woodlands, both in private and communal ownership, form an extensive and valuable resource in South Africa. They contribute significantly to sustainable socio-economic development and environmental resilience, at national and particularly local and household levels (DWAF 1997). There are about 400,000 ha of closed-canopy forests (DWAF 1997) representing 0.2% of the country's land surface. Of these, 58% is State forests and 42% in other legally defined protected areas (Kidd 1997). The open savanna woodlands originally covered 42 million ha or 32% of South Africa's total land surface, but now extends to just over 23 million ha (17%). Forest and woodland resources in the Eastern Cape Province is represented in two out of the seven biomes which occur in this region (Low and Rebelo 1996). The forest covers an area of 279,500 ha, while savanna covers an area 1,743,900 ha. Of the forest biome in Eastern Cape, 90,600 ha comprise Coastal scarp forest vegetation type (1), (Acock 1953; Low and Rebelo 1996).

The White Paper on Sustainable Forest Development (DWAF 1997a) and the National Forestry Action Programme (DWAF 1997) notes that the indigenous forest resources have been declining at unknown rates. The causes are apparently well known, but poorly understood. Most of these were lost to past and current unsustainable exploitation, subsistence farming, overgrazing, fires, conversion to industrial forestry and commercial agricultural production, infrastructural development, mining, land speculation, limited or no management provisions and adverse effects of climate (Cooper and Swart 1992; van der Merwe 1997). Large areas of forests and woodlands, particularly in the former "homelands", where 40% of the black rural communities dwell in South Africa (Langford 1994; Kruger 1996; DWAF 1997a), are most affected.

Although accurate assessments of the contribution of forests and woodlands at national, local and household levels have been difficult to quantify, attempts to do so (Mander *et al.* 1996; Cawe and Ntloko 1997; DWAF 1997; Hutchings *et al.* 1997; Laird and Wynberg 1997; Obiri 1997) indicate that it is significant. Examples of a recent quantified value of products and services derived from indigenous forests and woodlands in South Africa (DWAF 1997) include: i) fuelwood, accounts for about 11 million tonnes, estimated at about R 1 billion annually, of which 66% come from natural forests and woodlands, ii) food security, iii) grazing, iv) medicinal plants, for health care needs estimated to be worth between R 500 to R 1,000 million and employ 150,000 to 300, 000 traditional healers, v) the curio industry, whose annual retail value from formal and informal industries are valued at R 4.89 million and R 2.48 million respectively, vi) commercial timber, vii) biodiversity conservation, viii) services, such as maintenance and regulation of soil, water and climatic conditions, ix) supporting aesthetics and ecotourism, which earned R 12.5 billion in 1993, and x) cultural and spiritual value. This economic valuation- approach (Wass 1995; DWAF 1997; Scherr and Current 1997; Simula 1997) is envisaged to attract the interest and involvement of the people, leading to their gradual acceptance and integration of high value indigenous trees into specific niches on farms (Scott 1996). Sustaining the income generating role among other competing values, necessitates that factors which influence management and sustainable resource use are given more attention.

1.6 Relevance of Intensifying Land Use

Land constitutes one of the most essential elements of any strategy for sustainable development. Agriculture and forestry are integral parts of the land use continuum, upon which the needs and expectations of many families depend for a better quality of life (Department of Agriculture 1995). However, it is recognised that land use stands little prospect of being sustainable, if modifications to long-term agricultural productivity which are amenable to conserving the natural resource base is disregarded (Bennett 1996). Increasing food production and household income from the farm is an increasing necessity. Similarly, a land use management system that combines or moderates the positive and negative impacts of a single agricultural or forestry production system is more desirable for sustainable production and environmental resilience (Leaky 1996; Ford Foundation 1998). Trees, particularly the high value indigenous species, are recognised as an integral part of a diversified farm production system (Bene *et al.* 1977; Leaky *et al.* 1996). They have the capacity to recover lost production and service values of an ecosystem.

Further, the culture of conserving popular high value indigenous plants through cultivation (Mander *et al.* 1996; Prin 1996) is new in most countries, including South Africa. However, recent developments, particularly in agroforestry and non-wood forest products (Leaky *et al.* 1996) demonstrates the value of indigenous plants in intensifying farming, diversifying household income and enhancing environmental resilience. The International Centre for Research in Agroforestry's (ICRAF) collaborative research and development programmes with national institutions and farmers in the tropics, is contributing to this realisation (Dunn 1991; Scotts 1996; ICRAF 1997; ICRAF 1998a; 1998c).

The fact that indigenous tree resources are *finite* emphasises the need for their conservation within sustainable land use management systems. Such systems must be capable of incorporating: i) biophysical, ii) prevailing socio-economic diversity in the affected areas or regions and iii) have a resemblance to natural succession processes which sustain indigenous forests and woodlands (Sanchez 1995). In essence, the specific land use management system must provide and sustain a higher or the same output per unit area, with the same or less resource inputs, in order to be acceptable to the farmers. This paradigm shift is embodied in a current broader definition of agroforestry as a "dynamic, ecologically based natural resource management system, that through the integration of trees in the farmlands, diversifies and sustains production for increased social, economic and environmental benefits" (Leaky 1996) of land users at all levels. Agroforestry is not the only answer to diversifying and intensifying land use (Bene *et al.* 1977). However, it is regarded as one of the few important alternative strategies for sustainable farming systems (Owusu 1993; Langford 1994), social change and rural development (Budd *et al.* 1990).

1.7 Agroforestry: Definition and Perspectives

Put simply, agroforestry refers to using trees on the farm (ICRAF 1998a). Agroforestry has been defined as a collective term for any land use system in which woody perennials are deliberately managed on the same unit of land as agricultural crops and/or animals simultaneously or sequentially, where the social, economic and environmental benefits are derived from the interaction between the various components (Bene *et al.* 1977; Lundgren 1982;1987; MacDickens and Vegara 1990; Nair 1992; 1993; Govere 1995). This definition has, "until recently, served well" (Sanchez 1995). However, Leaky (1996) contends that it made agroforestry "fall far short of its ultimate potential as a way of mitigating deforestation, land depletion and alleviating poverty". He suggested, the current broader definition adopted by ICRAF as stated in section 1.6 above.

To many people, agroforestry is almost synonymous with alley farming (Baxter 1994; Carter 1995). This misconception also applies in South Africa. For example, Armstrong (1992) argues that agroforestry is misconceived to be a static concept, which it is not, but rather one which suggests the most useful role it can play under conditions prevailing within southern Africa. Nevertheless, it is these differences in the perceptions, concept and practices which makes research and development in agroforestry so challenging.

1.8 Need, Recognition and Support for Agroforestry

In their proposal for an International Council, the Bene/IDRC Report (Bene *et al.* 1977), recognised and supported the need for agroforestry. The need for agroforestry in South Africa has long been underscored (Esterhuyse 1989; 1994; Loxton, Venn and Associates 1990; Koen 1991;

Erskine 1993; Nair 1993; Langford 1994; DWAF 1997) and encompassed in Social forestry (Christie and Gander 1995). Armstrong (1992) specifically advocated dryland agroforestry in the Western Cape Province with Port Jackson willow *Acacia saligna*, an alien tree species. Casual observation of South Africa's rural landscape reveals that there is potential for agroforestry in most areas or regions. This view is supported by the nature of the terrains which limit extensive use of machinery, a rapidly increasing population, prevailing socio-economic circumstance of the people and the limited land size per capita, to which they have both access and control. However, this potential has yet to be fully used for practical development of agroforestry, particularly in the Eastern Cape, which is primarily a *"rural province"* (Bishop 1998). Further, the biophysical factors are less limiting than the institutional and technical ones. Therefore, the need to address the issues of promoting and sustaining the willingness and ability of the relevant government departments and NGOs, to initiate and implement viable agroforestry projects for the benefit of the rural communities within South Africa's own limits, cannot be overemphasised. The issues are discussed in detail in Chapters 3 and 4, based on a survey undertaken in Umzimvubu District, other regions of Eastern Cape Province and similar areas of South Africa.

Sentiments similar to Bene *et al.* (1977), are also expressed by van Eck *et al.* (1997) in the case of South Africa. They lament the renewed forest destruction in some villages of Umzimvubu and Lusikisiki Districts of Eastern Cape stating that, *"it is clear that our natural forests are not going to be saved from destruction by legislation and law enforcement only and that alternatives will have to be found"*. The Port St. Johns Transitional Local Council (TLC) in collaboration with the Director General and the Eastern Cape Provincial Director of DWAF convened a public meeting in October, 1998 to address the destruction of indigenous forests in Umzimvubu District. Further, the van Eck *et al.* (1997) survey on tree use patterns and species preferences covering the villages of Tombo, Mtambalala, Lower Mtambalala and Cwebe, established the 25 most popular indigenous trees used for firewood, poles, craft, medicinal and fruit values. Most of these are over-exploited in the nearby forest reserves. The Natal Milk Plum, *E. natalense*, (UmThongwane), *M. grandis* (UmSimbithi) and the Sneezewood *P. obliquum* (UmThathi) trees, were rated among the top five species. The three species are among the 72 protected indigenous trees in Eastern Cape (Cooper and Swart 1992; Fanie and Venter 1996; Obiri 1997). A detailed status analysis of *E. natalense* and *P. obliquum's* abundance and size-class distribution is presented in Chapter 6. It is within this context that agroforestry is applied to ensure that these species are in adequate supply and within easy reach of the farmer. A detailed description, attributes and agroforestry potential of the three tree species is presented in Chapter 5.

1.9 Imperatives in Agroforestry Research and Development

International recognition of agroforestry has facilitated extensive collaborative research and development work at regional, national and local levels, particularly with the farmers. Within this context, four key process-oriented imperatives upon which agroforestry should evolve as a science are suggested as: i) competition, ii) complexity, iii) profitability, and iv) sustainability (Nair 1993; Sanchez 1995; Place 1997). However, this should take cognisance of the fact that agroforestry research and development activities are multidisciplinary and are therefore addressed differently in different regions (ICRAF 1991;1997).

Agroforestry is applicable to almost every inhabitable part of the world (Harts 1998). However, it is not an end in itself, but its systems and practices need to be blended and balanced with other systems for it to address socio-economic and environmental needs. It achieves this due to its multidisciplinary nature and variability which is present at all levels of interaction. The interactions are displayed within the only two functionally different types of agroforestry systems. These are the simultaneous and sequential systems, with each having its specific practices (ICRAF 1994; Sanchez and Palm 1996).

A simultaneous agroforestry system is where the trees and crops component grow at the same time and sufficiently close to each other to allow competition for light, water or nutrients. They are often linear arrangements either in strips or a row. Competition is minimised by using appropriate spacing and periodical silvicultural practices such as trimming, pollarding and thinning. Examples of simultaneous systems include: i) boundary plantings, ii) contour hedges, live hedges and fences, windbreaks, shaded perennial crops, parklands systems, silvopastoral systems and hedgerow intercropping (alley cropping). All these interventions have very high potential for success in Umzimvubu District and similar areas of South Africa. However, it is now recognised that alley cropping has far less potential than was originally anticipated. Carter (1995) contends that its major limitations have emerged in both its technical and socio-economic characteristics. Similar view is held by Sanchez and Palm (1996) who note that in most cases the trees' competition for water and nutrients is likely to exceed the fertility benefits from the leguminous mulch additions.

Sequential agroforestry systems are those where the trees and crops take turns in occupying most of the same land management unit. The time sequence keeps competition to a minimum in this case. Examples of sequential system include; i) shifting cultivation, relay intercropping, improved fallows, *taungya* (shamba) systems, and multistrata systems. Most of these interventions can easily be applied in Umzimvubu District and similar areas of South Africa. Growing trees and crops in harmony means that the system can be biologically sustainable, while having several plant species makes agroforestry one of the most biodiverse agricultural systems. This is the primary merit of the agroforestry systems. Nevertheless, the socio-economic factors will determine the actual sustainability of the selected agroforestry system (Raintree 1991; Buck 1995; Scotts 1996; ICRAF 1998a).

1.10 Prospects for Cultivating and Domesticating High Value Indigenous Tree Species

Since 1991 ICRAF has endeavoured to develop a database embracing both exotic and indigenous trees and shrubs species for different agroforestry systems and practices. The concept of cultivating and domesticating high value indigenous tree species is a recent initiative and programme. This is now featuring prominently in the research and development agenda of most collaborating countries (ICRAF 1997). Examples of high value indigenous tree species in ICRAF's domestication programme include *Markhamia lutea, Irvingia gabonensis, Balanites aegyptiaca, Melia volkensii, Zizyphus mauritiana, Prunus africana, Sclerocarya birrea* and *Uapaca kirkiana*. In South Africa, improved varieties of *Sclerocarya birrea* have been produced through selection and vegetatively propagated to maintain high quality (Maghembe *et al.* 1998). The Natal milk plum *E. natalense*, *M. grandis* and the Sneezewood, *P. obliquum* could benefit from similar experiences. Their popularity is attributed to: i) fruit, medicinal value and durable wood characteristics of the Natal milk plum, ii) excellent structural, wood carving, durable and termite resistant value of *M. grandis,* and iii) wood carving, poles, posts, and durability and high medicinal and cultural value of *P. obliquum*. (von Breitenbach 1965; Palgrave 1993; Fanie and Venter 1996; van Eck *et al.* 1997).

1.11 Sustaining Agroforestry

One of the most limiting factors to establishing a lasting capacity for agroforestry in Africa is a shortage of well trained staff with the necessary competence. The demand for persons with competence in agroforestry is increasing as it gains attention in rural development and research programmes (Roche 1992; Department of Agriculture 1995; Rudebjer and Temu 1996; van Zyl *et al.* 1996; Govere 1997). Training in agroforestry was, not until recently, included in the curricula of most universities and colleges that trained agriculturalists and foresters. However, educational institutions are now responding to these needs by incorporating agroforestry into their programmes (ICRAF 1992; Nair 1993; Rudebjer and Temu 1996). To-date, South Africa has four Universities and one Technikon as members of the African Network for Agroforestry (ANAFE). This is a joint effort by 98 other colleges and universities, in 34 countries to strengthen the teaching of agroforestry in land use programmes in Africa (Temu 1998). The initiative should be supported by appropriate policy changes.

1.12 The Study Aim and Objectives

1.12.1 Aim

The aim of this study is to determine the perceptions of rural communities of Umzimvubu District, in Eastern Cape Province, on agroforestry and to establish how agroforestry may contribute to optimising land productivity, reducing pressure on natural forests and ensuring sustainable production and provision of the desired products and services for their own benefit.

1.12.2 Objectives

1. Determine whether agroforestry in the Eastern Cape has potential as an integrated land use management system for optimising land productivity and ensuring self-sufficiency in the desired products and services.

2. Identify key players, potential linkages, roles and opportunities for enhancing development and adoption of agroforestry in Umzimvubu District and similar areas of South Africa.

3. Identify and describe appropriate agroforestry system(s) and practices which would support the cultivation, management, conservation and sustainable use of high value indigenous tree species, particularly *E. natalense, P.obliquum* and *M. grandis*.
4. Identify and analyse the factors which constrain or promote the cultivation, management, conservation, and sustainable use of *E. natalense, P. obliquum* and *M. grandis*.
5. Determine the current status of *E. natalense, P.obliquum* and *M. grandis* in Mt. Thesiger Forest Reserve (MTFR) and resource use impact by the adjacent the rural communities.

1.13 Conclusion

The need to pursue agroforestry development within a socio-economic and environmental context in the rural areas of South Africa is so important that it cannot be left to a few people to take decisions. As a result, the extent to which the people, particularly the resource-poor rural communities are informed about the potential of agroforestry and sources of information, the more likely they will able to contribute to its development, both as a science and popular sector of rural development. Furthermore, it cannot be overemphasised that prolonged delay in initiating measures to facilitate practical development of agroforestry is at the expense of the ecological integrity and the quality of life of the resource-poor rural communities in Umzimvubu District and similar areas in South Africa.

CHAPTER 2:

THE STUDY AREA AND RESEARCH METHODS

2.0 Introduction

Chapter 2 comprises two sections; the study area and research methods used. The first section describes the location, biophysical and socio-economic environment of Umzimvubu District, in Eastern Cape Province, South Africa. The second section describes the combination of research methods used in the study, to determine issues which provide and constrain opportunities for sustainable agroforestry development in Umzimvubu District and similar areas of South Africa.

2.1 The Study Area

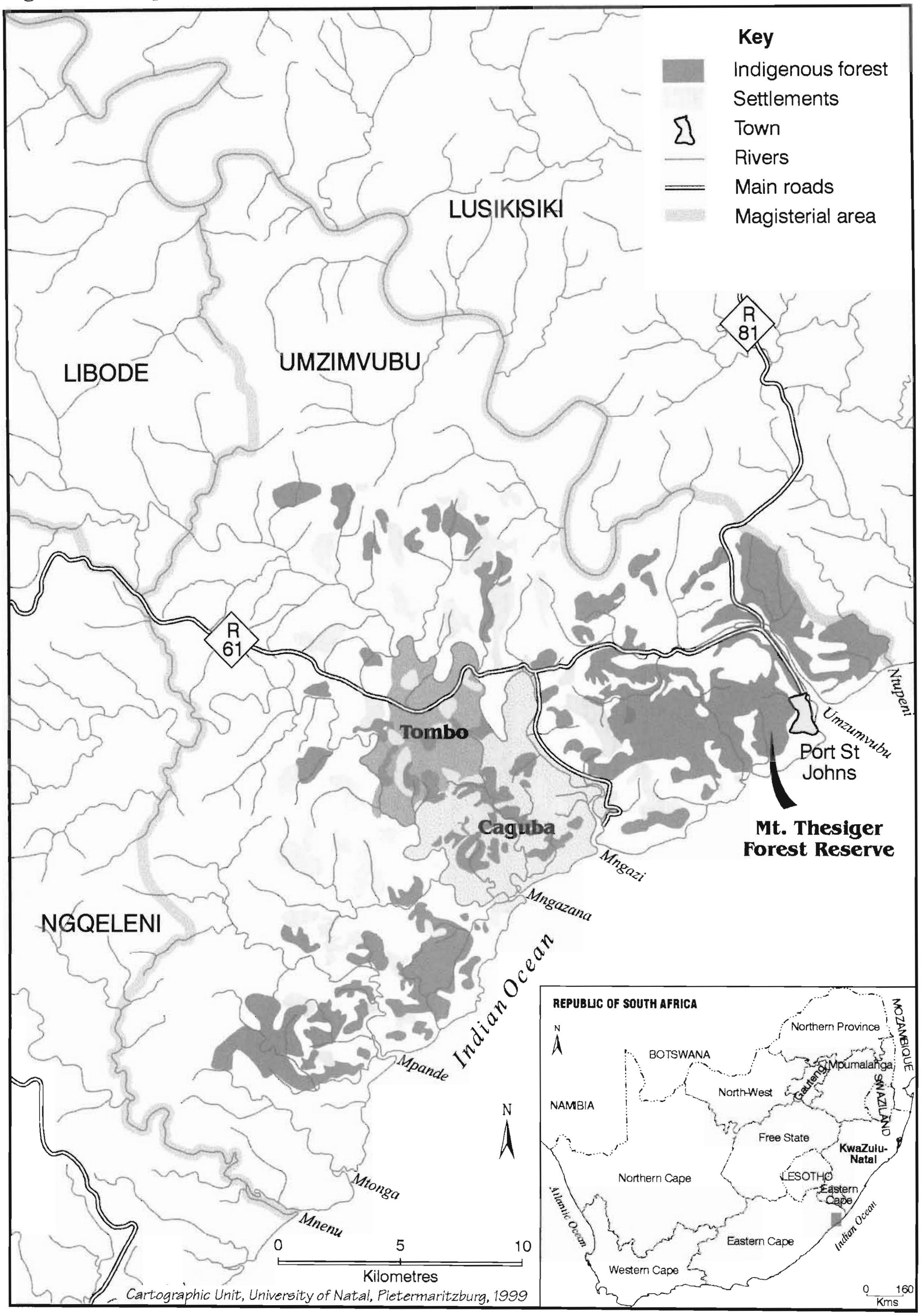
2.1.1 The Provincial and District Context

Eastern Cape is home to about 16% (6.3 million people) of South Africa's total population. Of these, 63% live in rural areas, giving the province a primarily *rural character* (Erasmus 1996; CSS 1998; Bishop 1998. The Province has the highest poverty rate (71%) in South Africa (May (1998).

The Eastern Cape has excellent agricultural and forestry potential. According to Low and Rebelo (1996), all the seven floral biomes of southern Africa, occur in this region. This makes it a floristically rich province with several endemic tree families.

South Africa is administratively divided into 371 Magisterial districts, of which 77 are in Eastern Cape Province. Umzimvubu District is number 283 (Readers' Digest 1994). The situation of the District in relation to South Africa and Eastern Cape Province is presented in Figure 2.1. The description of the study area has been drawn from several authors (Loxton, Venn and Associates 1990; Cawe 1980;1992; Cooper and Swart 1992; Pooley 1993; Readers' Digest 1994; Obiri 1997; Turner *et al.* 1997). The specific study locations are Caguba and Tombo.

Figure 2.1. Map of the Study Area



Umzimvubu District is located at the north eastern end of the Eastern Cape Province between latitudes 29° 15' and 29° 30' E and longitudes 31° 30' and 31° 45' S, along the coastal region. The District covers an area of about 55,150 ha (Cawe and Ntloko 1997). It has 17 residential locations of which Caguba is the largest. There are many villages within these locations. These are located on slopes or tops of flat hills, but near water and indigenous forest resources. Caguba and Tombo are situated south east of Port St. Johns town at a distance of 12 km and 20 km, respectively. Like in many other locations, the villages are administered by the Pondoland Tribal Authority.

2.1.2 The Biophysical Environment

2.1.2.1 Geology

Umzimvubu District comprises rock formations laid down during the pre-cambian, palaezoic, mesozoic and cainozoic eras It is dominated by the Beaufort sandstones of the Karoo sequence with bands of the older Ecca and Dwyka groups towards the coast. The cretaceous formations are also found distributed in narrow localities along the coastline from Umngazana River mouth. They constitute the parent structures of the soil on which the Coastal scarp forests occur. The palaezoic and mesozoic era rocks are the most important in terms of the distribution of forests in the region (Cawe 1980, Butchart 1989).

2.1.2.2 Topography

The combined effect of the underlying geology, erosion and weathering processes has created a varied topography in Umzimvubu District. The District is made up of steeply sloping land which descends from about 700 m above sea level over a distance of about 30 km. Mt. Thesiger and Mt. Sullivan are two outstanding geomorphological outcrops of sandstone with steep cliffs which end abruptly into the sea as shown in Plates 2.1, 2.2 and 2.3. Further, Umzimvubu District is traversed by several rivers and streams, for example, Rivers Umzimvubu, Bulolo, Umngazana and the Umtambune stream. Overall, the relief comprises a steeply rolling feature (Cawe 1980; Mbande 1998). Aspect within a topographical area is of importance in terms of species distribution.

THE RURAL LANDSCAPE

Plate 2.1
Coastal landscape at which Mt. Thesiger and Mt. Sullivan are traversed by Umzimvubu River estuary from the Light House in Port St. Johns.

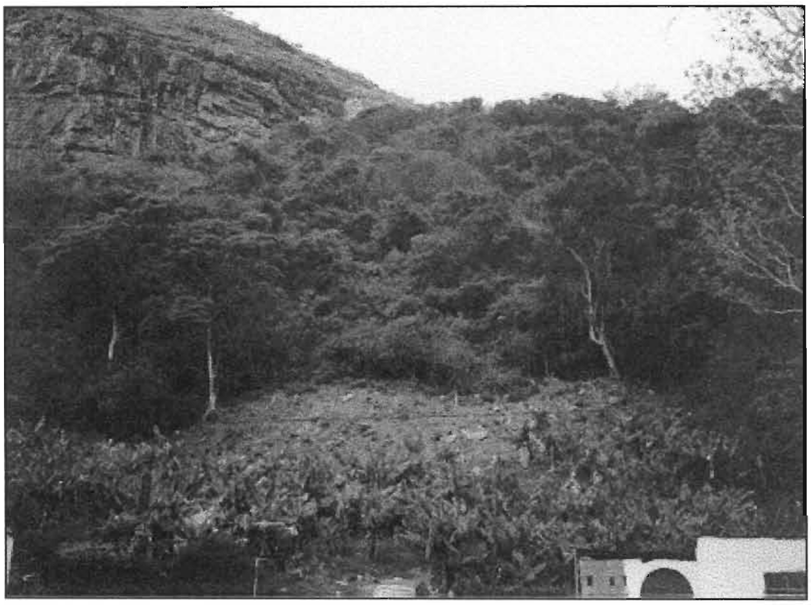


Plate: 2.2
Evidence of adverse human activity on a once closed indigenous forest patch next to a Shell Petrol Station in Port St. Johns.

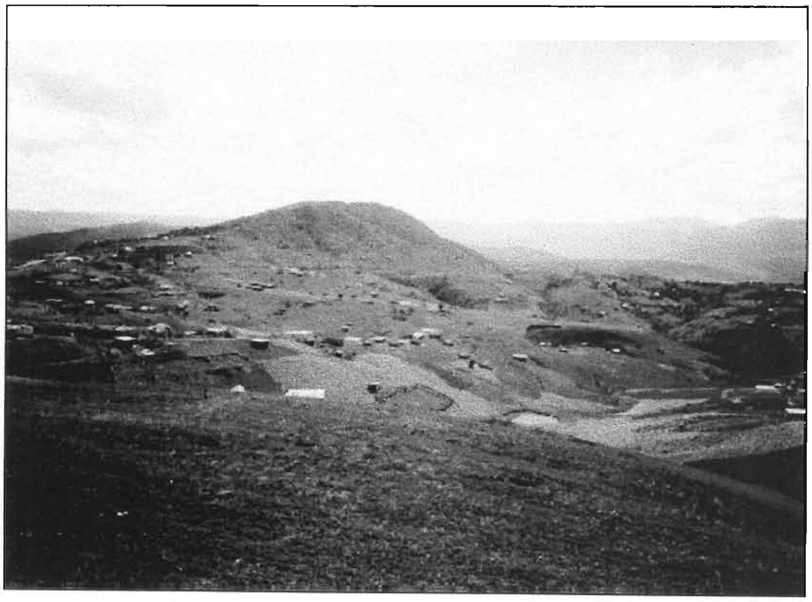


Plate: 2.3
A bare human settlement and agricultural landscape near Tombo TRC Centre in Umzimvubu District.

2.1.2.3 Soils

The coastal belt soils are acidic and highly leached (Wood and van Schoor 1976) . This is because of the high rainfall and poor drainage in the region. Soil type is observed as a strong influence on the structure and composition of tree species which grow in different areas of the forest (Butchart 1989). For example, the most common tree species in the deeper sandy soils include Forest Mahogany *Trichilia dregeana*, Yellowwood *Podocarpus latifolius*, Stinkwoods *Celtis africana* and *C. kraussii*, *Drypetes gerrardii* and *Ficus natalensis*, the white Ironwood *Vepris undulata*, *Combretum kraussii* and *Rawsonia lucida* are found in the more clayey soils. Further, *Euphorbia traingularis,* the Knobwood *Zanthoxylum davyi and Aloe bainsii* occur on the well-drained soils. However, the understorey of the coastal forest is fairly uniform regardless of the soil type. Examples of understorey species include *Buxus natalensis* (Oliv.) Hutch., *Dalbergia arbutifolia, E. natalense* and *Entanda spicata.*

2.1.2.4 Climate

The climate of Umzimvubu District is subtropical and falls within the summer rainfall region of southern Africa. It is influenced by two main factors: i) its proximity to the sea, hence effect of ocean currents and ii) topography. The region receives higher rainfall compared to most of South Africa. Most of the rain (70%) occur between October and March. The annual average rainfall is above 1000 mm. However, the amount of rainfall generally diminishes towards the west, with distance from the sea, but increases with altitude (Cawe 1980; Obiri 1997).

The temperatures are strongly affected by altitude, latitude and ocean currents. The range of temperatures is least at the coast and greatest in the inland. Further, the average daily maximum temperatures along the coastal area is 23.2° C, while the average minimum is 16.7 C (Obiri 1997).

There are at least seven wet months, but no completely dry month. The potential evapotranspiration is between 830 and 850 mm per annum, while frost is rare (Department of Agriculture and Forestry *undated*).

The prevailing wind direction is north easterly in summer and south westerly in winter along the coast. Further, salt laden winds tend to either limit the occurrence of many plant species or prune vegetation, particularly the canopy species (Low and Rebelo 1996). The inland is generally calmer with wind blowing from south east in summer and north west in winter.

2.1.2.5 Vegetation

The phytogeography of Umzimvubu District is mainly of the forest biome. Indigenous forests cover about 9% of the District's surface area (Cawe and Ntloko 1997), comprising of the coastal vegetation type of southern Africa (Acocks 1953; Low and Rebelo 1996) and grasslands. Most of these occur within the legally defined protected areas such as state, private and communal. However, their conservation status is increasingly undermined by unsustainable human activities.

The forest biome is represented by the Afromontane and Coastal forests (Low and Rebelo 1996; van Wyk *et al.* 1996). Different plant communities can be found within these forests. They occur in patches which range in size from 1 ha to 934 ha.

The Coastal forest is the most dominant vegetation type in Umzimvubu District. It is categorised into six sub-types (Cooper 1985; Cooper and Swart 1992). These include the: i) dune forests, ii) swamp forests, iii) Pondoland coast forests, iv) South coast forests, v) coastal scarp forests, and vi) the mangrove communities. The dune, swamp and mangrove communities are found in special habitats which are vulnerable to development initiatives, commercial monocultural cropping and over-exploitation. Their extent is small, often limited by influence of strong salt spray and sea winds. However, they are of importance in maintaining beach stability and buffer to inland vegetation. They are also rare and unique forest sub-types. The dominant dune and swamp tree species include the Coastal Red Milkwood *Mimusop caffra* White Milkwood *Sideroxylon inerme* and the Wild Frangipani *Voacanga thoursii* (Pooley 1993).

The Pondoland coastal forest is found in predominantly moist sandstone outcrops with grassy plateaus cut by narrow gorges on the south and east-facing slopes (Pooley 1993). They are floristically rich with several endemic tree families, genera and species. Examples of Pondoland coastal forests in Umzimvubu District occur on Mt. Thesiger (Pembeni) and Mt. Sullivan (Bovini). Mt. Thesiger Forest Reserve (MTFR) is one of the oldest nature reserves in South

Africa. It covers an area of 1,468 ha (Turner *et al.* 1997) and is managed by the DWAF. Mt. Sullivan area is partly under private ownership, municipal commonage of Port St. Johns and the DWAF. It covers an area of 1,103 ha (Cooper and Swart 1992; Turner *et al.* 1997). These forests are of great conservation importance to the District. They contain vulnerable species such as grass-like climbing vine *Flagellaria guineensis* (Ugonothi) (Cawe and Ntloko 1997) and endemic species such as *Colubrina nicholsonii*, the Pondoland coconut *Jubaeopsis caffra*, *Leucadendron pondoense*, the Rock Lemon *Pseudosalacia streyi*, the False Red Pear *Pseudoscolopia polyantha* and *Raspalia trigyna* (Cawe 1992; Pooley 1993). Further, they are of importance to the local communities for health care, nutrition, energy, generating local income from craft works, poles, posts, grazing, other utilitarian needs and ameliorating the local microclimate (Cawe 1992; Cooper and Swart 1992; Fanie and Venter 1996; Hutchings *et al.* 1997; Obiri 1997; van Eck *et al.* 1997).

The coastal scarp forest occur as a transitional forest type, where the coastal forest merges imperceptibly with mist-belt forest on the south and east-facing slopes of the high coastal escarpment (Pooley 1993; Low and Rebelo 1996). Examples of important tree species found in these forest include, the Stinkwoods *C. africana*, C. kraussii Forest Bushwillow *C. kraussii*, *D. gerrardii*, Natal Milk Plum *Englerophytum natalense*, Wild Plum *Harpephyllum caffrum*, *Millettia grandis*, Giant UmSimbithi *Millettia sutherlandii*, Sneezewood *Ptaeroxylon obliquum*, Forest Mahogany *T. dregeana* and the Knobwood *Z. davyi* (Cooper 1985; Cawe 1992; Obiri 1997; van Eck *et al.*1997). Most of these trees are of high value and importance to most rural communities and for sustaining the forest ecosystem. These include conserving water resources, particularly the major stream and river source areas and as a source of many tree products and services.

Invasive exotic (alien) plant species are an increasingly common form of plant communities within Umzimvubu District. Examples include the Mauritius Thorn *Caesalpinia decapetala* (Roth.) Alston., *Lantana camara, Lippia javanica,* Guava *Psidium guajava* Peanut Butter Cassia *Senna didymobotrya* (Fresen.) Irwin & Barneby., Goat Apple *Solanum aculeastrum* Dun. and the Bugweed *Solanum mauritianum* Scop. (Pooley 1993; Henderson 1995). These are found in either closed thickets, clusters, or isolated in forest gaps, margins and communal grazing areas. The main concern is that they tend to displace indigenous plant communities where they occur.

2.1.2.6 Fauna

The conservation value of the indigenous forests in Umzimvubu District is enhanced by the presence of faunal species. These include: i) insects, such as the Swallow tails and Charaxes butterflies; ii) over different 32 bird species, for example, the Trumpeter Hornbill *Bycanite bucinator* (Temmincle), Knysna Lourie *Tauraco corythaix* (Wagler), Narina Trogan *Apaloderma narina* (Stephens), Green Barbet *Pogorimulus simplex,* and the Yellow Streaked Bulbul *P. flavostriatus* classified in the South African Red Data species list; iii) crustaceans, such as the Coastal scarp forest Crab; and iv) mammals, such as the Velvet monkey *Ceriopethicus aethiops*, Samango monkey *Ceriopethicus mitis*, Blue Duiker *Philantomba monticola*, Bushbuck *Tragelaohus scriptus* and the Giant Golden mole *Chrysopalax trevelyani* (Cooper 1985; Cooper and Swart 1992; Obiri 1997).

2.1.3 The Socio-economic Environment

2.1.3.1 Demographic Profile

Umzimvubu District has a population of about 55,200 people, of which 57% are women. The District is densely populated with about 80 people per km^2 (Goldfield/WWF 1996; Obiri 1997).This is relatively high compared to the provincial and national population densities of 38.2 and 41.4 people per km^2, respectively (Erasmus 1996; CSS 1998). About 80% of the population is considered to be rural, while the average household size is 8 people. Further, the economically productive age group range from 15 to 64 years, of which the ratio of male to female is 1:2. Women constitute a major source of labour at household level. This is because most men tend to seek employment opportunities away from home.

2.1.3.2 Socio-economic Context

About 87% of the people do not earn an income, 9.2% earn below R 500, 1.9% earn R 500 - R 1000 and 1.1% earn above R 1000 per month (Ridsdale and Kallman 1996). Remittance and pension are important sources of income to some people in the area. Almost all of the people

(94.6%) do not receive any remittance, 5.4% receive R 100 - R 500, and only 0.1% receive over R 1000 per month (Obiri 1997). Furthermore, almost all of the people (95%) do not receive pension, 5% receive R 500 to R 1000 and only 0.1% receive over R 1000 per month (Powell 1996).

Ecotourism is the largest potential income earner to the District. This accounts for 30% of all formal employment (Sullivan and Robinson 1997). However, the closure of infrastructure such as the Cape Hermes Hotel and several seaside cottages has adversely affected this sector.

The above situation suggests that the primary sources of employment are agriculture, government and community services sectors. However, the opportunities are limited and declining, including those in the secondary and tertiary sectors (May 1998). The current unemployment levels are estimated at more than half of the population (60%). Since most people receive income below subsistence level, the living standards are relatively low. The low income level limit the ability of the resource-poor rural households to invest in high input and extensive farming activities. Further, the situation is aggravated by the declining migratory patterns and retrenchment programmes, particularly the mining sector (Obiri 1997). The combination of limited employment opportunities, low income, remittance and pension predisposes the indigenous forests to heavy exploitation by the resource-poor rural households in an attempt to offset the economic burdens. However, May (1998) contends that poverty is not primarily a rural issue in South Africa, but one of vulnerability to becoming and remaining poor.

2.1.3.3 Development Initiatives

Spatial development initiatives (SDIs) now constitutes a major thrust of government development policies. The Wild Coast SDI is envisaged to create 61,000 jobs, through involvement of the private sector partnerships and management expertise. Community based forestry projects is one potential area of concern (RDP 1998). Further, the Malaysian and Japanese government interest in providing finance for development and completion of the untarred 20 km stretch of road between Port St. Johns and Lusikisiki District may enhance economic growth in the area (Turner *et al.* 1997). Other development initiatives in the District include the Coast Management Planning and Policy (CMPP) and Agroforestry Development

Services-World Wide Fund for Nature (South

Africa) and Goldfields Foundation (WWF/SA & Goldfields). The project is locally known as the Master Farmer and Apprenticeship Programme (MFAP) in Port St. Johns.

2.2 Research Methods

The multidisciplinary nature of agroforestry implies that no single method of data collection can be used to record perceptions, socio-economic, biophysical, ecological and institutional dimensions of agroforestry. For this reason, a combination of qualitative and quantitative techniques were used to obtain empirical evidence to support the aim and objectives of the research study. In addition, literature review was done to complement information obtained using the two techniques (Bless and Higson-Smith 1995; Slocum *et al* 1995; Neuman 1997).

2.2.1 Household Level Agroforestry Interviews in Umzimvubu District

Qualitative techniques were used in the South African context, to determine whether the households and institutions were aware of, and responding to the need to: i) diversify and optimise on-farm production; ii) improve the quality of life of the resource-poor rural households; iii) improve income opportunities; and iv) contribute to conservation of indigenous forests through agroforestry.

The primary approach at the household level was based on a face-to-face interview and complemented by on-farm visits to the homesteads. A sample population of 43 farmers representing 43 households, in Caguba and Tombo the locations of Umzimvubu District, were interviewed. The two locations are situated at about 12 km and 20 km, respectively, south-east of Port St. Johns town. The interviews were based on a structured questionnaire (Appendix I). The questionnaire was divided into 7 activity areas, namely: i) general household characteristics, ii) land tenure and land use type, iii) farming practices, iv) tree resource use type, v) tree resource conservation perceptions, vi) provision of agroforestry related services, and vii) linking households to agroforestry. Detailed results and discussion are presented in Chapter 3.

2.2.2 Institutional Agroforestry Interviews at Local and National Level in South Africa

The approach for institutions involved a set of a self-administered questionnaire (Appendix II) for interest groups, such as the Department of Agriculture (DA), DWAF, non-governmental organisations, Academic institutions and Key informants involved in the development and promotion of agroforestry. Forty structured questionnaires were distributed by post with pre-paid postage for return. Fax facilities were also used to receive or send some questionnaires. Twenty responses (50%) from 5 institutions/informants were received. The issues and perceptions relating to agroforestry were established based on questions which investigated institutional: i) involvement in agroforestry, ii) initiatives and achievements to date, iii) factors constraining the latter, and iv) problem solving capacity. The detailed analysis is presented in Chapter 4.

Structured questionnaires comprising both closed and open-ended questions (Bless and Higson-Smith 1995; Slocum *et al.* 1995; Neuman 1997) were used. These enabled the respondents to give their views to the issues raised. Both questionnaires were developed, pre-tested and amended to capture the objectives of the respective surveys.

2.2.3 Sampling *E. natalense* and *P. obliquum* Using Modified Whittaker (Stohlgren *et al.* 1995) and "Modified" Benitez-Malvido (1998) Plot Designs

Quantitative techniques were used to determine the abundance and size class distribution (SCD) of the Natal Milk Plum, *E. natalense* (Sond.) Heine & J.H Hemsl. (UmThongwane) in the forest areas of MTFR adjoining Caguba and Tombo locations. The area was divided into 2 zones; i) "moderately" exploited forest areas near the Forest office, and ii) "heavily" exploited forest areas adjacent to the villages. The distinction is based on ease of accessing the species for various uses and that most areas of the forest have been subjected to some level of exploitation (Marlene Powell 1998 pers. comm[1]). A similar survey for *M. grandis* was done (Obiri 1997), while a more comprehensive one for the Sneezewood *P. obliquum* (Thunb.) Radlk (UmThathi) has yet to be done. The Modified Whittaker nested vegetation sampling method was used to inventory

E. natalense. However, *P. obliquum* required a different sampling design than Modified Whittaker

plot design because it was represented by mainly seedlings in some forest patches and an occasional mature or canopy tree, in MTFR.

The Modified Whittaker plot design allow better estimates of mean species cover, analysis of plant diversity patterns at multiple spatial scales (*i.e. nested quadrat sizes of 1* m^2, *10* m^2, *and 100* m^2 *within a 1000* m^2 *area*), and trend analysis from monitoring a series of strategically placed, long-term plots in heterogeneous landscapes. Further, this method also eliminates the chances of double counting (Shimda 1984; Stohlgren *et al.* 1995). However, it is time consuming if a very large area has to be covered. For each sample plot, all seedlings in the 10 subplots, 2 x 0.5 m were counted and recorded, and all saplings in the 2 subplots, 2 x 5 m were counted and recorded. All mid-storey trees in the 5 x 20 m subplots were counted, diameter measurements at breast height (dbh) taken and recorded. The same variables were recorded for above canopy trees within the 20 x 50 m subplot.

Thirty four plots of *E. natalense* were sampled using the Modified Whittaker plot design method. However, emphasis on this species was mainly coincidental. The study had assumed that Modified Whittaker method was versatile enough to accommodate all the intended species. The Modified Whittaker plot design was considered inappropriate for *P. obliquum* because the dominant size class distribution comprised seedlings. Therefore, a modified version of the Benitez-Malvido (1998) sampling design was adopted. However, the method required as much time as the Modified Whittaker and hence only 5 plots were completed.

The "modified" Benitez-Malvido (1998) plot design consists of a standard 20 x 20 m (400m^2) quadrat (Chapman 1976; Cawe and Mckenzie 1989). However, the original plot design is 100 x 100 m (10,000m^2). The quadrat (20 x 20 m) was stratified into 16 subplots, 1 x 1 m (1 m^2) which were located along 4 equidistant transects at 4 m apart, as described by Benitez-Malvido (1998). The seedlings were counted, measured by height and recorded. The height rather than diameter size class gave a better distinction since all the size class distributions were in one size class of seedlings (0 - 6 cm).

The data recorded were analysed within size class distributions to determine the population structure and harvesting impacts on *E. natalense, P. obliquum* and *M. grandis* in MTFR. The size class distributions are a good indicator of population structure (Everard *et al.* 1994; Condit *et al.* 1998; Lykke 1998). Nonparametric statistics, particularly chi-square and Kolmogorov-Smirnov tests (Siegel and Castellan, Jr. 1988) were used for the analysis. The Kolmogorov-Smirnov Test (K-S statistic) was chosen because it is less sensitive to small numbers of observations in a size-class than the chi-squared statistic. The chi-square requires that such classes are pooled (typically if a class has fewer than 5 observations). Therefore, as many classes as feasible are used in the Kolmogorov-Smirnov Test. The detailed illustrations of the Modified Whittaker (Stohlgren *et al.* 1995) and "Modified" Benitez-Malvido (1998) plot designs, results and discussion is presented in Chapter 6.

CHAPTER 3:

THE HOUSEHOLD AGROFORESTRY PERSPECTIVES IN UMZIMVUBU DISTRICT

3.0 Introduction

The potential of agroforestry to address a range of socio-economic needs of resource-poor rural households (Bene *et al.* 1977; Kerkhof 1989; Nair 1989; Erskine 1991; Sanchez 1995) and in enhancing ecological resilience (Leaky 1996; Sanchez and Palm 1996; ICRAF 1998) are reasons for its appeal. The appeal may vary from one region, area, institution or community, to another (ICRAF 1991; 1997). This variation may be attributed to the different perceptions and experiences of agroforestry. For successful implementation agroforestry should be considered at two levels, namely, the household and institutional levels. The object of this chapter is to place agroforestry in the South African context of the resource-poor rural households of Umzimvubu District.

3.1 Methods

The occupants of 43 households in Caguba (25) and Tombo (18) locations, were interviewed using structured questionnaires (Appendix I). The questionnaire comprised close-ended and open-ended questions (Bless and Higson-Smith, 1995; Slocum *et al.* 1995; Neuman 1997). This was intended to determine whether households were aware of, and responding to the need to intensify and diversify on-farm productivity and improve income opportunities through agroforestry. The questionnaire was divided into 7 sections, each assessing responses on the feasibility of initiating, implementing and sustaining the practice of agroforestry at household level. The factors affecting the outcome of each item of the questionnaire were recorded and also physically observed in each homestead. These included: i) general household characteristics (e.g. size, sources of income, decision-making); ii) land tenure and land use type (e.g. allocating authority, types and effects on agroforestry); iii) farming practices (e.g. crop and livestock production); iv) tree resource use type (e.g. energy, other wood usage, sources); v) tree resource conservation perceptions (e.g. planting, species planted, source of propagation materials, belief or taboos in tree planting and conservation); vi) provision of agroforestry related services (e.g. visits, material, training and advisory services); and vii) linking households to agroforestry (e.g. knowledge of agroforestry concepts and practices, value in integrating trees into existing farming systems, constraints in practicing agroforestry and suggestion on how to promote agroforestry). Persons at the Tombo location were particularly interested in agroforestry. A total of 32 (74%) patriarchal and 11 (26%) matriarchal Xhosa speaking households were interviewed through a translator.

3.2 Results

3.2.1 General Household Characteristics

3.2.1.1 Household Size and Sources of Income

The average household size was 7 persons (± 3.3 s.d., n = 43 households). Of these, 49% had at least 2 members who lived or worked elsewhere. The household size is of importance in terms of labour requirements and decision-making processes in implementing agroforestry practices.

About 12% of the people in Umzimvubu District earn an income (Ridsdale and Kallman 1996). These are in the range of: i) below R 500 (9.2%), ii) R 500 - R 1000 (1.9%), and above R 1000 (1.1%). In this study, the sources of household income were; salary (35%), farm produce (14%), small scale business such as vending, craftworks, sale of firewood (7%), pension (2%), and a combination of the four sources (42%). None of the households received any remittance. Agroforestry may open new employment opportunities for more people to earn some income.

3.2.1.2 Decision making

The survey revealed that 70% of the decision-making on resource use is determined by either the male or female head of the household, 16% by both man and wife, and 14% by other members of the household. Nevertheless, the ultimate decision-making is still the domain of males. The proportion of the members of the households who had or were undergoing some formal education in Caguba location were 27% in primary school, 49% secondary/high school, and 9% in tertiary institutions. Tombo location had 23% in primary school, 51% secondary/high school and 12% tertiary institutions. There were no reports on attendance in adult literacy education. Basic formal or informal education have considerable influence on the household's decision to allocate factors of production and increase benefits (Idabacha 1995; Mbatia and Okello 1996).

3.2.2 Land Tenure and Land Use Types

The land under settlement by each household in Caguba and Tombo locations fall under communal or tribal tenure. A total of 91% of the heads of households were allocated land by the Chief. The other 9% was inherited from parents who had initially been allocated the land by the Chief. The land parcels were about 50 x 50 m (0.25 ha) in area. However, other tenure systems such as leasehold, private, state and local authority ownership were found in specific areas of Umzimvubu District (Turner *et al.* 1997).

Although 63% of the households had occupied their land for more than 10 years to a life-time. Of these, only 28% felt that they had relatively secure ownership (access to, and control) of their land for settlement, cultivation and other uses. This duration is long enough for such households to have initiated or adopted sustainable land use management practices or to have improved their traditional land use management systems. However, most households (72%) acknowledged that they had access to communal land which they could only cultivate maize, graze livestock and obtain some of their tree related needs such as fuelwood and medicines. This, they felt limited their individual desire to venture into any innovative initiatives such as agroforestry. The fields were situated at least 1 km or more from the homesteads. Any individual initiatives in these fields would involve investing in fencing and resolving the adverse impacts of the common extensive grazing system in the area.

3.2.3 Farming Practices

3.2.3.1 Comparison of Current On-farm Production Activities

The criteria for comparison of on-farm production activities included: i) the level of farm organisation; ii) diversity of farming activities; iii) state of land management (soil conservation); iv) soil fertility; v) presence and abundance of indigenous trees; and vi) fruit trees and other exotic trees on the farm. Each criterion was ranked as low or none, medium or few and high or abundant. Fourteen percent of the households were rated as high, 47% medium and 39% low, with respect to each criterion's capacity of use. According to this criteria, the high to medium achievement indicates a relative shift from traditional farming practices and response to the need to diversify on-farm production activities. Further, these were found in areas where households felt that land ownership was relatively secure.

3.2.3.2 Crop Production

Subsistence farming was the only farming system among the resource-poor communities in Umzimvubu District, in Caguba and Tombo locations. The most important on-farm food and cash crops, included maize, cabbages and beans (83%), irish potatoes, spinach and pumpkins (58%), onions, tomatoes and carrots (24%), bananas, pineapples and sugarcane (8%), and others (8%). Trees were deliberately retained or planted along the farm borders and isolated or scattered within the farm, to enhance microclimate. In addition, such trees provided intermediate products such as medicines, firewood, mulch, fruit, and protection against strong winds. It was also evident that monocropping of maize was a predominant farming practice in the area. However, some households were rapidly intensifying and diversifying their on-farm production activities by intercropping both food and cash crops. The evidence of such practices are as shown in Plates 3.1, 3.2 and 3.3.

Sixty-three percent of the households produced just enough food for subsistence, while 26% harvested enough to sell and generate extra income. Most households were keen to generate extra income by intensifying and diversifying their on-farm production activities. All households, without exception, reported that they experienced problems in crop production. The problems and suggested solutions are outlined in Table 3.1.

3.2.3.3 Livestock

About 81% of the households keep livestock as a source of food, income, savings, prestige or labour. These include, poultry (72%), goats (51%), cattle (42%), pigs (33%) and donkeys

(14%). Of these, 82% keep a combination of livestock and the rest only one type. Half of the households keep goats and cattle, which are most destructive to crops and establishing trees.

THE POTENTIAL OF AGROFORESTRY IN UMZIMVUBU DISTRICT

Plate: 3.1
Boundary and hedge planting with **Grevillea robusta** (alien) and **Dovyalis caffra** diversifying and intensifying production.

Plate: 3.2
Individual initiatives to diversify and intensify land productivity in Caguba Location, Umzimvubu District.

Plate: 3.3
The fruits of a farmer's labour and pride. (Avocados, Pawpaws, Bananas and Pineapples).

Table 3.1. Problems and suggested solutions in crop production

Summary of problems	Suggested solutions	Remarks
1. Adverse weather causing water scarcity, drought, flood and desiccating winds.	-Boost water supply resources, sink more wells, tap water from nearby major rivers for irrigation and domestic use.	Integrate high value indigenous trees to protect catchment areas.
2. Communal land tenure and farm size are a hindrance to long-term investment in intensifying and diversifying crop production.	-Institutional reforms. Increase individual land holding sizes.	Most resource-poor households are settled on 50 x 50 m (2500 m^2) piece of land (Bolus 1991). At least 0.4 ha is adequate (van der Zel 1997)
3. Long distance to the maize fields.	-Decentralise settlement. -Land consolidation.	-
4. Animal damage to crops (livestock, moles, birds).	-Fencing. -Tending unattended livestock. -Physical methods, e.g. trapping, digging out.	Communal fields are grazing areas during off-seasons. Individual initiatives are constrained. Potential damage to unprotected trees.
5. Insects pest damage to crops (stalk borers, aphids, weevils, cutworms, termites).	-Physical methods, e.g. application of ash, collection, digging out. -Pesticides and herbal concoctions.	Integrated pest management.
6 Declining land productivity.	-Use fertilizers -Physical methods (application of manure, construction of terraces, planting ground cover crops).	Sustainable land management measures tree planting, soil conservation, and soil fertility improvement measures.
7. Distant sources of farm inputs (seeds, fertilizers, pesticides).	-Setting up cooperatives nearby to stock agricultural inputs.	Action: Department of Agriculture (DA)
8. Lack of adequate capacity among farmers.	-More involvement and interest in farmer-oriented problems by relevant governmental departments and other agencies through awareness creation, training, infrastructural support, demonstrations.	Action: DA and DWAF.
9. Labour shortage.	-Market opportunities.	

Source: Interviewees.

Livestock constitute one of the three main components of agroforestry. The tree and shrub components are important sources of feed/forage and herbal veterinary medicines in subsistence farming system. Most livestock grazed usually unattended, except when everyone was planting in the maize fields. Seventy-two percent of the households keeping livestock encountered various management problems. The most common problems and suggested solutions are as in Table 3.2.

Table 3.2. Problems and suggested solutions in livestock management

Common Problems	Suggested Solutions
1. Tickborne diseases (gall sickness, redwaters, foot and mouth).	-Administer local solution of "mabula" mixed and stirred with sump oil to make it stick to the affected parts. -Dipping/spraying with acaricide. -"umLungumabele" leaves crushed in 1 litre of cold water for gall sickness. -Traditional herb"Ndolowane" for foot and mouth disease. -Teramycin injection. -Use Isinuka River water.
2. Donkey feats.	-No solution.
3. Worms in livestock.	-Veterinary worms remedies and herbal concoctions.
4. Poultry diseases (Newcastle).	-Potash medicines, including crashed Aloe solution. -Black-tea solution.
5. Thefts and losses in the forest.	-A new phenomenon, create more employment opportunities
6. Run-down by vehicles.	- Tending/herding.
7. Damage to crops, trees in the fields and farm/garden.	-Fencing (live hedges) and tending.
8. Absence or inadequate number of cattle dip tanks.	-Technical and material support.
9. No co-operatives stocking veterinary products nearby.	-Setting up cooperatives nearby.

Source: Interviewees.

3.2.4 Tree Resource Use Forms

3.2.4.1 Energy

The common sources of energy for cooking and heating are; firewood, paraffin, gas and electricity. Only 5% of the households use either firewood or paraffin alone. The combined energy use from: firewood and paraffin is 56%; firewood, paraffin and gas 21%; and others 2%. About 44% of the households using firewood, use up to 10 bundles ("inyanda") per month, while 65% use up to 30 litres of paraffin per month. Although the relative use of firewood is low in this case, the actual situation in the area is one of an increasing demand. This may be attributed to the increasing: i) collection distance, ii) number of firewood vendors along the main roads traversing the area, and iii) a bundle of firewood lasts only a short time (2-3 days).

3.2.4.2 Wood Usage

It was evident from the respondents that they have a valuable knowledge of the uses of trees. Virtually all tree species are useful in one way or another. The farmers reported that the most common uses of indigenous trees included, construction/building (86%), medicines (79%), craftworks (70%), fencing (65%), fuelwood (58%), protection against intense wind, dust and sun shine (49%), food supplements (33%), conservation of soil and water resources (7%) and fodder, hunting and as "toilet" to relieve themselves (2% each). A large proportion of households (93%) specifically used trees for medicinal needs. Only women reported on potential of some trees for fodder. Examples of some important uses and resource status reported by 43 respondent households are as shown in Table 3.3 and Plates 3.4 to 3.7. The general observation among the households was that most indigenous tree species in the forest were increasing. However, not all households commented on the status of the species, therefore, the values in column 4, Table 3.3, represent a summary for those who did.

3.2.4.3 Sources of Tree Products

Forty two percent of the indigenous tree products were from State forests, 26% from Headmen's forests and 32% from both. About 40% of the households obtained their tree products from a forest patch less than a kilometre away, 44% from a forest 1 to 5 km away, and 16% from forests 5-10 km away. Most of the households (77%) reported that they were able to obtain the tree products in desired quantities. This may perhaps explain why on-farm sites were not yet established sources of tree products. The 23% of households that were unable to acquire the products in desired quantities, attributed this to: i) human population increase, ii) increased demands for medicinal needs and craftworks, iii) long distances from the sources, and iv) some species were habitat/site specific. Issues (i) and (ii), have in all likelihood led to deteriorating conditions in (iv).

Table 3.3 Some important indigenous trees, their uses and status (N=43 Households).

Scientific Names	Local Name	Main Uses	Status		
			Decreasing	Same	Increasing
1. *Millettia grandis*	umSimbithi	Walking sticks, knob sticks, batons, poles, posts, construction timber, fuelwood.	12	3	18
2. *Ptaeroxylon obliquum*	umThathi	Fencing and building poles, posts, medicine against headaches, sinusitis, rheumatism, fuelwood, socio-cultural values.	10	4	13
3. *Acacia karoo*	umUnga	Fuelwood, medicine against sore throat, shade, utility wood.	9	4	7
4. *Englerophytum natalense*	umThongwane	Fruit, fencing and building poles, posts, utility wood, medicinal.	3	3	11
5. *Harpephyllum caffrum*	umGwenye	Fruit, medicinal.	3	2	5
6. *Trichilia emetica*	umKhuhlu	Medicine against waist and stomach complaints, shade, "toilet paper".	2	3	5
7. *Vepris lanceolata*	umZane	Circumcision rites, powdered roots used against influenza, utility wood.	1	2	5
8. *Duvernoia adhatodoides*	isiPheka	Poles.	2	2	2
9. *Drypetes gerrardii*	umHlakela	Making sticks, poles and posts.	0	1	5
10. *Erythrina caffra*	umSintsi	Shade, floats for fish nets, ornamental, medicinal bark.	0	3	3
11. *Xanthoxylum davyi*	umLungumabele	Medicinal bark is a snake bite remedy, roots for toothache, leaves for fever, utility wood.	2	0	4
12. *Xymalos monospora*	umHlwehlwe	Medicine against gastro-intestinal complaints, fencing poles and post, furniture.	2	0	3
13. *Coddia rudis*	iNtsinde	Fruit, fodder for goats, fencing posts.	0	1	3
14. *Strychnos henningsii*	umNonono	Fencing poles and post, hedge, building and kraal poles, utility wood, bark used medicinally for nausea, intestinal worms and pains.	0	0	4
15. *Tricalysia lanceolata*	isiXeza	Fencing poles and posts, building and kraal poles.	2	0	2

(Cont./d)

16. *Dalbergia obovata*	umZungu	Love charm, medicinal, fuelwood, bark strips used as ropes for tying fuelwood bundles.	0	1	3
17. *Mimusops caffra*	umThunzi	Utility wood, craftworks, poles, construction.	1	0	3
18. *Celtis africana*	umVumvu	Magical properties against lightning strikes, utility wood, fodder.	0	1	2
19. *Hypercanthus amoenus*	umThongothi	Fruit, fruits and roots used against respiratory complaints, posts.	2	0	1
20. *Cussonia sphaerocephala*	umSenge	Traditional treatment of malaria and mumps.	1	1	1
21. *Ficus thonningi*	umThombe	Windbreak.	0	2	1
22. *Bersama lucens*	isiNdiyandiya	Love charm, medicinal.	1	1	1
23. *Macaranga capensis*	umBengele	Bark used medicinally for livestock.	0	2	0
24. *Calodendrum capense*	umBaba	Skin health care, facial cosmetics.	0	0	2
25. *Millettia sutherlandii*	umQunye	Yoke, sledge, poles.	0	0	2

Source: Interviewees and Pooley (1993) for scientific names of trees.

3.2.5 Tree Resource Conservation Perceptions

3.2.5.1 Tree Planting and Conservation

Sixty-three percent of households confirmed the need to plant indigenous trees. They contended that planting indigenous trees would ensure: i) protection of soil and water resources, ii) conservation of indigenous forests, and iii) a sustained source of medicines, firewood, food supplements, raw materials for construction and craftworks, and employment opportunities. The balance of households (37%) saw no value in planting any indigenous trees. They attributed this to their: i) self-perpetuating nature, ii) abundance in the forest, hence no immediate need to plant, iii) ease of access to the forests and desired products, iv) perceived belief that cultivated indigenous medicinal trees have a lower medicinal potency than naturally growing ones, and v) a preference for planting fast growing exotic species, particularly fruits trees. However, specific indigenous trees, for example, *Euphorbia triangularis* are planted only when there is a socio-cultural need.

TREE RESOURCE USE

Plate: 3.4
Harvested poles of **Englerophytum natalense** on the forest floor in Mt. Thesiger Forest Reserve.

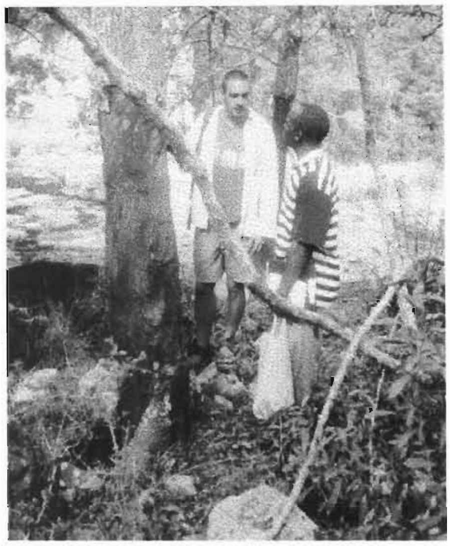


Plate: 3.6
Intensive bark removal from **Harpephyllum caffrum** for medicinal use

Plate: 3.5
The different uses of wood within a resourse - poor household in Tombo Location.

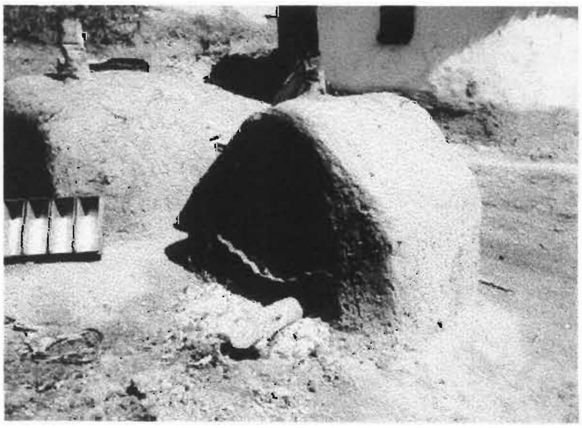


Plate: 3.7
A local initiative, wood-dependent traditional bread baking Kiln at Cwebeni Village, Caguba Location.

The households (63%) which saw the value in planting indigenous trees, were willing to plant and conserve, particularly *P. obliquum*, *M. grandis*, *A. karoo*, *V. lanceolata*, *D. adhatodoides* and *T. emetica*. However, they were also willing to retain or conserve rather than plant *H. caffrum*, *E. natalense*, and *C. africana*, growing naturally in their homestead farms/gardens. Forty-seven percent of the households already had and were conserving between 1 and 3 indigenous trees, particularly where they considered land and tree ownership as relatively secure. These were ready sources of medicines and shade. The unwilling households (33%) expressed: i) fear of damage by goats, ii) difficulty in obtaining planting materials, iii) interference on food crops, iv) uncertainty on appropriate species to use, and v) lack of information or technical know-how. The significance of this finding relates to the issue of how many trees a household should plant in order to provide enough resources to meets its needs. However, the ultimate number of tree/plant component to plant or conserve would depend on what a household considers to optimise its land productivity and tree benefits and DWAF as easing pressure on indigenous forest in the intermediate to long-term.

3.2.5.2 Tree Species Planted in the Agricultural Landscape

The survey revealed that 84% of the households had planted some trees in their farm/yard/garden, in the last ten years. However, most of these were exotic species planted for fruit (41%), hedge (23%), shade (9%), medicinal, windbreak, boundary, food supplement, and income (5% each) and decoration (2%). Fruit trees accounted for 77% of the planted tree components. The most commonly planted fruit trees by households included; peach (53%), citrus species (51%), guava (42%), avocado (37%), banana (30%), pawpaw (19%), and mango (16%). The other types of fruit trees that were present in small quantities included; apples, lemons, grapes, naarjties, granadilla and mulberry. The most commonly planted exotic trees included: *Grevillea robusta*, *Casuarina* spp, *Cinamomum camphora*, *Melia azedarach, and Ficus elastica*. At least 80% of the households in Caguba location had planted between 1 and 3 trees, while in Tombo 89% had done the same. It is evident that the density of trees planted in homesteads is insufficient to be regarded as a viable agroforestry process.

3.2.5.3 Sources of Tree Seedlings

Twenty-eight percent of the households raised their own seedlings, planted and tended them without advice from any extension agencies. The main seedlings were those of fruit trees. Twenty-five percent of the households used wildlings and seedlings from neighbours who collected or raised them on their own. This is an encouraging self-initiative among some households which could be use as an entry point to enhancing the supply of the needed seedlings for on-farm planting. Some households obtained their seedlings by buying from: i) DA in the neighbouring Districts (19%), ii) MFAP (7%) and iii) DWAF (2%).

3.2.5.4 Beliefs or Taboos in Tree Planting and Conservation

At least 84% of the households in Caguba and Tombo locations, were aware of traditional beliefs or taboos, which encouraged or discouraged tree planting and conservation efforts. Sixteen percent of the households did not recognise such beliefs or taboos. Of these (16%), half of the households attributed it to their Christian faith, while the rest did not give any response. The beliefs or taboos which encouraged tree planting and conservation were associated with: i) protection, particularly against witchcraft, death or physical impairment due to lightning strikes or evil powers (67%), ii) health care needs (11%), iii) socio-cultural values (11%), and iv) income generation (11%), (Table 3.4). Further, 47% of the households planted or deliberately retained between 1 and 3 indigenous trees. These included *Erythrina caffra, Dovyalis caffra and T. emetica*. The beliefs or taboos which discouraged planting and conservation of indigenous trees were associated with: i) fear of lightning and thunder strikes (44%), ii) family instability, quarrels, bad luck, divorces, family disintegration, and negative effects on livestock (44%), iii) traditionally sacred (7%), and iv) poor wood characteristics (4%), (Table 3.5).

3.2.6 Provision of Agroforestry Related Services

Most households (74%) had not been visited or advised by extension staff from any of the relevant agencies. Most of those households that were visited, were last visited in 1989 by Stock Inspectors. Some households had been interacting with a local NGO, MFAP, on vegetable production, crop rotation, fruit-tree pest management and agroforestry. However, the activities of this organisation were constrained by an inadequate number of skilled extension staff and extension resources. The failure and lack of advisory services were attributed to; i) laxity and lack of initiative among relevant government agencies (45%), ii) lack of capacity in relevant government and non-governmental organisations (15%), iii) lack of collaboration and rivalry between relevant organisations (15%), and iv) extension staff situated far away from where services are needed (10%). The other 15% of the households attributed the failure to a combination of the mentioned factors. There was consensus that extension services were necessary and needed for the development of agroforestry. The advisory services required by various households included: i) tree and vegetable seedling production, integrated crop production, safe use of pesticides, fertilizers and acaricides and tree planting and tending (68%), ii) agroforestry (14%), and iii) training on appropriate knowledge, skills and integration of indigenous knowledge systems into contemporary issues, conservation of high value indigenous trees and livestock management (6%, each).

Table 3.4. Beliefs or taboos encouraging tree planting and conservation

Scientific names	Local name	Beliefs encouraging conservation
1. *Portulacaria afra*	iNtelezi	- Protects homestead against lightning and thunder strikes. - As a protective portion during tribal wars. - Edible leaves and fodder.
2. *Ptaeroxylon obliquum*	umThathi	- Protects homestead against lightning and thunder strikes. - Used to make plates for specific cultural rites; snuff, traditional medicine. - General protection against evil spirits.
3. *Euphorbia triangularis*	umHlonthlo	- Planted behind a traditional hut to protect twins against evil spirits. - Ensures good crop when burned in the fields.
4. *Millettia grandis*	umSimbithi	- For craftworks, particularly sticks and associated sources of income.
5. *Chionanthus foveolatus*	umDlebe	- Protects homestead against lightning.
6. *Vepris lanceolata*	umZane	- Used as medicine against anthrax in livestock.
7. *Brachylaena elliptica*	umPhlahla	- Used medicinally against diabetes - Used as posts.
8. *Erythrina caffra*	umSintsi	- Ornamental and medicinal uses.
9. *Umtiza listeriana*	umThiza	- Traditionally sacred and have healing powers. - Protects homestead against lightning and evil spirits.
10. *Zizyphus mucronata*	umPhafa	- Sacred. - For cultural rites when establishing a new home. - Fodder

Source: Interviewees and Pooley (1993) for scientific names of trees.

Table 3.5. Beliefs or taboos discouraging tree planting and conservation

Scientific names	Local name	Adverse beliefs or taboos
1. *Kiggerlaria africana*	iDungamuzi	- "Split" a home, brings bad luck, quarrels, attracts lightning and not to be used for firewood brings bad luck.
2. *Baphia recemosa*	uTchupu	- Encouraged quarrels in the home; when in flower never to be used for firewood; not used as building poles.
3. *Ficus spp*	umThombe	- Prone to lightning strikes.
4. *Unidentified*	umBalabala	- Attracts a lot of water, making ground underneath sink, hence attracting lightning.
5. *Maerua caffra*	umPhunzisa	- Destroys a home; like"iDungamuzi" causes abortion to cows in calf when hit with a stick from this species.
6. *Duvernonia adhatodoides*	isiPheka	- Wood too hard for carving.
7. *Dalbergia obovata*	umZungu	- Causes abortion and weight loss to cows in-calf when hit with a stick from this species like "iDungamuzi".
8. *Cussonia sphaerocephala*	umSenge	- Attracts lighting, but used to treat mumps.
9. *Halleria lucida*	umBinza	- Attracts lightning, brings bad luck, sacred.
10. *Unidentified*	uTavane	- Causes allergic reactions all over the body such as, rashes, itches, etc.
11. *Unidentified*	umTungwa	- Not to be used as fire, because it brings bad luck.
12. *Millettia sutherlandii*	umQunye	- Wood decays rapidly.
13. *Pterocelastus spp.*	umTyina	- As in umBinza.

Source: Interviewees and Pooley (1993) for scientific names of trees.

3.2.7 Linking Households to Agroforestry

3.2.7.1 Knowledge of Concept and Practices

The term or concept "Agroforestry" was new to 86% of the households in Umzimvubu District, particularly Caguba and Tombo locations. A reconnaissance survey in the 17 locations of Umzimvubu District, indicates that the households were initiating or practising the multi-strata home garden system. Fourteen percent of the households with prior knowledge of agroforestry had learned about it through their involvement with MFAP. All households interviewed were willing to learn more about agroforestry following their enlightment through the face-to face interviews. Thirty percent of the households were not sure from whom to learn more about agroforestry. Further, 27% suggested DA, 18% MFAP, 15% anyone or organisation with the expertise, 3% teachers, and a combined team of; agriculture and forestry staff and agriculture and nature conservation staff, 3%, each. The DWAF were conspicuous for the fact that they were not mentioned by the households interviewed for agroforestry training. This suggests that DWAF's extension services are relatively unknown compared to their activities in the State forests.

3.2.7.2 Integration of Trees into the Farming Systems

Forty-four percent of the households concurred on the need to integrate high value tree species into appropriate agroforestry systems. They contended that this would intensify and diversify on-farm production and income opportunities at subsistence level. Twenty-one percent of households were concerned about: i) the effect of the planted trees on food crops, ii) lack of experience and available information on the performance of indigenous trees under cultivation, iii) appropriate indigenous trees to use, and iv) lack of capacity to undertake the integration activities. A further 14% of the households were apprehensive about integrating trees in any farming systems for the same reasons expressed in section 3.2.5.1. The remaining 21% of respondents provided no answers. This was due in part to the difficult nature of the question and also distortion of the idea during translation from English to Xhosa and vice-versa. Nevertheless, lack of exposure remains a bottleneck to integrating high value indigenous trees into the existing farming systems among the resource-poor rural communities.

3.2.7.3 Difficulties in Practising Agroforestry

Some 47% of the households who were willing to learn and practice agroforestry, had no difficulties in doing so. However, 35% suggested some difficulties, while 18% could not give any response, since they had yet to try it out. They listed some potential constraints as: i) availability of resource inputs such as seeds, seedlings, water, time, labour and other production materials (23%), ii) absence of extension services from which to seek advise when stranded (23%), iii) adverse climatic factors (9%), and iv) other not well understood factors (31%).

3.2.7.4 Promoting Agroforestry to Neighbours

Sixty-three percent of the respondents were positive about recommending agroforestry to their neighbours, while 37% were neutral. This could be due to their lack of experience of agroforestry. Nevertheless, 41% of the respondents in agreement stated that they needed to learn more about agroforestry in order to be confident and effective.

3.2.7.5 Suggestions on How to Promote Agroforestry

Eight percent of the respondent households in Caguba and 44% in Tombo locations provided suggestions on how to promote agroforestry in their areas. These included: i) creating awareness and conducting specific training courses through extension services (60%), and ii) on-farm demonstrations and projects (40%). A summary of the households' closed-ended responses (N=43) is as shown in Table 3.6.

Table 3.6. **Summary of closed-ended household responses to agroforestry**

	Issue	Responses		
		No (%)-1	Yes (%)-2	N/A (%)-3
1	Leave or work elsewhere	22 (51)	21 (49)	0
2	Access to and control of any extra land	32 (74)	11 (26)	0
3	Access to land only	12 (28)	31 (72)	0
4	Harvest enough crops to use	16(37)	27 (63)	0
5	Harvest enough crops to sell	32 (74)	11 (26)	0
6	Problems in crop production	0	43 (100)	0
7	Keep livestock	8 (19)	35 (81)	0
8	Problems in keeping livestock	4 (10)	31 (72)	8 (18)
9	Tree products available in desired quantities	10 (23)	33 (77)	0
10	Use trees for medicinal needs	3 (7)	40 (93)	0
11	See value in planting indigenous trees	15 (35)	27 (63)	1 (2)
12	Planted trees on the farm/yard/garden	7 (16)	36 (84)	0
13	Conserved indigenous trees on the farm	23 (53)	20 (47)	0
14	Traditional belief or taboo on trees	7 (16)	36 (84)	0
15	Visited or advised by any extension staff	32 (74)	11 (26)	0
16	Aware of agroforestry	35 (81)	6 (14)	2 (5)
17	Willing to learn about agroforestry	0	43 (100)	0
18	See difficulties in practising agroforestry	20 (47)	15 (35)	8 (18)
19	Recommend agroforestry to neighbours	0	27 (63)	16 (37)

3.3. Discussion

The household characteristics and decision-making processes are critical factors in adoption of any sustainable land use management system. They help to determine how the household's resources are used, allocated and capacity developed to address its socio-economic needs (Chambers 1997).

The land use issues in South Africa, particularly in Umzimvubu District are of importance in agroforestry development. Most resource-poor rural households were settled on 0.25 ha. of land

(Bolus 1991). However, this is less than 0.4 ha. which is the world accepted parcel of land needed to feed a person (van der Zel 1997). The arable fields which could serve to complement agricultural needs are communal and hence constrain individual initiatives. It is noted that some of the best tree planting and conservation initiatives are found where land and tree tenure are secure, for example, homestead gardens (Bolus 1991; Erskine 1991; Peden 1993; Pasicolan *et al.* 1997; Ham and Theron 1998). It is suggested that the on-going land reform process should be flexible enough to permit inheritance and secure land ownership.

The rural communities value most indigenous tree species for medicinal, socio-cultural, energy, building, fencing, craftworks, income generation and other products and services. Most of these products and services are appropriate for agroforestry and merit integration into on-farm-production activities. Further, the study confirms important farmer-preferred tree species in Umzimvubu District (van Eck *et al.* 1997). It goes further to identify species which farmers not only preferred, but also, were willing to conserve or plant. The top five species to be planted and conserved on farms include, *P. obliquum, M. grandis, A. karoo, V. lanceolata,* and *T. emetica.* The top five species which grow naturally and are preferred to be retained but not planted on farms include, *H. caffrum, E. natalense, C. africana, M. capensis* and *D. adhatodoides*. Several taboo species were also identified. The top five taboo species include *K. africana, B. racemosa, H. lucida, Z. mucronata* and *M. caffra*. It is important to pay attention to the social barriers which provide or constrain opportunities for integrating high value trees into existing farming systems. Furthermore, efforts should be directed at optimising farmer preferred species (Weber *et al.* 1997; Maghembe *et al.* 1998). Where significant destruction of taboo species is inevitable to the extent of threatening its population, DWAF should encourage their conservation in alternative niches.

The constraints to conserving and integrating high value indigenous trees into the subsistence farming systems through agroforestry are many, but can be resolved. These may be categorised as: i) institutional, ii) technical, and iii) socio-economic (Vijoen 1991; van Zyl *et al.* 1996). Nevertheless, these constraints were inevitable, considering the socio-political characteristics of South Africa's pre-independence era (Fuggle 1995; Foy and Willis 1998). The main concern is that institutional and technical constraints continue to hinder initiatives favouring agroforestry research and development. Therefore, DWAF should reassert itself by providing appropriate institutional arrangements that will work towards alleviating these broad constraints.

The issue of how farmers perceive and value agroforestry provide important pointers to its promotion in Umzimvubu District and similar regions in South Africa. It is evident that resource-poor households are poorly informed and have poor capacity to practice agroforestry (van Zyl *et al.* 1996; Bembridge 1997).

The primary merit of agroforestry is its diversity of tree/plant components and their ability to enable the household to optimise land productivity and tree benefits. Therefore, both socio-economic and environmental factors will determine the ultimate number of trees that may be planted or conserved in a subsistence farming system (Raintree 1991; Buck 1995; Scotts 1996; Chambers 1997).

Optimising on-farm production, minimising risks, increasing household incomes and enhancing the quality of life, among the resource-poor rural communities is a priority. However, this was constrained by among other factors, lack of awareness and capacity to practice agroforestry (Underwood 1995; van Zyl *et al.* 1996; Bembridge 1997). Agroforestry is not an end in itself, but its proven on-farm systems and practices should be integrated with other interdisciplinary efforts to enhance local capabilities in agroforestry. Furthermore, simply having this kind of knowledge is not a guarantee to successful adoption of appropriate agroforestry systems and practices, but having an enlightened people who are capable of making well informed decisions about sustainable land management and resource use. One avenue through which households could be informed and facilitated is by having an integrated extension services.

Some of the best household agroforestry related activities in Umzimvubu District are self-initiated. However, the relevant land use management agencies are still too detached from the realities of integrating high value indigenous trees into subsistence farming. Therefore, considerable effort should be directed at establishing an integrated agroforestry extension services that identifies with the farmers and high value indigenous tree species (Erskine 1991).

3.4 Summary

Agroforestry has been unknowingly practised for a long time by many rural households in South Africa. Most rural households value indigenous trees for various uses. Over 60% recognise the need to integrate high value indigenous trees into on-farm production activities. Over 65% expressed willingness to plant and conserve *P. obliquum* and *M. grandis,* but to retain or conserve *E. natalense* on-farm. The constraints to on-farm tree planting and conservation are many but can be resolved. Strategies emphasising public sensitisation, integrated extension service delivery, participatory research and technology development and appropriate grassroots training are likely to contribute to the establishment of self-sustaining agroforestry activities. Agroforestry remains one of the many sustainable land use management options through which resource-poor farmers should adopt to optimise land productivity, improve the quality of life and enhance ecological resilience, in a holistic manner. The choice to adopt and practice agroforestry lies with the farmer, however, the pace of the adoption should be accelerated by enhancing their awareness, attitude, ability and capacity beyond their own indigenous knowledge and technical skills. Therefore, a well trained personnel and an integrated extension services is a critical institutional concern.

CHAPTER 4:

INSTITUTIONAL AGROFORESTRY PERSPECTIVES IN UMZIMVUBU DISTRICT AND SIMILAR AREAS OF SOUTH AFRICA

4.0 Introduction

The need to develop and promote participation in agroforestry requires the commitment, partnership and involvement of local, national and international institutions (Bene *et al.* 1977; Kerkhof 1990; Erskine 1991; Scotts 1996; ICRAF 1997). The International Centre for Research in Agroforestry (ICRAF) and the International Institute of Tropical Agriculture (IITA) have been at the forefront in collaborating with local and national institutions, to develop and accelerate adoption of sustainable agroforestry practises. Agroforestry research and development is centred on: i) institutional capacity building; ii) technology development and transfer; iii) socio-economic and policy issues; and iv) assessing impacts in natural resource management (ICRAF 1997; Izac 1998). Similar initiatives to enable resource-poor rural households to realise the benefits of agroforestry exist in the South African context, but are not well established (Koen 1991; Graham von Maltitz 1998, pers. comm[6]). Examples of local institutions are; Department of Water Affairs and Forestry (DWAF), Department of Agriculture (DA), academic institutions and affiliates (e.g. Stellenbosch University, University of the North, Institute of Natural Resources), non-governmental and community based organisations (e.g. Master Farmer and Apprenticeship Programme (MFAP) in Umzimvubu District, Trees for Africa), (Koen 1991; DWAF 1997). The aim of this chapter is to place agroforestry in the South African context. The successful implementation of agroforestry by these institutions is measured by their delivery capacity and ability to adapt to the changing socio-economic needs of the stakeholders. Their major challenge is to ensure that agroforestry evolves as a sustainable land use management system subject to land use policies, strategies and practices, and an applied scientific concept.

4.1 Methods

Four broad categories of institutions and key informants (Table 4.1) comprising 40 respondents were each sent a structured self-administered questionnaire (Appendix II). The purpose of the questionnaire was to determine whether the relevant land use management institutions and other interest groups were through agroforestry, responding to the need to: i) diversify and optimise on-farm production; ii) contribute to conservation of indigenous forests; and iii) improve the quality of life among resource-poor rural households,. The questionnaire investigated an institution's: i) involvement in agroforestry; ii) initiatives and achievements to-date; iii) factors constraining the latter; and iv) problem solving capacity. The coverage was not limited to Umzimvubu District but extended to other regions in South Africa. Twenty (50%) responses were received (Table 4.1).

Table 4.1 Respondent institutions and key informants in the agroforestry survey

Category	Name	Institution	Remarks
Key Informants	1. Mr. Ben Dekker 2. Mr. Michael Underwood	- Independent - Community Environmental Development Services	- Environmentalist and life- time resident of Port St. Johns. - Consultant in agroforestry for 5 years in Port St. Johns.
Non-governmental organisations	1. Mr. Richard Bolus 2. Ms. Jeunesse Park 3. - 4. -	MFAP Trees for Africa Group Farmers Association Environment & Development Agency (EDA) Marshall Town	- Project Coordinator. - Executive Director. - Agricultural Technician. - Director.
Academic Institutions	1. Prof. F.H.J. Rijkenberg 2. C. Ham 3. - 4. Mbodi Khormbi	- University of Natal (PMB) - Stellenbosch University - University of Fort Hare - Technikon South Africa	- Dean, Faculty of Agriculture. - Researcher, Faculty of Forestry. - Dean, Faculty of Agriculture. - Lecturer, ANS.

(Cont./d)

Department of Agriculture (DA)	1. Don Sunday 2. Mrs. N.P. Keswa 3. Mr. Lucas Swart 4. Mr. Benson Maqubela. 5. Ms. Vuyokokazi Fono	- DA, Southern Region: Eastern Cape Province-ECP - DA, EG KEI Region-ECP - DA, Northern Region-ECP - DA, Port St. Johns - DA, Port St. Johns-Central Division	- Regional Director Port Elizabeth. - Regional Director, Kokstad. - Regional Director, Queenstown. - District Agricultural Officer. - Agric. Extension Officer.
Department of Water Affairs and Forestry (DWAF)	1. Mr. F.K. von Krosigk 2. Mr. Graham von Maltitz 3. Ms. Maswana Nokulunga 4. Graham Harrison 5. Mr. S.M. Mngqete	- DWAF, Community Forestry Programme (HQ) - Environmentek, CSIR - DWAF, Head Office, King Williams Town (ECP) DWAF, Regional Office DWAF, Libode (ECP)	- Director. - Business Area Manager - Deputy Director - Deputy Director - Deputy Director, Kokstad - Forester

4.2 Results

4.2.1 Institutional Involvement in Agroforestry

4.2.1.1 The Aim(s) of Agroforestry Institutions

The respondent institutions aim to enhance and promote activities which ensure: i) multiple use of indigenous forests; ii) diversified on-farm production; iii) enhanced income generation; and iv) a better quality of life among rural communities in Umzimvubu District and similar areas in South Africa.

4.2.1.2 Socio-economic and Environmental Values of Agroforestry

Sixty-five percent of the respondents felt there was socio-economic and environmental value in promoting agroforestry practices. The ultimate beneficiaries would be the resource-poor farmers in areas suited for agroforestry. The White Paper on Agriculture of 1995, recognises that the destruction of indigenous forests by agriculture is a real and significant problem. Agroforestry can aid in the conservation of indigenous forest/trees by encouraging the growth of forest resources on farmland. However, in Umzimvubu District and similar areas of South Africa, the DA was hesitant to venture into agroforestry, in spite of the value of agroforestry in conserving indigenous forests and optimising land productivity. The DA respondents strongly suggested that agroforestry initiatives: i) are the responsibility of DWAF, ii) that DA lacked suitable expertise to initiate programmes, iii) required feasibility studies, and iv) monocultural farming systems were more highly favoured because they are regarded as more effective at maximising productivity depending on the allocated production resources.

A large number of respondents (70%) supported the use of agroforestry as a means of conserving indigenous trees. Although some (30%) felt that the perceived abundance of desired indigenous trees in the natural forests and woodlands, the lack of agroforestry experience, and the long investment time, would all work against an immediate implementation of agroforestry principles in the district.

4.2.1.3 Institutional Agroforestry Programmes

Sixty-five percent of the respondent institutions had agroforestry related goals which were promoted by government agencies. The Master Farmer and Apprenticeship Programme (MFAP) is the only NGO involved in promoting agroforestry in Umzimvubu District. However, progress toward sustainable agroforestry activities has been a recent phenomenon in the Umzimvubu District and in other areas of South Africa (DWAF 1997; van der Merwe 1997; Richard Bolus 1998. pers. comm[7]).

No academic institutions offer degree courses in agroforestry. Some of the University affiliates such as the Institute of Natural Resources (INR) and Farmer Support Group (FSG) of the University of Natal, have agroforestry outreach projects in KwaZulu-Natal. Similarly, the University of Stellenbosch collaborates with the Environment and Development Agency (EDA) in the Herschel area of Eastern Cape. Most academic institutions hope to develop agroforestry programmes in the year 2000.

It was evident that DWAF and DA recognise the value of agroforestry. Further, agroforestry is discussed in the White Paper on Sustainable Forest Development of 1997. Although the National Forestry Action Programme of 1997 embraces agroforestry within its Community Forestry Programme, it is still not well defined. This may be attributed to the practice being a recent venture within the South African context. Nevertheless, DWAF had in the past commissioned

Environmentek and the Council for Scientific and Industrial research (CSIR), and presently the University of the North to initiate agroforestry pilot projects to test its value (Graham von Maltitz 1998. pers. comm[6]). However, Environmentek and the CSIR both lack the expertise and logistical back-up to sustain agroforestry activities on the ground.

4.2.2 Constraints on Practicing Agroforestry

Eighty-five percent of the respondents observed that their institutional capacities to develop an integrated and self-sustaining agroforestry programmes were mainly constrained by: i) institutional (e.g. restricted mandates and priorities, weak linkages); ii) technical (e.g. shortage of personnel, knowledge gaps, skills); iii) socio-economic (e.g. attitude, land tenure, logistic and operational resources); and iv) ecological (e.g. biological, climatic and edaphic influences) issues (Table 4.2). Furthermore, 80% of the respondents observed that the willingness and ability of the farmers to practice agroforestry was constrained by similar factors (Table 4.2).

Table 4.2. Summary of factors constraining the practice of agroforestry

Constraints	
Institutions and Key Informants	Farmers
1. Institutional constraints i) Trees were for many years not part of agricultural systems. They have always been cleared for crop production. Further, the DA encouraged monoculture of subsistence crops. This perpetuated a cultural/historical bias against trees by the agricultural sector and resource-poor rural households. ii) Agroforestry is not a priority of the DA but it is gradually gaining attention in DWAF. iii) Lack of a broad based consultative and coordinating body in agroforestry in South Africa. iv) Sectoral bias and approach rather than integrated approach to land management issues.	**1. Institutional constraints** i) Poor information and/or lack of understanding of agroforestry, its potential benefits, and requirements. ii) Lack of public sensitisation by relevant land management agencies through coordinated extension services.

(cont./d)

2. Technical constraints i) Shortage and lack of personnel with the competence and expertise to initiate effective self-sustaining agroforestry programmes. ii) Lack of understanding and specific information on applied agroforestry, e.g. what agroforestry is all about and how it interlinks with crop, animal and value-adding sub-systems.	**2. Technical constraints** i) Lack of appropriate knowledge and technical skills which lie outside their own indigenous knowledge. ii) Lack of knowledge on appropriate species to plant.
3. Socio-economic constraints i) Perception of low value benefits from agroforestry by the some institutions. ii) Poorly integrated extension services to address on-farm production, conservation and sustainable resource-use, among resource-poor rural communities. iii) Absence of appropriate information, education and in-service training programme in agroforestry. iv) Land under communal or tribal tenure limits individual initiatives that would benefit specific communities.	**3. Socio-economic constraints** i) Insecure land and tree tenure, since tree planting is a long-term investment. ii) Lack of appropriate incentives, (promotional events, credit facilities, grants). iii) Long distance to sources of agricultural inputs. iv) Lack of seeds and seedlings to plant. v) Exorbitant cost of appropriate seedlings from private tree nurseries. vi) Livestock damage due to free range, unherded grazing.
4. Ecological constraints i) None	**4. Ecological constraints** i) Unfavourable climate

Source: Interviewees.

4.2.3 Institutional Strategies for Research and Development of Agroforestry

The outlined strategies below were suggested by the respondents for initiating and implementing self-sustaining agroforestry activities in Umzimvubu District and similar areas of South Africa: i) an integrated extension service; ii) human resource development in agroforestry through information, education; training and re-training; iii) adaptive on-farm research in a broad range of environmental and tree resource use issues; iv) policy reforms in the context of agroforestry; v) inter-institutional collaboration and partnership; vi) awareness creation through incentives and promotional events; vii) commitment of funds; viii) commitment by stakeholders, and ix) initiation of agroforestry pilot projects. Most of these concur with the National Forestry Action Programme's (NFAP) seven operational strategies on Community Forestry Programme. However, the mechanisms to translate these strategies for successful implementation of agroforestry are not well established (Graham von Maltitz 1998. pers. comm[6]).

4.2.3.1 Policy Reforms

Most respondents (70%) except for DWAF, were not aware of the existence of any policy reforms in the context of South African agroforestry. DWAF recognises that agroforestry was implied in the White Paper on Sustainable Forest Development of 1997. The White Paper and the National Forestry Action Programme have embraced agroforestry as part of Community Forestry Programme.

It was also observed that the University of Natal (PMB) has created the post of Director of Farming Systems and Extension, to teach, research and develop an integrated extension programme (Fredericus H.J. Rijkenberg 1998, pers. comm[5]). This may serve as one of the entry points to establishing linkages and lasting capacity for promoting agroforestry in South Africa.

4.2.3.2 Inter-Institutional Collaboration

Sixty percent of the institutions had no well established mechanisms to ensure collaboration or partnership in agroforestry activities at local, national and international level. It was felt that collaboration between, for example DWAF and DA was not strong enough to promote participation in agroforestry at local and national level (Erskine 1991; Gander 1991). However, there is an increasing emphasis on the need for collaboration among land use management organisations (Republic of South Africa 1995; 1997a). Integrated approach is needed to ensure that any agroforestry related activities are not characterised by competition, fragmentation and duplication.

Only four South African universities (Stellenbosch University, University of Fort Hare, University of Natal and University of Zululand) and one technikon (Technikon South Africa), were focal institutions of ICRAF's African Network for Agroforestry Education (ANAFE). The aim of ANAFE is to strengthen teaching of agroforestry in land use programmes in member countries (Temu 1998). Some linkage between DWAF and ICRAF exists (Graham von Maltitz 1998, pers. comm[6]). However, DWAF, DA and most academic institutions do not feature in ICRAF's Agroforestry Research Networks for Africa (AFRENA) programmes, in spite of a strong presence of AFRENA's Southern Africa Agroforestry initiatives (ICRAF 1997; 1998b; Maghembe *et al.* 1998). Therefore, the need for inter-institutional collaboration among related land use management institutions in agroforestry is imperative in South.

Agroforestry is by its nature, multi-disciplinary and multi-institutional. Therefore, the administration of agroforestry should be dealt with through a strong and special institutional arrangement. There is no such specific organisation taking the initiative to coordinate research and development activities in agroforestry at all administrative levels, in the South African context (Gander 1991). However, there is a general assumption that agroforestry is within the jurisdiction of DWAF. The proposed institutions which could coordinate research and development activities in agroforestry are: i) Agricultural Research Council (Richard Bolus 1998, pers. comm[7]); ii) University of Natal (PMB), via the available expertise in its affiliated groups, namely, Institute of Natural Resources and Farmers Support Group (Fredericus H.J. Rijkenberg 1998, pers. comm[5]); and iii) DWAF, as the organisation mandated to implement the Community Forestry Programme. A summary of the findings on institutional issues and perceptions relating to agroforestry is as outlined in Table 4.3.

Table 4.3. Summary of closed-ended institutional responses to agroforestry

	Issues	Responses		
		No (%)	Yes (%)	N/A (%)
1	Have agroforestry as one of the programmes.	7 (35)	13 (65)	0
2	Have agroforestry outreach activities/programme.	15 (75)	5 (25)	0
3	See value in having agroforestry programme.	5 (25)	13 (65)	2 (10)
4	Aware of any NGOs and CBOs involved in agroforestry.	4 (20)	14 (70)	2 (10)
5	See value in using agroforestry for conservation of indigenous trees/forests.	6 (30)	14 (70)	0
6	Constraints to willingness and ability of institutions.	3 (15)	17 (85)	0
7	Constraints to willingness and ability of farmers.	4 (20)	16 (80)	0
8	Have education and training activities in agroforestry.	10 (50)	9 (45)	1 (5)
9	Organise training and promotional events in agroforestry.	15 (75)	3 (15)	2 (10)
10	Have policy reforms favouring agroforestry development.	10 (50)	6 (30)	4 (20)
11	Lead institution(s) in agroforestry.	14 (70)	4 (20)	2 (10)
12	Collaboration and agroforestry membership at local, national, regional or international level.	12 (60)	8 (40)	0

NB: Information is based on responses from respondents.

4.3. Discussion

It is evident that government land use management agencies are poorly informed and lack the facilities to promote agroforestry. Furthermore, these agencies are still too detached from the high value indigenous tree related needs of the local resource-poor agricultural economy.

The White Paper on Sustainable Forest Development of 1997 discussed the value of agroforestry in South Africa (Republic of South Africa 1997b). The agriculture and forestry interface through agroforestry is an integral component in optimising land productivity (Erskine 1991). By encouraging other stakeholders to practice agroforestry, DWAF through its National Forestry Action Programme of 1997 may ensure that: i) South Africa would contribute to systematic research and development in agroforestry in the country and region (Maghembe *et al.* 1998); ii) the resource-poor rural communities in Umzimvubu District and similar areas of South Africa are encouraged to realise the benefits of agroforestry; iii) DWAF may attract much funding at multilateral and bilateral levels to support research and development in agroforestry; and iv) enhance its ability as a lead organisation to take the initiative to coordinate research and development in agroforestry. There is a wide scope for improvement since agroforestry is a new initiative (DWAF 1997; van der Merwe 1997).

Improving the quality of life among resource-poor rural communities is a priority (Republic of South Africa 1995; 1997b). However, this is constrained by among other factors, lack of exposure and capacity to practice agroforestry in Umzimvubu District. One approach through which this could be alleviated is by establishing an integrated extension services. However, the provision of extension services is limited by lack of: i) adequate personnel, ii) expertise, and iii) logistical support to sustain agroforestry activities on the ground. There was no DWAF Extensionist in Umzimvubu District. According to van der Merwe (1997), there are about 70 DWAF Forestry extensionists, while South Africa has 371 Magisterial Districts. This is far less than the number needed to realise significant impact in promoting agroforestry in the context of Community forestry. Therefore, there is a need for a greatly expanded Forestry extension services in terms of personnel and delivery capacity in South Africa.

Potential exits to integrate high value indigenous tree species into the subsistence farming systems in Umzimvubu District and similar areas in South Africa (Fanie and Venter 1996; Eck *et al.* 1997; Obiri 1997). As yet, the use of indigenous tree species in agroforestry continues to receive little or no attention among land use management institutions in South Africa. This is because the common opinion is that their potential as integrated crops in farming systems is limited (Gander 1991) or at best left to nature (Dorsen 1996). The challenge to is to initiate activities which will help to change the negative perception of the value of cultivating and the conserving of indigenous trees on-farm (Mander *et al.* 1996).

Both DWAF and DA are well placed to fully integrate agroforestry activities, linked with research and technology development, into their programmes as partners in the process. The linkage should be facilitated through integrated agroforestry extension services. It is suggested that the institutions should determine how best they can operate as partners in agroforestry research and development by: i) identifying and harmonising their internal structural deficiencies, ii) prioritising activities, and iii) formulating a logical framework approach for joint or institution specific pilot projects. Further, it is suggested that a mechanism is needed to establish self-sustaining agroforestry programmes among the stakeholders. This will enable agroforestry to evolve into Farm forestry (Erskine 1991; Nair 1993), which is a more versatile form of agroforestry. Farm forestry refers to tree planting and management initiatives mainly on the farm where the principle land use is not forestry. Most subsistence farmers practising mixed farming for their basic needs often sell surplus to generate extra income for the household (Nair 1993).

The slow pace with which educational institutions in South Africa are venturing into agroforestry is constraining the establishment of a lasting capacity for agroforestry research and development in South Africa. This has resulted in the misinterpretation of agroforestry, a shortage of well trained personnel with multi-disciplinary knowledge and skills, and less informed resource-poor rural communities (Underwood 1995; van Zyl *et al.* 1996; Bembridge 1997). Immediate action should be taken to identify and fill the gaps of knowledge and skills in agroforestry at all levels. The challenge is for South Africa's ANAFE members and similar academic institutions to make this a reality.

Little research has been done or is on-going in agroforestry in the South African context, in spite of the increased interest in agroforestry world wide (Fenn 1991; Koen 1991; ICRAF 1997; Graham von Maltitz 1998, pers. comm[6]). Gander (1991) argues that past research work in agroforestry was characterised by lack of scientific data. The process of integrating high value indigenous trees into the farming systems through agroforestry would therefore, be difficult without recognising the value of adaptive on-farm research in agroforestry (Fenn 1991; Wyant 1996). Atta-Krah (1994) describes on-farm research as a crucial link between research and transfer arm of technology development and suggests two types of on-farm research, namely; experimental and developmental. The former validates or compares different technologies, while the latter introduces new technologies under a controlled and structured conditions.

Agroforestry is, by its nature, multi-disciplinary and multi-institutional (ICRAF 1998a), hence it has suffered fragmentation and competition due to uncoordinated initiatives (Erskine 1991; Gander 1991). Furthermore, challenges related to sustainable forest management cannot be resolved by forestry alone (Unaslyva 1996). Therefore, inter-institutional collaboration is likely to complement and enhance institutional, technical and economic capacities for promoting and sustaining agroforestry service at two levels, namely, institutional and household (Scotts 1996; ICRAF 1998b; 1998c). It is evident that the administration of agroforestry should be dealt with through a review of institutional problem solving capacities under a lead institution (Erskine 199; Langford 1994). The Agricultural Research Council, University of Natal (PMB) and DWAF were proposed.

The constraints in promoting the practice of agroforestry, as a sustainable land use management system at institutional and household level are many. However, they can be resolved by enhancing the problem solving capacity of key stakeholders. The issues constraining successful implementation of agroforestry were identified and categorised as: i) institutional, ii) technical, iii) socio-economic, and iv) ecological (Viljoen 1991; Armstrong 1992; Langford 1994; Carter 1995; van Zyl *et al.* 1996). Some of these constraints were inevitable, considering the socio-political characteristics of South Africa's pre-independence era (Fuggle 1995; Foy and Willis 1998). It is of concern that both institutional and technical constraints continue to hinder initiatives favouring agroforestry.

4.4 Summary

Agroforestry is an increasingly important sustainable land use management system available to the government to promote better land productivity, improve quality of life and enhance environmental resilience in a holistic manner. The potential of agroforestry to contribute to this realisation continues to attain global recognition. However, the pace towards this realisation in South Africa is very slow, despite the country's enormous resource potential. The constraints to institutional arrangements for on-farm tree planting, conservation and sustainable use are many, but can be resolved. Strategies emphasising inter-institutional collaboration, public sensitisation, integrated extension service delivery, participatory research and technology development, and education, training and re-training, are likely contribute to the establishment of self-sustaining agroforestry programmes. Well established agroforestry programmes and activities are likely to evolve into Farm forestry, which is a more versatile form of agroforestry.

CHAPTER 5:

THE DESCRIPTION AND AGROFORESTRY POTENTIAL OF *E. natalense, P. obliquum* and *M. grandis*

5.0 Introduction

Any tree that is cultivated to address either ecological or socio-economic problems faces the risk of failure (Macqueen 1992), however, "*a well known tree is better than unknown*" (Chilufya and Tengnäs 1996). The species *E. natalense, P. obliquum* and *M. grandis* are the most popular trees among the rural people of Umzimvubu District (van Eck *et al.* 1997). Their uses include, nutrition, medicinal, energy, socio-cultural values, timber, construction and as utility wood (Pooley 1993; Fanie and Venter 1996; van Wyk and van Wyk 1997). Nevertheless, the success of any species cultivation or domestication programme entails availability of, and access to proven scientific or socio-economic information (Franzel *et al.* 1996; Simons 1997), on attributes which makes the trees popular. Consequently, the knowledge and access to such information merits more attention for integrating high value indigenous tree species in any appropriate agroforestry system. Such a process must be farmer-centred to enhance acceptance and adoption.

This chapter highlights the physiological characteristics and socio-economic attributes of *E. natalense, P. obliquum and M. grandis* which would ensure their integration into appropriate agroforestry systems. Research and development needs which are required to facilitate the biophysical evaluation and validation of the positive attributes of the species for use in agroforestry, are also suggested.

5.1 The Natal Milk Plum *Englerophytum natalense* (umThongwane)

5.1.1 Tree Description

The species *Englerophytum natalense* Krause (UmThongwane) belongs to the Milkwood family

Sapotaceace. The family comprises over 40 genera and 600 species (von Breitenbach 1965), of which 10 genera (Palgrave 1993) and 22 species (van Wyk and van Wyk 1997) are found in South Africa. The Genus *Englerophytum* T.D. Bennington (Hutchings *et al.* 1997) was until recently referred to as *Bequaertiodendron* De Wild (Dale and Greenway 1961; von Breitenbach 1965; Beentje 1994). However, *Bequaertiodendron* is still used as a synonym. It is represented by two species in South Africa, one of which is *E. natalense*.

E. natalense is a gregarious small to medium sized, evergreen tree 6-15 m tall. The tree develops a straight stem up to 25 cm in diameter (occasionally up to 45 cm) in the coastal scarp forests (Plate 5.1). The bark is brown and smooth when young, but flutes with maturity. Fluting reduces the pole value, but not fruit productivity. The characteristic milky latex from the bark could be examined to determine any unknown potential use.

The tree has a compact crown with a horizontal and distinctly subterminal branching. The leaf, twig and floral parts display characteristics which ease the level of competition, nutrient recycling and handling during management. However, there is need to establish whether the leaves are allelopathic to other plant associations.

E. natalense flowers in November to March and bears an edible red, single seeded fruits which are densely crowded along the old wood. Fruiting occurs in September to December. Seed dispersal is mostly by animals and natural seedfall processes or slight disturbances on the mother-tree when ripe. The tree is a non-nodulating species with a non-aggressive rooting system, but adapts well to low nutrients soils.

The wood of *E. natalense* is hard and durable, but cut stumps coppices readily, particularly at an average stump diameter of 14 cm and 30 cm above the ground. Nevertheless, more information on coppice vigour and longevity, particularly under cultivation, is required.

5.1.2 Ecology

E. natalense inhabits frost free areas of the coastal belt. It extends from Eastern Cape Province, KwaZulu-Natal to the lowveld woodlands and lower mistbelt forests of northern Mpumalanga

M. Mukolwe 1998

a) Mature tree in Mt. Thesiger Forest Reserve

b) Leaves

c) Fruits

Pooley 1993

d) Fluted stem

Plate 5.1 Morphological features of **Englerophytum natalense** in South Africa, Swaziland and Mozambique. Its distribution extends further north into eastern tropical Africa, particularly in Kenya's moist or dry evergreen forest, 1450-1850 m above sea level. The tree is drought resistant (Dale and Greenway 1961; von Breitenbach 1965; Beentje 1994). The species occurs in mixed, ravine and coastal forests at margins, openings (gaps) and forest core. It performs well in coastal scarp forests, particularly in association with the Giant umSimbithi *M. sutherlandii* a dominant canopy species. The association may be attributed to; i) the genus *Millettia*'s nodulating capacity and ability to fix nitrogen, ii) the shading effect on *E. natalense* and iii) all tree roots leak nutrients, particularly from those with high nitrogen contents, which benefit closely neighbouring roots containing little nitrogen such as *E. natalense* (van Noordwijk and Dommergues 1990). Therefore, *M. sutherlandii* among other plant associations, plays an important role in creating a favourable micro-climate and edaphic conditions, for enhancing the regeneration and growth of *E. natalense*. The tree is a larva food plant for several butterflies, namely *Euptera pluto kinugnana, Pseudacraea boisduvali trimeni, P. eurytus imitator* and *P. lucretia* (van Wyk and van Wyk 1997).

5.1.3 Socio-economic Values

5.1.3.1 Wood Usage

The wood of *E. natalense* is strong, durable and provides good quality fuelwood. However, the most preferred use is fencing and hut building poles (Pooley 1993; van Eck *et al.* 1997). The wood is also used for making tool handles and milking buckets by the Zulus (Smith 1966; Palgrave 1993). The fruit of *E. natalense* is more popular than the widely used Wild plum *Harpephyllum caffrum* Bernh. (umGwenya). This is due to its sweetness and relatively smaller size of the trees, which makes the fruits more accessible (van Eck *et al.* 1997). Furthermore, the trees are early fruiters. However, its processing possibilities and market potential are still not well known.

5.1.3.2 Medicinal Usage

Although there is little information on the medicinal usage of *E. natalense*. Kokwaro (1993), observes that in East Africa, the roots are used for abdominal pain. *E. magalismontanum* is closely related to *E. natalense*. It is used to treat headaches and epilepsy (fruits and roots), abdominal pain and rheumatism (roots), and invoking ancestral spirits in certain ceremonies (Hutchings *et al.* 1997). The fruit is used to make jam and a strong alcoholic Afrikaans drink own as "*Mampoer*".

5.1.4 Propagation and Management

5.1.4.1 Propagation

A survey undertaken to determine the abundance and size-class distribution of *E. natalense* at Mt. Thesiger Forest Reserve (MTFR), indicates a density of about 23,382 seedlings per hectare (Chapter 6). The high recruitment implies that *E. natalense* regenerates readily from seeds in its natural environment. Experience with *E. magalismontanum* under cultivation indicates that seed treatment is not necessary and better results are realised if the seeds are sown when still fresh (Chilufya and Tengnäs 1996). The same may apply to *E. natalense*, but subject to seed germination studies. The large number of seedlings (wildings) may also indicate that on-farm tree establishment is possible using wildings as an alternative. However, this must be done selectively and with a lot of care, particularly tending the wildings until they attain planting sizes. Nevertheless, seeds provide a better option for tree improvement because the source and characteristics of the mother tree are well known (Dawson 1997).

5.1.4.2 Management

Field observation at MTFR, indicates that *E. natalense* coppices readily from cut stumps, particularly at pole size (12-16 cm dbh). The advantages of having a multi-stemmed tree/shrub (2-4 stems) per tree should be explored to improve fruit production. The most common and appropriate silvicultural (tending) practices to enhance on-farm tree productivity include, regular weeding, pruning, and protection against damage by pests, diseases, livestock and interference by people (Maghembe *et al.* 1998). Farms or gardens situated near the natural forests will need to take extra care, because the fruits are eaten by birds and monkeys. The sunbird, particularly feeds on nectar-laden flowers. The tree is also a good shade and container plant (Pooley 1993).

Most of the physiological characteristics and socio-economic attributes of *E. natalense* favour its integration into either simultaneous or sequential agroforestry systems (ICRAF 1994; Sanchez and Palm 1996). Nevertheless this must be complemented with research addressing how to: i) enhance the productivity of the tree and ii) limit any constraints it may impose on soil productivity and other human resources.

5.2 The Sneezewood *Ptaeroxylon obliquum* (umThathi)

5.2.1 Tree Description

The Sneezewood family Ptaeroxylaceae is a monogeneric family, *Ptaeroxylon* Eckl. & Zeyh and monogeneric species, *Ptaeroxylon obliquum* (Thunb.) Radlk. (von Breitenbach 1965; Palgrave 1993;.Pooley 1993; Mbuya *et al.* 1994; Fanie and Venter 1996; Hutchings *et al.*1997).

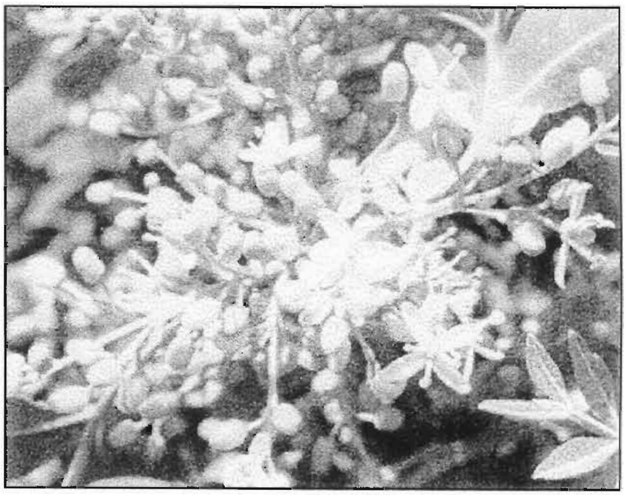
P. obliquum is deciduous shrub or large tree, up to 35 m tall and 130 cm dbh, at its greatest size (Plate 5.2). However, it seldomly exceeds 5 m in height or 14 cm dbh in the coastal forest. This is because of intensive illegal cutting for hut building and health care needs (David Russell 1998. pers. comm[2]; Vinny 1998. pers.comm[3]).

The stem of *P. obliquum* is usually clean and straight, with a rounded crown. However, In the drier areas, it is often small, multi-stemmed with a cone-shaped crown. The leaves produce a characteristic peppery smell when bruised. There is a need to determine whether the leaves exhibit allelopathic properties. This is because allelochemicals have negative effects on nitrogen fixing and growth of other plant associations.

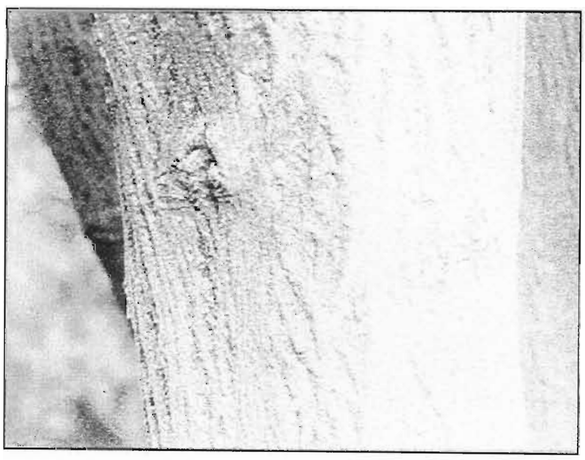
P. obliquum is a dioecious tree. It flowers at age 5 in favourable site conditions, producing very attractive flowers during August to December in South Africa. However, the female tree bears fruits once every second or third year (von Breitenbach 1965), from December to February. The seeds are dispersed by wind, however, the old capsule remains on the tree for some time. Timing of seed collection is therefore an important management activity to ensure future propagation and establishment.

a) Mature tree in the bush

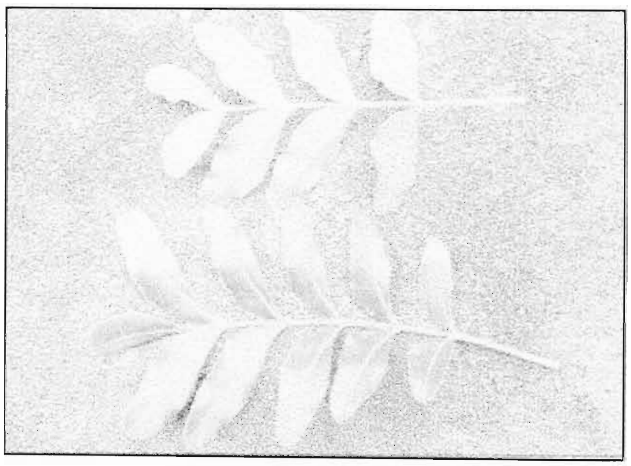
b) Fruits



c) Flowers



d) Mature stem



e) Leaves

Modified, Fanie and Venter (1996)

Plate 5.2. Morphological features of **Ptaeroxylon obliquum**

P. obliquum has a non-aggressive root system which makes it ideal for small gardens (Fanie and Venter 1996). Further, the species usually coppices freely from the stump when cut, particularly at an average stump diameter of 14 cm and 30 cm above the ground. These are positive attributes for integration into agroforestry systems, but based on actual field observation. Therefore, there is need for information, particularly to enhance coppice performance under cultivation.

The wood of *P. obliquum* is fine-grained with a beautiful satin lustre, yellowish brown sapwood and honey-brown heartwood. The sapwood is liable to decay, while the heartwood is hard, heavy (air-dry 1040 kg/m^3) and durable (von Breitenbach 1965; Fanie and Venter 1996). The wood is easy to saw and seasons well. The heartwood is termite resistant, an attribute that endears it to most resource-poor farmers for building huts and as kraal posts. However, it contains aromatic resin and highly volatile oil which makes it very inflammable and burns with ease even shortly after felling.

5.2.2 Ecology

The family Ptaeroxylaceae occur in the tropics, particularly in Eastern Cape Province and KwaZulu-Natal in South Africa, Swaziland, Botswana, Mozambique, Madagascar and Tanzania. It grows in diverse habitats ranging from well-drained sandy to rocky ridge soils in woodlands, scrub, bushveld, coastal and evergreen montane forests. The species *P. obliquum* can tolerate moderate frost and is drought resistant. The mature trees are susceptible to defoliation by the Citrus swallow tail butterfly *Papilio demodocus* and Trunk Rot disease *Fomes rimosus* (Berk.) (von Breitenbach 1965; Pooley 1993; Mbuya *et al.* 1994).

5.2.3 Socio-economic Values

5.2.3.1 Wood Usage

P. obliquum was heavily used in the past for beams, railway sleepers, bridge and jetty construction. The wood is used for high quality furniture and musical instruments. It is in high demand, particularly as poles and posts for fencing, building, pestle and mortar and other purposes where durability and termite resistance are of importance. The wood *P. obliquum* is very inflammable and makes excellent fuelwood. Nevertheless, van Wyk and van Wyk (1997) claims that "*the family is of no significant economic importance*", perhaps as a result of the heavy reduction in the density of mature trees. However, there is sufficient evidence to refute this claim (Fanie and Venter 1996; Mander *et al.* 1996; Dold and Cocks 1997; Hutchings *et al.* 1997; van Eck *et al.* 1997). There is need to determine to what extent the products are profitable to the households, the local economy, and of ecological significance.

5.2.3.2 Medicinal Usage

P. obliquum is widely used in traditional medicine and cultural issues. The medicinal usage involves preparations from the bark, roots and the wood. The bark or powdered wood infusion is taken for rheumatism, arthritis and heart disease. Root decoction is taken to purify blood. The snuff made from the bark and wood is used to treat headaches and sinusitis. Alcoholic extracts of the wood are used to treat patients suffering from fits. The resinous sap from heated wood is applied to lupus and warts until they disappear, both in humans and cattle. However, powdered wood or sawdust produce an intense irritating pungent smell which easily induces sneezing (Palgrave 1993; Pooley 1993; Fanie and Venter 1996; Hutchings *et al.* 1997; van Eck *et al.* 1997; van Wyk and van Wyk 1997). *P. obliquum* is also used as a traditional pesticide for stored grain using smoke from burning wood in Tanzania (Mbuya *et al.* 1994). The sawdust and small pieces of wood are used as insect repellant for bedsteads and to keep moths out of cloths.

5.2.3.3 Cultural Usage

The cultural usage of *P. obliquum* is upheld strongly among the Xhosas and Zulus in protection, cleansing and communicating with ancestral spirits. For example, burnt wood is used as a charm to discover an evil-doer or as a protection against contamination when a man marries his deceased brother's wife. Pegs of wood are used for applying protective medicines "*intelezi*" against lightning, hence its preference as fencing posts (David Russell 1998. pers. comm[2]; Vinny 1998. pers. comm[3]). The wood is also used in rituals where animal sacrifices are made to ancestral spirits. Therefore, both medicinal and cultural usage of *P. obliquum* present an entry point through which the species can be cultivated and conserved (Fanie and Venter 1996; van Wyk and van Wyk 1997).

5.2.4 Propagation and Management

5.2.4.1 Propagation

Natural regeneration in *P. obliquum* is by seeds and sometimes by root suckers. The latter process is important because it contributes to the species' recruitment during the non-fruiting years. This is because the female tree bears fruits once every second or third year. *P. obliquum* is readily propagated from seeds without any treatment. However, seeds remain viable for only a few months at room temperature. There are about 30,000 seeds per kilogramme (Mbuya *et al.* 1994). Best germination results are realised when the seeds are raised in the nursery, particularly in a mixture of river sand and compost in a ratio of 1:1, covered with shifted sand (Fanie and Venter 1996). Seedlings raised in containers (potted), for example, polythene bags, spent fruit juice and "*Ijuba*" packets, ensures: i) low handling costs during tending, etc., ii) low damage in transit, iii) extended planting season and iv) higher survival at establishment in the field (Shepherd 1986). Germinating seedlings should be transplanted (pricked out) into pots (bags) when they develop the third leaf stage. Pricking out is a delicate operation which should be done with a lot of care. Further, it is important to observe the subsequent nursery operations such as watering, weeding and protection against pests, diseases or damage by animals, for healthy and vigorous seedlings.

5.2.4.2 Management

Field observations at MTFR indicate that *P. obliquum* coppices readily from stumps, particularly at pole size. The capacity to coppice implies that it can be cultivated for specific pole sizes in prescribed rotations under on-farm conditions. *P. obliquum* is fairly fast growing under cultivation and attains a growth rate of 0.4-1 m per year (von Breitenbach 1965; Fanie and Venter 1996). Farmers in high rainfall areas can plant one hectare or more of this species as a financially viable long-term investment of 30 years (Fanie and Venter 1996). This is because of the existing high demand for the wood of *P. obliquum* for various uses. Consequently, the tending activities to enhance productivity include, weeding/slashing, pruning, thinning and protection against pests, diseases or damage by animals in the field. There is also need for information on the silvicultural aspects in the field to improve both management and yield.

5.3 The "Ironwood" *Millettia grandis* (umSimbithi)

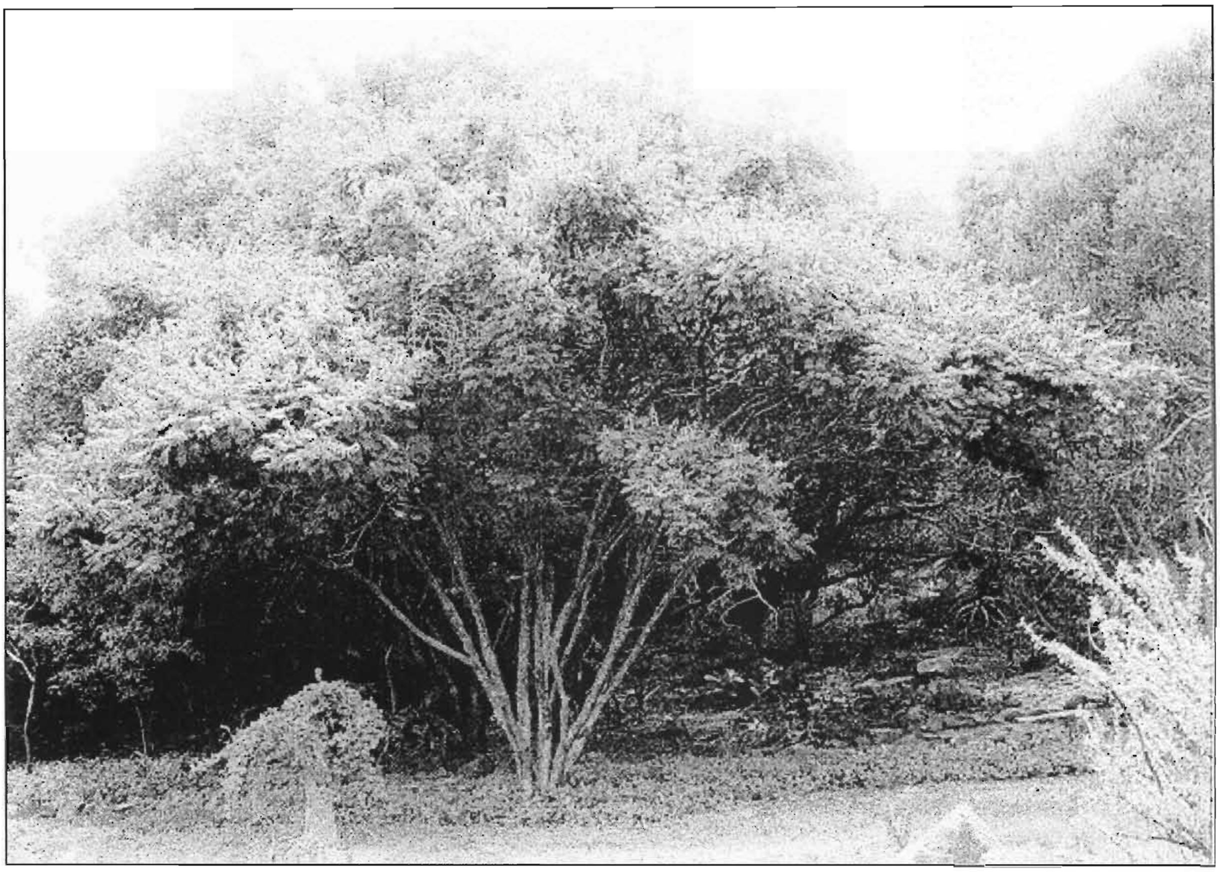
5.3.1 Tree Description

The species *Millettia grandis* (E. Meyer) Skeels, belongs to the legume (pod) family Fabaceae (Leguminosae) (Fanie and Venter 1996). This is the third largest family of the angiosperms with over 600 genera and 12,000 species (Kokwaro 1994). The genus *Millettia* Wight. & Arn. belongs to the Pea sub-family Papilionoideae (Faboideae) (Blundell 1994). Members of this genus have root nodules containing nitrogen-fixing bacteria. This factor is of special significance for integration in agroforestry systems (Brewbaker 1987; Werner and Müller 1990; Sanchez and Palm 1996). The nitrogen-fixing factor has attracted much interest in tree or plant physiological characteristics responsible for and attributed to tree growth, soil fertility improvement and animal production. Further, international emphasis in nitrogen-fixing trees is apparent from the extensive networks of trials in the tropics (Macqueen 1992; Odee 1996; ICRAF 1997). However, the potential benefits will vary depending on the species, climate, soils and management practices used (Nair 1989).

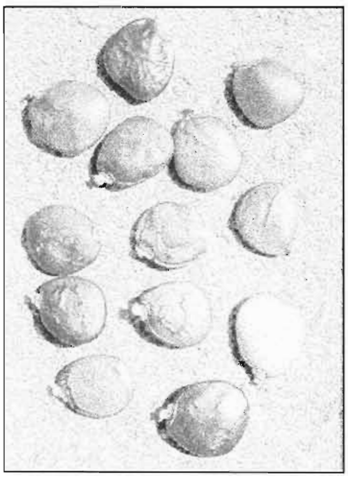
M. grandis is a deciduous, small to medium sized tree up to 13 m tall or more, under favourable conditions (Plate 5.3). It has a variable stem form which is prone to becoming multi-stemmed, reaching 30-45 cm dbh. However, it responds well to pruning, which enhances its cylindrical form. The bark exudes a sticky red sap when cut, but whose potential use is still unknown.

M. grandis develops a wide-spreading and flattened crown. The leaves are compound and are a potential source of fodder and mulch. The larvae of the Pondo charaxes *Charaxes pondoensis* breed on the leaves (Pooley 1993; Fanie and Venter 1996). The potential extent of damage by this pest under cultivation is still unknown.

M. grandis is a monoecious tree. It produces attractive pea-shaped, purple to mauve flowers, from November to March in South Africa. The fruits are a large, flat woody pod, up to15x4 cm, covered with brown velvety hairs when mature and dry. Seed dispersal is effected by an explosive fruit splitting on the tree generated by dry tensions in the pod walls.

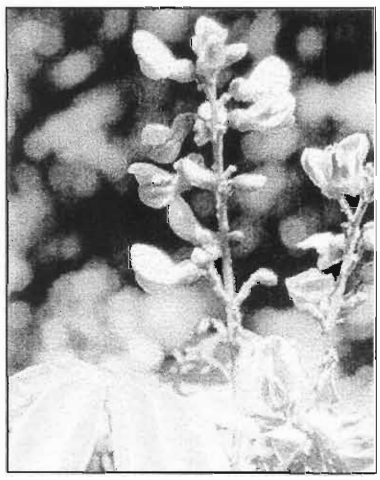


a) Mature tree in flowers



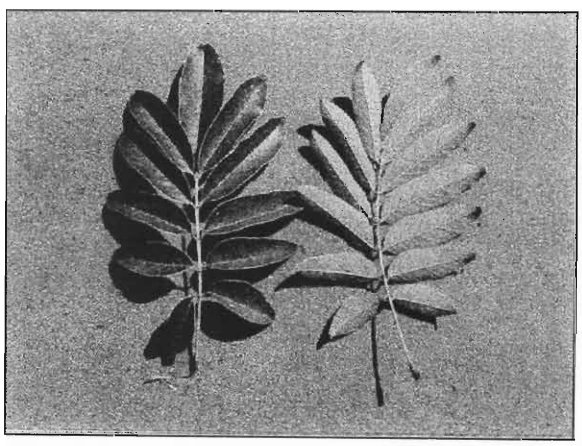
b) Seeds

c) Fruits



d) Flowers

e) Stem



f) Leaves

Modified, Fanie and Venter (1996)

Plate 5.3. Morphological features of **Millettia grandis**

This process releases seeds with a spinning motion to a relatively long dispersal distance, often up to 10 m, from February to September. The explosive fruit dehiscence may impose difficulties in obtaining sufficient seed quantities, hence timing of seed collection is an essential management activity. The larvae of the Orange-barred playboy *Deudorix diocles* and the Striped policeman *Coeliades forestan* butterflies breed inside the pods of *M. grandis*. Therefore, there is need to generate information on the phenology and effects of pests on seed production, to enhance its natural regeneration and on-farm cultivation.

M. grandis coppices freely, has nodulated and a non-aggressive root system. The roots have the capacity for nitrogen-fixing and soil conservation, thus enhancing its chances for integration into agroforestry systems (Fanie and Venter 1996). Nevertheless, these are positive attributes which merit attention to enhance their capacities under cultivation.

The wood of *M. grandis* has a yellow sapwood and a dark brown heartwood. The heartwood is close-grained, heavy, hard and durable. It weighs 1281 kg/m^3, when green and 1105-1185 kg/m^3, when air-dry (von Breitenbach 1965). The wood is permeated with an oily substance which enhances its durability when in contact with the ground.

5.3.2 Ecology

M. grandis occur naturally in evergreen coastal forests, particularly on forest margins of the Eastern Cape and KwaZulu-Natal provinces in South Africa. This is often on doleritic sandstone and seldom above 700 m altitude. It remains stunted on shale soils (von Breitenbach 1965; Palgrave 1993; Fanie and Venter 1996). *M. grandis* is also cultivated as an ornamental tree in gardens and along the roadside. It prefers warm and sunny conditions on deep soils, can withstand several degrees of frost, and is drought resistant. However, it is susceptible to a rust disease *Diorchidium woodii* (K.& Cke.) near the coastal belt (von Breitenbach 1965) and prone to bark stripping by baboons who eat them (Fanie and Venter 1996). *M. grandis* is an attractive garden plant and is already used for roadside planting and windbreaks.

5.3.3 Socio-economic Values

5.3.3.1 Wood Usage

The heartwood of *M. grandis* is heavy, hard and durable. It is favoured for carpentry, building poles, posts and domestic tool handles. However, the most important use is for making fancy walking sticks, knob sticks and Police batons (Pooley 1993; Obiri 1997). Culturally, any Xhosa or Zulu man must have at least one or more such sticks (David Russell 1998. pers. comm[2].). The wood is a major raw material for the craft industry in Umzimvubu District, and of importance as a source of income for most resource-poor households in the area (Obiri 1997). The wood of *M. grandis* is also preferred as an excellent source of energy when used as fuelwood. In addition, it does not wet easily as fuelwood due to rain. Further, it is termite resistant, hence preferred as building, fencing poles and posts when still young trees up to 13 cm dbh. Although *M. grandis* is a nationally protected indigenous tree, it is still subjected to high levels of illegal exploitation both in the State and Headman's forests (Marlene Powell 1998. pers. comm[1].)

5.3.3.2 Medicinal Usage

M. grandis is also used in health care needs. The parts mostly used are the roots and seeds. Ground roots when prepared with other plant and animal components is used to induce sleep and as a tranquilliser to dispel worries. The ground roots is a potent arrow poison and can also be used to poison fish, if it is prepared in a special way . The seeds of *M. grandis* can also be prepared for the same effects. Further, the seeds are poisonous to humans, if eaten in quantity. However, when ground and soaked in milk, seeds provide a remedy for roundworms (Palgrave 1993; Pooley 1993; Fanie and Venter 1996; Hutchings *et al.* 1997; van Wyk and van Wyk 1997).

5.3.4 Propagation and Management

5.3.4.1 Propagation

M. grandis regenerates naturally in the forest and also under cultivation from seeds. However, best results are realised when viable, fresh mature seeds are sown after soaking in hot water overnight. The river sand provides the best media for germinating the seeds in the nursery. The germinated seedlings should be transplanted (pricked out) at the second leaf stage as described in section 5.2.3.1. Wildings can also be used as an alternative method of raising seedlings. However, wildings should be used on a limited scale because of the same reasons mentioned in section 5.1.3.1.

5.3.4.2 Management

Established trees will require specific tending operations in the field such as, weeding, slashing, pruning, protection, selective singling and harvesting. Singling is of importance because *M. grandis* coppices readily, particularly at pole size. The seedlings establish into trees fairly fast, at a growth rate of 0.8-1 m per year and start to flower at 2-3 years, under good site conditions and tending practices (Fanie and Venter 1996). *M. grandis* often develops crooked stems, however straight stem forms can be formed by pruning regularly.

5.4 Agroforestry Tree Features and Systems

5.4.1 Agroforestry Tree Characteristics

The general agroforestry tree (Simons 1997) characteristics of importance and systems have been described by several authors (Huxley 1983a; 1983b; Wood and Burley 1989; Hanover 1990; Raintree 1991; Hitimana *et al.* 1994; Ong 1994; Chilufya and Tengnäs 1996; Sanchez and Palm 1996; ICRAF 1994;1997a; Weber et al.1997). The desirable tree characteristics include: i) compatibility with climatic and soil factors of the site. This is a major requirement irrespective of purpose; ii) ease of establishment, especially by seeds, seedlings or vegetative propagation; iii) fast growing, although Ong (1994) notes that fast growth may be counter-productive because the tree is too competitive; iv) easy to manage by weeding, pruning, looping, thinning, pollarding, etc.; v) deep or non-aggressive rooting habit (for drought tolerance, efficient recycling of nutrients, minimal surface root competition with crops, etc.); vi) ability to provide the desired products and services (in quality and quantity) under prescribed management practices; vii) ability to facilitate root associations with symbiotic microbes (e.g. rhizobia and mycorrhiza) for nitrogen fixation and phosphorous absorption; viii) early maturity of desired product; ix) good coppicing ability and indeterminate growth habit; x) resistance to pests and diseases. This is a major requirement irrespective of purpose; xi) low nutrient demand; xii) low soil water demand; xiii) no allelopathic effects on crops and other trees in managed associations; and xiv) no or low potential of becoming an invasive weed.

The information on the tree description, ecology, socio-economic values and propagation and management of *E. natalense, P. obliquum* and *M. grandis,* indicate that the three species have the capacity and demonstrate most of the outlined (i - xiv) characteristics. A quick check-list of the desirable characteristics and uses is provided as Table 5.1. Nevertheless, the main challenge lies in the willingness and ability of the farmers and relevant government departments and agencies to integrate the three high value indigenous trees into appropriate simultaneous or sequential agroforestry systems (ICRAF 1994; Sanchez and Palm 1996). Chapters 3 and 4 provided the necessary perspectives and imperatives to this challenge.

5.4.2 Potential Simultaneous and Sequential Agroforestry Systems

The simultaneous and sequential agroforestry systems were introduced with examples, in Chapter 1 (section 1.9). Therefore, examples of interventions (technologies) with a high potential for successful integration of *E.natalense, P. obliquum* and *M. grandis* include, i) boundary and border plantings, ii) live hedges and fences, iii) woodlots iv) contour planting within cropland, v) improved fallows and vi) mutlistrata systems. Some of these interventions are already being practiced (Obiri 1997). This implies that lack of interest is not a constraint, but lack of guidance from the relevant government departments and agencies.

Table 5.1. A comparative check-list of desirable agroforestry tree characteristics and uses.

	Desirable Tree Characteristics														Potential Uses										
Species	I	ii	iii	iv	v	vi	vii	viii	ix	x	xi	xii	xiii	xiv	F	P	CON	UW	FW	M	C	MU	FO	SCV	LM
E..n	✓	✓	✓	✓	✓	✓	×	✓	✓	?	✓	✓	?	✓	✓	✓	✓	✓	✓	✓	✓	?	?	✓	✓
P.o	✓	✓	✓	✓	✓	✓	×	✓	✓	?	✓	✓	?	✓	×	✓	✓	✓	✓	✓	✓	?	?	✓	✓
M.g	✓	✓	✓	✓	✓	✓	✓	✓	✓	?	✓	✓	?	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
G.r	✓	✓	✓	✓	✓	✓	?	✓	×	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	?	✓	✓	✓	?	✓
P.a	✓	✓	✓	✓	✓	✓	×	✓	×	✓	✓	✓	×	✓	✓	?	?	✓	✓	✓	✓	✓	?	?	✓

NB. **Species**

E.n - *E. natalense*

P.o - *P. obliquum*

M.g - *M. grandis*

G.r - *Grevillea robusta* (exotic)

P.a - *Persea americana* (exotic)

Tree characteristics

✓ - desirable characteristic

× - unusual characteristic

? - more information needed under cultivation

I - xiv - check-list of desirable characteristics (section 3.4.1)

Uses

F - Fruit: P - Poles/posts: CON - Construction: UW - Utility wood: FW - Firewood: M - Medicine:

C - Craft: MU - Mulch: FO - Fodder: SCV - Socio-cultural values: LM - Land management (Amenity, Soil conservation, etc.)

5.4.3 Potential Exotic Tree Species

High value exotic tree species have an important role to play in the welfare of resource-poor farmers and environmental conservation. The Australian Silky oak *Grevillea robusta,* Whistling pines *Casuarina cuninghamiana* and *C. equisetifolia*; Avocado *Persea americana* (Ponyoponyo); Mango *Mangifera indica*, Peach *Prunus persica* and *Citrus* species, are consistently mentioned by farmers as local favourities in their homesteads (gardens/yards). Further, the trees also display most of the outlined tree characteristics in section 5.4.1 and Table 5.1. However, fruit trees will need to be grafted, budded and managed to enhance early maturity, fruit quality, food security, income generation and environmental conservation. Further, planting these species could serve to: i) inculcate a tree planting culture among the resource-poor farmers, and ii) complement and facilitate research and development initiatives in agroforestry, in Umzimvubu District and other similar areas of South Africa (Pooley 1993; Murless 1994; Fanie and Venter 1996; Obiri 1997).

5.5 Conclusion

E. natalense, P. obliquum and *M. grandis* are promising high value indigenous tree species for integration into appropriate agroforestry systems, for the farmer's benefit and ecological resilience. Research and development information is needed to facilitate the biophysical evaluation and validation of the positive attributes of *E. natalense, P. obliquum* and *M. grandis.* This would enhance their acceptance and adoption by the farmers, in realising their desired products and services. Nevertheless, strategies and mechanisms to enhance awareness and inculcate a culture of tree planting among the resource-poor farmers and relevant agencies, remains the main challenge to any endeavour in promoting agroforestry in Umzimvubu District and similar area of South Africa.

CHAPTER 6:

THE REGENERATION STATUS AND STOCKING CAPACITY OF *E. natalense, P. obliquum* AND *M. grandis* IN MT. THESIGER FOREST RESERVE (MTFR)

6.0 Introduction

Englerophytum natalense, Ptaeroxylon obliquum and *Millettia grandis* are examples of the many important high value indigenous tree species to the rural communities of Umzimvubu District (van Eck *et a*l. 1997). The continued dependence on these tree species will depend on the size of the standing crop, the rate individual species regenerate and the rate of use by the community surrounding Mt. Thesiger Forest Reserve (MTFR). A comprehensive inventory on the regeneration status of *M. grandis* is now available (Obiri 1997). A similar inventory to assess the abundance and distribution of *E. natalense* and *P. obliquum* is presented here. The objective of this chapter is to assess the abundance and distribution of *E. natalense, P.obliquum* and *M. grandis* to provide a sound ecological basis for integrating the species into an appropriate agroforestry system, and to contribute to the sustainable management of *E. natalense, P.obliquum* and *M. grandis* in MTFR.

6.1 Methods

6.1.1 Size Class Distribution for *E. natalense, P.obliquum* and *M. grandis* in MTFR

Thirty-four sample plots based on the Modified Whittaker plot design (Stohlgren *et al.* 1995; Figure 6.1) were used to obtain size class distributions (SCDs) of *E. natalense*. The SCDs of *M. grandis* are from Obiri (1997). However, because there were very few large canopy specimens of *P. obliquum,* and most individuals were less than 5 cm dbh, it was necessary to use a larger plot design and more intensive sampling of subplots, to adequately sample its size class distribution. A modified version of the plot design used by Benitez-Malvido (1998) was used (Figure 6.2; see also Chapter 2). Five of sample plots of *P. obliquum* were completed.

Figure 6.1 Modified Whitakker plot design (Stohlgren *et al.* 1995) **for** *E. natalense.*

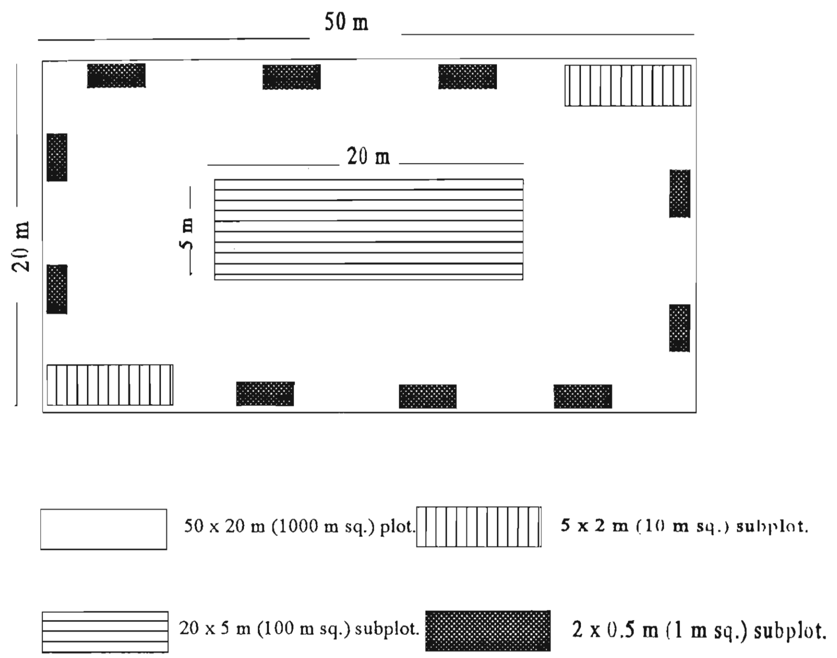
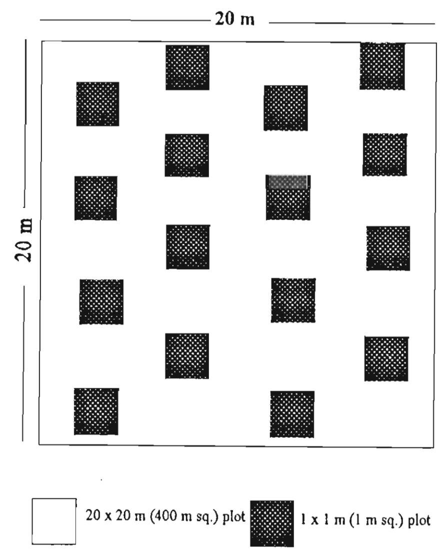


Figure 6.2."Modified" Benitez-Malvido (1998) plot design for *P. obliquum*



The MTFR area was stratified into 2 zones comprising 17 plots each. Zone 1 was "moderately" exploited areas adjacent to the Forest office, and Zone 2 was "heavily" exploited areas adjacent to the villages. No comprised unexploited forests since most indigenous forest areas in MTFR had been subject to some level of exploitation.

The 34 Modified Whittaker sample plots were drawn from 15 different forest blocks; Pembeni, Silaka, Sonkwe, Pungane, Ntswentswe, Zagwitye, Nositemu, Gxwaleni, Ntsonga, Ngogo, Peshlua Dip, Khovoti, Mbiza, Bulolo and Kobemnyango in MTFR.

Size class distributions (SCDs) were analysed using a method proposed by Condit *et al.* (1998) and tested by Lykke (1998). The following dbh size classes were used: 0-5, 6-10, 11-15, 16-20, 21-25, 26-30, 31-35, 36-40, 41-45 cm. Individuals > 45 cm were grouped into one size class. Stems with a dbh < 6 cm were regarded as newly derived stems, indicating the regenerative capacity of a species through seed germination and establishment (Shackleton, 1993). For each species a regression was calculated with class mid-point as the independent variable and average number of individuals in that class (N_i) as the independent variable. Slopes of these regressions are referred to in this study as SCD slopes. The size class variable was natural log transformed (ln), and the average number of individuals (N_i) was transformed by $\ln(N_i+1)$ because some size classes had zero individuals. All size classes with individuals present were included in the regressions. SCD slopes were used as an indicator of population structure (Lykke 1998). Slope values were used to summarize, in a single number, the shape of the size distribution. The interpretation of the SCD slopes was based on the four types of SCD described in Everard *et al.* (1994). Slopes are usually negative since larger size classes have fewer individuals, and indicate recruitment. Flat distributions have a slope of zero and indicate equal numbers of regenerating trees to mature individuals. Positive slopes are sometimes referred to as unimodal since they are typically characterised by relatively many canopy individuals but no regeneration (Shackleton 1993; Everard *et al.* 1994).

Everard *et al.* (1994) also apply the concept of grain to the interpretation of SCDs. Grain is form of spatial analysis and involves comparing the number of canopy individuals to the number of subcanopy or sapling individuals. In a fine-grained species we would expect to find that canopy and subcanopy individuals are well represented over a small area (in this case the area is about 0.1 ha - 20 x 50 m). These species would recruit from advanced regeneration and would be relatively shade tolerant. If the scale of variation from plot to plot is small over a large number of species then a forest could be considered fine grained (e.g. Midgley *et al.* 1990). A coarse-grained species would have few subcanopy individuals in a plot and would regenerate over a large area at relatively low densities. Such a species should not be favoured as a harvestable species and depending on harvesting pressure, may be a good candidate for agroforestry. In addition, coarse-grained species are generally shade intolerant and fast growing and often grow in gaps. Their life-history is suited to agroforestry applications. As part of the analysis of grain a further index of size distribution was calculated - the fraction of adults in each species. In this index the size class at which individuals first produced fruit was estimated. All individuals greater than this cut-off were counted and the total divided by the total population for each species (Condit *et al.* 1998).

Significant differences in size-class profiles between the three species were examined and differences between the 2 zones of usage, were tested using the Kolmogorov-Smirnov Two-sample Test (Zar, 1984; Siegel and Castellan, Jr. 1988). The goodness of fit of the size-class profiles to expected cumulative frequency distributions (e.g. poisson) were also tested. The Kolmogorov-Smirnov Test (K-S statistic) was chosen because it is less sensitive to small numbers of observations in a size-class than the chi-squared statistic which requires that such classes are pooled (typically if a class has fewer than 5 observations), and thus as many classes as are feasible are used in the Kolmogorov-Smirnov Test.

6.1.2 Harvesting impacts on *E. natalense* in MTFR

Five out of 34 Modified Whittaker sample plots had coppice stumps of *E. natalense*. Only the coppiced stumps were used in this study because they could be clearly distinguished as belonging to this species. All the coppice stumps and their dbh were counted and recorded for each sample plot (0.1 ha - 20 x 50 m). The SCDs was calculated to compare the harvesting impact on the population structure. Further, structure interviews with the rural households around MTFR (Chapter 3, Table 3.3) was used to complement information on whether the population of *E.*

natalense was declining, same or increasing.

6.2 Results

6.2.1 Population Structure of *E. natalense* and *M. grandis* in MTFR

In MTFR both *E. natalense* and *M.grandis* had typical inverse J-shaped size class distributions (Type 1, Everard *et al.* 1994) indicating fairly high levels of regeneration over a fine spatial scale (fine-grained species) (Figure 6.3). The shape of the SCDs were not significantly different between these two species (K-S statistic = 0.4, p = 0.4). However, *E. natalense* individuals were significantly more abundant than *M. grandis* in all size classes (chi-square = 548.2, df = 9, $p < 0.0001$, Table 6.1) and are not restricted to the forest edge like *M. grandis. Englerophytum natalense* is a truly fine-grained species and shows advanced regeneration (dbh < 6 cm = 23 382 stems ha^{-1}) achieving high densities of pole-sized stems as understorey trees (dbh < 11cm = 765 stems ha^{-1}). *Englerophytum natalense* is mainly an understorey tree and there were few stems larger than 30 cm dbh (Table 6.1). Most trees were in the intermediate size classes ranging from 10 to 25 cm (Table 6.1). The detailed raw data is presented in Appendix III.

High seedling density can aid population maintenance, but seedling survival is critical to population maintenance. Although seedling densities (here individuals with a dbh < 6 cm are regarded as seedlings) were two orders of magnitude different between *E. natalense* and *M. grandis*, their finite survival rates (Krebs 1989) to the next size-class were similar (3.3% and 4.6% respectively) (compare Figures 6.4 and 6.5). Note that a very low proportion of seedlings survive to the next class or stage (dbh = 6 - 10 cm), and that survival is slightly greater for *M. grandis* seedlings. A further interesting difference in survival of size-classes between these species is the relatively low survival (4.3% and 54.5%) of pole size-class individuals of *E. natalense* (dbh = 11 - 15 cm). This may be because most poles are harvested from this dbh range or could be due to self-thinning.

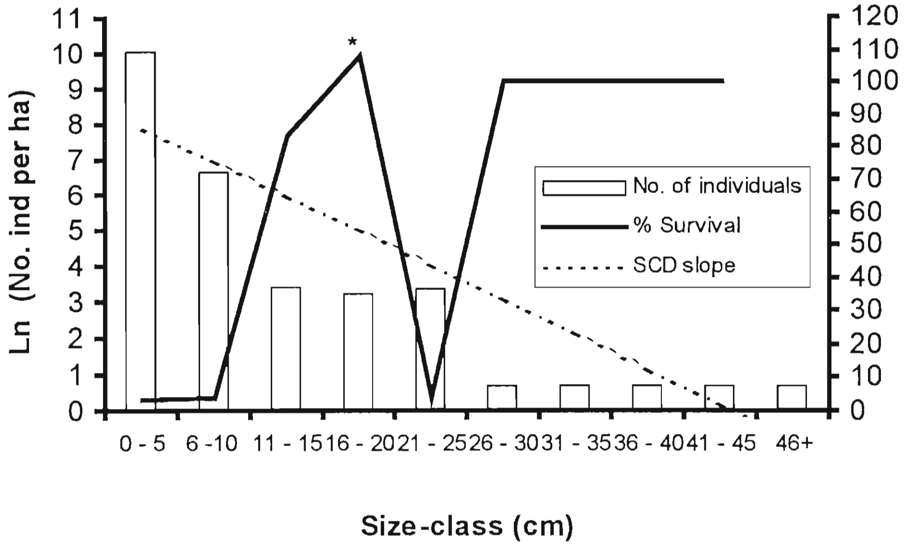
A stable population is characterised by a low ratio of change between the successive growth stages of seedlings, saplings and mature trees (Shackleton 1993). The observed high ratio between seedlings and mature trees, at least in *E. natalense,* suggests that intermediate stages in the population structure are differentially affected by both natural and human influences.

Table 6.1. The SCD of *E. natalense, M. grandis* and *P. obliquum* per hectare in MTFR.

Size class (cm)	Mean of trees ha^{-1}			Basal area m^2 ha^{-1}.			Mean of coppice stumps of ha^{-1}		% Survival between each size class ha^{-1}	
	E. natalense Mean ±SE	**M. grandis Mean ±SE*	*P. Obliquum Mean ±SE*	E. natalense	*M. grandis*	*P. obliquum*	*E. natalense*	* M. grandis	E. natalense	*M. grandis*
0 - 5	23382±3969	237	4.4510e+12	11.5	0.1	2.2	0	1.1e+08	-	-
6 - 10	765 ±155	11		3.4	0.1	0	0		3.2	4.6
11- 15	29 ±5	6		0.4	0.1	0	34 ±12		3.8	54.5
16 - 20	24 ± 4.1	4		0.6	0.1	0	0		82.6	66.7
21 - 25	26 ±4.4	4		1.0	0.2	0	0		**107.7	**100
26 - 30	0	2		0	0.1	0	0		0	50
31 - 35	0	1		0	0.1	0	0		0	50
36 - 40	0	1		0	0.1	0	0		0	100
41 - 45	0	1		0	0.1	0	0		0	100
46+	0	1		0	0.2	0.4	0		0	100
Total	24226	268	4452	17	1.2	2.6	34	13		

* Source Obiri (1997): ** Suggests a high impact of harvesting.

Figure 6.3. Population structure of *Englerophytum natalense*



As expected from the size-class distributions the SCD slope for *E. natalense* (-3.23) was steeper than for *M. grandis* (-1.14). Tree species with SCD slopes in this range have been described as Type 1 species (Everard *et al.* 1994) with good regeneration (Lykke 1998).

Figure 6.4. Population structure of *Millettia grandis*

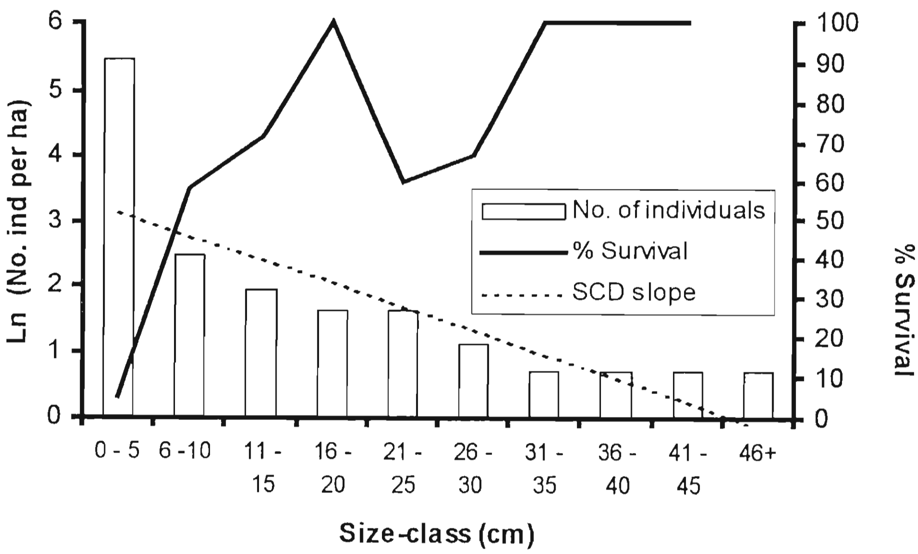
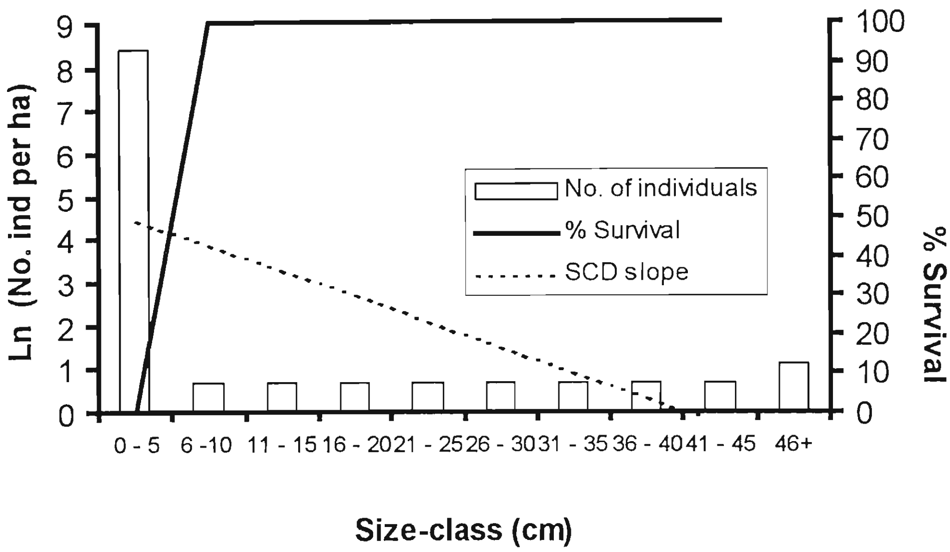


Figure 6.5. Population structure of *Ptaeroxylon obliquum*.



In contrast to *E. natalense* and *M. grandis*, *P. obliquum* occurs infrequently, and only in patches at the forest margins and in gaps in MTFR (Figure. 6.5). It is a coarse-grained and light-demanding species. The density of *P. obliquum* stems decreased rapidly after 25 m from the forest edge. Stems ≤6 cm dbh were most common (4,451 stems ha^{-1}), occasionally growing up to 5 m tall. The intermediate diameter size classes between the seedlings and saplings were rare or absent. Mature trees were rare, with 1 ± 1 mature stem ha^{-1}. The tallest mature tree of *P. obliquum* was 30 m high and 73.5 cm dbh.

6.2.3 Harvesting impacts on *E. natalense, P. obliquum* and *M. grandis* in MTFR

There were significantly more *E. natalense* stems in Zone 1 ("moderately" exploited forest) than Zone 2 ("heavily" exploited forest areas surrounding the villages) (Table 6.2) (chi-square contingency table test $\chi^2 = 57.28$, df = 4, $p < 0.0001$). However, the shape of the SCDs of *E. natalense* in the 2 zones were not significantly different (Kolmogorov-Smirnov goodness of fit Two-sample statistic = 0.628, p = 0.82).

Table 6.2. Zonal population structure of *E. natalense* per hectare in MTFR

Size class (cm)	Mean of trees ha^{-1}		%Survival between each size class ha^{-1}		Mean of coppice stumps ha^{-1}		Basal area m^2 ha^{-1}.	
	Zone 1 (Mean ±SE)	Zone 2 (Mean ±SE)	Zone 1	Zone 2	Zone 1	Zone 2	Zone 1	Zone 2
0 - 5	27824 ±3820	18941±6901	-	-	10000	0	13.7	9.3
6 - 10	1029 ±194	500 ±231	3.7	2.6		0	4.5	2.2
11- 15	80 ±7	*40 ±10	7.8	8		*24	1.0	0.5
16 - 20	50 ±5	50 ±13	62.5	*		0	1.2	1.2
21 - 25	20 ±2	0	40	0		0	0.8	0
26 - 30	0	0	0	0		0	0	0
Total	29003 ±4028	19531 ±7155			10	24	21.2	13.2

*:Suggests a high impact of harvesting.

On average 34 ± 12 *E. natalense* stumps ha^{-1} were recorded (Table 6.1) with a mean dbh of 13.3 ± 0.7 cm . Pole-sized *E. natalense* trees were selectively harvested and since the standing crop of pole sized trees (dbh = 10-15 cm) is 34 ± 12 stems ha^{-1}, it appears that about half the available stems had been harvested over a period of years. Because I was unable to age the size classes I am unable to estimate the rate of harvesting or replacement of favoured size-classes. Nevertheless, a considerable portion of the standing crop had been harvested, particularly closer to the villages and indicates the need for controls on unlimited harvesting.

The pole size class is also the class in which fruit is first produced in *E. natalense* and forms 9.4% of the tree population (i.e. everything from sapling size up). However, because this species existed at high density this apparently high harvesting rate did not appear to be severely affecting seed production capacity. The same seed producing fraction of the *M. grandis* population accounted for 64% of trees.

Similarly, 84.6% of *M. grandis* harvested in MTFR comprised dbh > 10 cm and stems in size class 20 - 25 cm are most exploited (30% of the total harvest). Trees in the size classes comprising 10 - 25 cm are mostly exploited for traditional walking and fighting sticks and poles because they are easy to cut, carry and work on. The impact of harvesting on the regeneration of *E. natalense* and *M. grandis* was exacerbated by the presence of gaps caused by livestock. Furthermore, *E. natalense* is a shade-tolerant species and does not grow well or regenerate in large gaps. Because of compounded anthropogenic effects on the survival of these species, it is imperative that appropriate management interventions are applied or initiated to ensure that these resources are managed, used and sustained.

Although there were relatively large numbers of *P. obliquum* seedlings there were few seed-producing mature trees (1 ± 1 mature stem ha^{-1}). This was most likely caused by the harvesting of saplings and mature trees of this favoured species, which is used extensively for pole and medicinal needs.

6.3 Discussion

Although only 3 high value species, *E. natalense, P. obliquum* and *M. grandis,* are studied here, they do provide insights to the problems and potential of indigenous trees species for integration into farming systems through agroforestry (Pooley 1993; Fanie and Venter 1996; Hutchings *et al.* 1996; van Eck *et al.* 1997). Most of these high value species are heavily harvested and used extensively by the resource-poor rural households in Umzimvubu District and similar areas of South Africa (van Eck *et al.* 1997).

Englerophytum natalense is found in most areas of MTFR from the forest margins and gaps to the forest core (Cawe 1996). The species. readily establishes itself as a fine-grained species within the subtropical coastal scarp forests. Furthermore, this suggests that *E. natalense* can be exploited without any long-term negative effects if they are well managed in the indigenous forest (Everard *et al.* 1994). Nevertheless, an emerging management concern is that about half of the pole-sized trees up (6 cm≤ 20 cm dbh) have been harvested.

A species with more than 10 mature stems ha^{-1} has a very high potential for sustaining a demand for tree products (FAO 1995). *Englerophytum natalense* occurs at high density but is also an important fruit tree in the Umzimvubu district (v.an Eck *et al.* 1997). This species is thus used for a variety of purposes (food and wood products) and could be cultivated as a marketable crop through agroforestry (van Eck *et al.* 1997; Maghembe *et al.* 1998).

Ptaeroxylon obliquum is not widespread in Umzimvubu District. It is found in 5% of subtropical and 50% of Afrotemperate forests (Cawe 1996) including those in this district. Further, *P. obliquum* is a coarse grained species and regenerates over a relatively large spatial scale. This species occurs at low density and cannot withstand even low levels of harvesting. There were very few mature *P. obliquum* trees in MTFR however, this may be due to heavy harvesting in the past (von Breitenbach 1965; Palgrave 1993). Although there was no visible evidence of recent harvesting of *P. obliquum* (e.g., stumps, fallen trees, laths), Cooper and Swart (1992) and Palgrave (1993) record that mature trees were heavily harvested for beams, railway sleepers, bridge and other heavy construction works early this century, because the timber is rot and pest resistant. Sixty-two percent of the rural households interviewed around MTFR (Chapter 3, Table 3.3), noted a decline in the number of saplings and mature trees of this species, and attributed this to harvesting and extensive use for poles and medicinal needs.

The tree characteristics which may be contributing to the low population density of *P. obliquum* in MTFR are: i) the species is dioecious (separate male and female trees) and produces seeds every 2 to 3 years (von Breitenbach 1965), ii) seeds are dispersed by wind, therefore seedlings tend to establish far from parent trees, and iii) the low number of seed trees per hectare (1 mature tree ha^{-1}) is theoretically below the critical minimum (3 - 4 seed trees ha^{-1}) to maintain adequate levels of seed production and tree recruitment (FAO 1995; Guariaguta and Pinard 1998). Nevertheless, seedlings were fairly abundant. This suggests that the low densities of mature trees are due to either: i) some natural mortality factor at the pole size class and above, which is unlikely, or ii) unsustainable harvesting. I favour the latter. Given the popularity of *P. obliquum*, the potentially high levels of harvesting in the past, and the ease with which the species can be grown (see Chapter 5) outside the forest around homesteads (> 80% of households use *P. obliquum*), the species should be promoted and integrated into on-farm production systems through agroforestry in Umzimvubu District.

Millettia grandis is relatively widespread in indigenous forests of Umzimvubu District (78.1% found in subtropical forests) (Cawe 1996). *Millettia grandis* typically grows at the forest edge and is a coarse-grained species (Everard *et al.* 1994). The species has a mean population density of 21 mature stems ha^{-1} in MTFR (Obiri 1997). Large trees with a DBH > 30 cm are scarce (4 mature stems ha^{-1}). The critical minimum for maintaining adequate levels of seed production and tree recruitment is 3-4 seed trees ha^{-1} (Guariaguta and Pinard 1998). Although *M. grandis* in MTFR does meet this requirement, it is an extremely popular timber species and is recognised for the relatively large contribution it makes to the local economy through the wood-carving industry (Obiri 1997). However, dwindling densities of *M. grandis* in MTFR have been noted; thus the species urgently needs to be integrated into farming systems in Umzimvubu District (Fanie and Venter 1996; Obiri 1997).

An abundance of seedlings of, for example, *E. natalense* (23,382 stems ha^{-1}) in MTFR should not be taken as an indicator of the good status of a tree species (Lamprecht 1989). It is important to review the shape of the size class distribution (Condit *et al.* 1998; Lykke 1998) and the spatial scale over which species tend to regenerate, the grain (Everard *et al.* 1994). Seedlings are a phase that can suffer high mortality due to factors such as insufficient light, moisture and predation. However, Shackleton (1993) suggests that a high ratio of change between successive size classes (i.e., my survival values), for example, in *E. natalense*, implies an unstable population. I have already argued above that this apparent instability is due to harvesting effects and that the survival of SCDs is not indicative of natural conditions.

The high cost of gum poles (*Eucalyptus grandis*) from plantations (R 3.20 per pole), compared to poles from indigenous forest (R 1.00 - R 1.20 per pole) (Obiri 1997; Vinny 1998. pers. comm[3].) is likely to discourage initiatives to plant and conserve high value indigenous trees in the farmlands of Umzimvubu District. Greater equality in the prices of plantation versus indigenous timber could have two effects on the use of indigenous wood: i) it could lower the use of indigenous wood since it is as economical to use plantation timber which is in ready supply; or ii) it could reset the market forces and effectively encourage the greater harvesting of indigenous timber as a source of ready income. In order to avoid the latter it is important to identify the high-value species ahead of time and to encourage there cultivation outside the forest. While DWAF should review its current pricing of poles and posts from these two sources, changes to pricing structure should be made cautiously and only once there is a clear understanding of the different socio-economic and environmental values in the district. Changes in pricing must go hand-in-hand with effective resource use and management interventions (annual allowable harvests, low impact harvesting techniques; FAO 1995), if the ecological integrity and the populations of *E. natalense*, *P. obliquum* and *M. grandis,* are to be sustained, both in the indigenous forest and on farms.

Although protected by the State, and faced with suitable biophysical conditions for the seeds to germinate and establish, *E. natalense P. obliquum* and *M. grandis* continue to decline in Umzimvubu District. Illegal harvesting for poles and sticks is the greatest threat to their survival at this time. The most affected areas are those close to the villages. The most preferred size-class are; 10 - 15 cm *(E. natalense*) and 20 - 25 cm (*M. grandis*). These size classes are easy to cut, carry and can be removed illegally from the forest or are not subjected to stem core decay (Obiri 1997; Wilson Z.M. Xhangayi 1998. pers. comm[4].). However the availability of large trees above these size classes is vital for sustaining seed production.

The main conservation and management concern in MTFR is that an age/size-class gap in *E. natalense, P. obliquum and M. grandis* is rapidly being created. This will greatly change the species' population structure and quality of the forest in the long-term. This size-class gap may, in fact, lead to successional collapse as large trees are removed and seed production and regeneration declines. Management interventions should include setting aside and managing areas for the perpetuation of natural processes (no harvesting), controlled harvesting from indigenous forest, and agroforestry ventures. Muir (1991) argues that cultivating alternative sources of high value indigenous tree species outside indigenous forest could be more cost-effective than investing in intensive monitoring programmes for sustaining the use of that resource.

6.4 Conclusion

Englerophytum natalense P. obliquum and *M. grandis* are capable of sustaining their populations in the natural forest from seed and coppice. However, the increasing intensity of human harvesting for poles, craftworks and health care needs, is increasingly constraining the species' ability to sustain their population structure. The analysis of size class distribution structure indicates that this was more evident in areas adjacent to the villages. The popularity and extensive use of these species from indigenous forest sources suggests a need for an alternative sustainable land use management system, particularly agroforestry. There is sufficient evidence indicating that *E. natalense, P. obliquum* and *M. grandis* can be grown and their market value improved with ease on-farm through agroforestry. Although only these three indigenous tree species are studied as examples of high value indigenous trees, considerable potential exists among other indigenous trees for integration into the subsistence farming system through agroforestry. Therefore, successful development and promotion of agroforestry is likely to enable the resource-poor rural households to address their tree resources needs and also contribute to easing resource-use pressure on the indigenous forests by initiating on-farm tree cultivation. Nevertheless, the selected measures should be complemented with appropriate policy and research initiatives.

CHAPTER 7:

SUMMARY AND RECOMMENDATIONS

7.1 Summary

The degradation and decline in indigenous forest resources is of increasing local concern. Indigenous forests are an integral part of the livelihoods of the rural households in Umzimvubu District and similar areas of South Africa. They are valuable for the fuelwood, food security, medicinal plants, building materials, forage, employment opportunities and enhancement of environmental resilience, that they provide. The ongoing degradation of indigenous forest constitutes a direct threat to the quality of life of the resource-poor rural households who directly depend on them and on ecological integrity. Declining tree resources, particularly the high value indigenous tree species, are caused by increasing subsistence demands from a rapidly growing population, and influences from competing land use types and socio-economic needs. It is clear that the management of the various tree products and services from indigenous forests must be altered to ensure their sustainable use. Furthermore, sustainable forest management should not be just by legislation and law enforcement, but by alternatives which imitate characteristics of a natural environment and address rural household's socio-economic needs, for example, agroforestry. Therefore, it is imperative that rural households should become the most important stakeholders in on-farm tree growing initiatives.

Agroforestry is recognised as an alternative land use management system. Agroforestry offers a viable option to mitigate the decline and increasing demands on tree-based resources, for the benefit of the resource-poor rural communities and other land users at all levels in South Africa. Although the potential of agroforestry was recognised in South Africa many years ago, there is still much to be done for the benefit of the resource-poor rural communities within South Africa's own limits. Presently, the role of agroforestry is mentioned in South Africa's White Paper on Agriculture of 1995 and discussed in the White Paper on Sustainable Forest Development of 1997. It is assumed that agroforestry is embraced as part of the Community Forestry Programme in the National Forestry Action Programme of 1997. The agriculture and forestry interface that agroforestry provides, is a core component in optimising land productivity, improving the quality of life among rural communities and enhancing environmental resilience. The practice of agroforestry is gaining in importance. DWAF should enhance its capacity to initiate, coordinate and promote research and development in agroforestry.

It is widely recognised that integration of high value tree species into farm or arable lands through appropriate agroforestry systems diversifies and sustains on-farm production. This may alleviate increasing rural household socio-economic needs and ease resource use pressure on indigenous forests. There are many high value tree species with the potential for cultivation at farm level through appropriate agroforestry systems. The species *P. obliquum, M. grandis, A. karoo, V. lanceolata, T. emetica, H.caffrum and E. natalense* constitute the core farmer-preferred species in Umzimvubu District. The strongest argument for their cultivation is that people recognise their value, continue to use them and acknowledge their demand in large quantities. Therefore, such high value tree species merit improvement in quality and production capacity. Agroforestry is not an end in itself, but its proven on-farm systems and practices should be integrated with other interdisciplinary efforts to enhance local capabilities in agriculture.

Rural households are an important social resource in conserving indigenous forests. This was evident in the rich local knowledge of uses, values and sources of various of high value indigenous trees by rural households of Umzimvubu District. Understanding local people's values and perceptions is essential for successful implementation of agroforestry. Further, it clarifies and encourages the implementation of policy concepts, action programmes, institutional and socio-economic dimensions of agroforestry. However, simply having this kind of knowledge is not a guarantee to successful adoption of appropriate agroforestry systems and practices, but does result in an enlightened people who are capable of making well informed decisions about sustainable land management and resource use.

Land issues presents a challenge to rapid development of agroforestry in Umzimvubu District and similar areas in South Africa. Although it may not be practical to bring about a radical change to the current situation, the on-going land reform process should be flexible enough to permit inheritance and set land ownership to evolve towards greater tenure security.

Some of the best tree planting and conservation efforts are found in small areas within homesteads where land ownership is relatively secure and owners are prepared to invest in relatively long-term resources like trees.

The challenges to promoting and developing appropriate agroforestry systems and practices at farm level are many but can be resolved. They include; institutional, technical, socio-economic and ecological challenges. Most of these continue to hinder initiatives for agroforestry development in Umzimvubu District and similar areas of South Africa.

The need to develop and implement appropriate agroforestry development strategies and approaches is imperative. The strategies include; revision of the Community Forestry Programme to incorporate agroforestry, institutionalisation of agroforestry, inter-institutional collaboration, integrated extension services, capacity building for technology development and research, intensified research, public sensitisation, integration of relevant agroforestry curriculum in education and training institutions, development of appropriate incentives, and development of appropriate processing and marketing systems for agroforestry products. Successful implementation of agroforestry in Umzimvubu District and similar areas in South Africa will depend on how well these strategies are conceived and articulated by the key stakeholders. Furthermore, the need to accelerate the pace of institutional reforms in the agricultural, forestry and rural development sectors is of importance in sustainable agroforestry development.

Agroforestry by its nature is multi-disciplinary and multi-institutional. Furthermore, agroforestry is subject to fragmentation, duplication and competition if uncoordinated as experienced in the regions where it is commonly practiced. Therefore, there is a need for a strong and special institutional arrangements that will provide coordination, research and development focus and linkages to contribute to establishment of self-sustaining agroforestry programmes at all levels.

The process of promoting agroforestry research and development would be difficult without depending on research initiatives. Research is needed to generate low-input on-farm technologies for subsistence farming systems in South Africa. Research areas should include: i) strengthening understanding of the mechanisms and interactions underlying the performance of trees with crops and/or animals; ii) solving practical problems to improve on-farm production systems, iii) adapting and assessing the generated low-input on-farm technologies to local conditions, and iv) on-farm resource use and equity issues. The highest demand for research results is expected to come from academic institutions, extension staff in government and non-governmental organisations and other interest groups. The results would contribute to: i) improved on-farm production capacity, ii) improved attributes of the tree which people value, iii) development of on-farm agroforestry management guidelines, iv) enhanced income and employment opportunities, v) improved quality of life, and vi) enhanced ecological integrity.

The Government agricultural and forestry extension services delivery capacity are still detached from the subsistence realities, needs and priorities of the resource-poor rural households in Umzimvubu District. Umzimvubu District is one of the 371 Magisterial Districts in South Africa, however, it does not have any forestry extension staff to promote on-farm tree planting activities. This may be due to the shortage of staff in forestry extension who are about 70 in number, to cater for the whole country. Furthermore, the extension staff lack expertise and facilities to promote agroforestry. This implies that the Forestry Extension Services' capacity is still far short of the well trained staff and facilities needed to promote and develop agroforestry. Therefore, the need for capacity building within DWAF is imperative. In addition, DWAF should forge close linkages with DA whose staff strength on the ground is relatively exposed to extension activities, but who still lack expertise in agroforestry.

NGOs are important stakeholders in encouraging and supporting agroforestry development. The successful initiatives of NGOs (e.g., Master Farmer and Apprenticeship Programme in Port St. Johns) to introduce agroforestry among the resource-poor rural households is commendable. Similar NGOs and CBOs activities merits support to expand their agroforestry related activities.

Agroforestry information, education and training are critical factors in establishing a lasting capacity for agroforestry development in South Africa. It is evident that agroforestry as a viable land use management practice is set to gain grounds in Umzimvubu District and similar areas in South Africa. This is supported by a number of on-going self-initiatives at farm level and a recognition of its role in sustainable rural development. More revealing is the number of rural households (100%; N=43), in Umzimvubu District who were willing to learn more about agroforestry. Those trained will in turn train other interest groups, particularly, other households. This provides a compelling reason to invest in agroforestry information, education and training by academic institutions, relevant government departments and non-governmental organisations at all levels.

E. natalense, P. obliquum **and** *M. grandis* **in MTFR are not under different levels of exploitation**. However, they are all subject to similar external pressure of exploitation. This implies that any resource management guidelines for these species should consider MTFR as a unit.

The distribution of in *E. natalense* **MTFR indicates that it is a fine grained species.** This implies that the species can be exploited without long-term negative effects on it population if they are well managed.

The distribution of *P. obliquum* **and** *M. grandis* **in MTFR indicates that they are course grained species.** This implies that their regeneration occurs over a large spatial scale and hence require large tracts of land to sustain their populations. Therefore, integrating these species into subsistence farming systems through agroforestry in Umzimvubu District, stands to complement indigenous forest sources, sustain their population and provide opportunities for enhancing their quality.

E. natalense, P. obliquum **and** *M. grandis* **demonstrate most of the desirable agroforestry characteristics, uses and values for integration into appropriate agroforestry systems, for the benefit of the rural households and environmental resilience**. However, there is need to validate the desirable attributes, improve their production capacity and quality at farm level. This would enhance their acceptance and adoption by rural households.

Disparity in pricing policy of poles in Umzimvubu District, particularly MTFR does not favour indigenous tree resource conservation efforts at farm level and in the natural ecosystems. The price of poles from *Eucalyptus grandis* (Blue-gum) plantations was higher than those of, for example, *E. natalense, P. obliquum* and *M. grandis*, from the indigenous forest. These were R3.20 and R1.00 to R1.20, per pole, respectively. Such a pricing policy: i) does not favour conservation of indigenous trees in the forest valued for poles, ii) encourages illegal exploitation of indigenous trees for poles, iii) discourages buying of long straight and fast growing gum poles, and iv) discourages initiatives to integrate such species into the subsistence farming systems, among the rural communities in Umzimvubu District and similar areas of South Africa. There is a compelling need to harmonise pricing of poles from the two sources.

7.2 Recommendations

Incorporate Agroforestry into the National Forestry Action Programme. The concept of Community forestry in South Africa also relates to those activities which are at the interface between agriculture and forestry in the rural environment. It is imperative that DWAF incorporates Agroforestry as an integral component of Community Forestry. In this way agroforestry should evolve into Farm Forestry, which is much broader and more versatile.

Define Community Forestry sub-Programmes. Community Forestry Programmes should be clearly defined, for example, as Urban forestry, Agroforestry, Social forestry, Farm forestry and Service sub-Programmes. This would contribute to broadening the scope, understanding and benefits of each sub-programme. However, activities will need to be prioritised and re-structured as planning, training (education is the responsibility of academic institutions), promotional events (awareness), adaptive on-farm research (research), seed supply, seedling production (plant supply) and information and advisory services (service provision).

Involve DA in Promoting Agroforestry. The activities of the agriculture sector in South Africa also influence those that interface between agriculture and forestry in the rural environment. Therefore, DA should broaden its mandate to include agroforestry. It should work in partnership with all relevant agencies willing to improve the quality of life among South Africa's resource-poor rural communities.

Establish a specially integrated institution within DWAF or a Council to coordinate, encourage and support all aspects of agroforestry research and development in South Africa. The efforts of such an institution should lead to the establishment of prioritised self-sustaining agroforestry programmes for each specific case, among rural households and institutions.

Involve Households in conserving and integrating high value trees at farm level through Agroforestry. It is imperative that rural households play an important role in conserving and integrating high value trees at farm level. Such practice is expected to ease pressure on indigenous forest resources at different spatial scales, diversify on-farm production and improve household income opportunities. The strategies and mechanisms to enhance awareness and inculcate a culture of tree planting among the resource-poor farmers and relevant agencies, remains a major challenge to any endeavour in promoting agroforestry in Umzimvubu District and similar area in South Africa.

Investment in agroforestry information, education and training is imperative. This should bring about technical change and sustainable management of the desired resources in the forestry and agriculture sectors. The highest demand for knowledge and skills is expected from professionals, technical staff in extension, interested groups and the rural households.

Improve extension services performance through an integrated approach. The relevant areas to reach out to stakeholders include: inter-institutional collaboration; enhanced linkages; networking; improved relationship with rural communities through involvement and participation of the households in the processes; joint planning, public sensitisation and training activities; and encourage horizontal and participatory management systems at all levels.

Promote adaptive on-farm research in prioritized areas of agroforestry. This requires considerable flexibility and ability to adapt to technical and institutional changes so as to;

evaluate compatibility, productivity, sustainability, and develop better understanding of agroforestry adoption processes, and create awareness of successful interventions at all levels.

Generate and validate tree-specific information for the high value indigenous trees for on-farm cultivation. The specific research areas for *P. obliquum, M. grandis* and *E. natalense* should include, physiology, reproductive biology, phenology, propagation and product improvement.

The other areas which merit attention include: i) development of appropriate marketing systems and incentives for agroforestry and ii) a comprehensive survey to determine the stocking capacity of *P. obliquum* in MTFR, which is one of the most harvested and extensively used indigenous tree species in Umzimvubu District.

Finally, the agroforestry potential covered in this study is in no way exhaustive. However, it comprehensively represents and recommends agroforestry as the way forward into the next millennium for the benefit of resource-poor rural households in Umzimvubu District and similar areas in South Africa, and that DWAF should promote this drive.

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9.0 LIST OF PERSONAL COMMUNICATIONS (pers. comm, 1998)

Name	Address	Remarks
1. Marlene Powell	Tel/Fax: (047) 564 1351 Port St. Johns.	Conservationist
2. David Russell	c/o "The Glass House" Port St. Johns.	A white S. African "Inyanga" Trainee.
3. Vinny	Port St. Johns	Long-time Vehicle Mechanic Ex-farmer in Port St. Johns
4. Wilson Z.M. Xhanagayi	P/Bag X 1058, Port St. Johns. Tel: 0827518401	Tombo Rural Development Centre (TRDC).
5. Prof. Fredericus H.J. Rijkenberg	Faculty of Agriculture University of Natal Pietermaritzburg.	Dean
6. Mr. Graham von Maltitz	Environmentek-CSIR P.O. Box 395, Pretoria 0001.	Business Area Manger
7. Mr. Richard Bolus	Agroforestry Development Services - MFAP.	Programme Coordinator.

10.0 APPENDIX I: FIELD SURVEY QUESTIONNAIRE (FARMERS)

GENERAL INFORMATION

1. Date of interview............................ 2. Interviewer number...

3. Location...4. Village...

5. Interviewee number..........................6. Gender_____(Male)............Female.....................

7. Interviewee's age (years). 16-25......26-35......36-45........46-55......56-66.......above 66.........

8 Type of household Male-headed............Female-headed..............

9. Size of the household (no.)....................

10.Are there members of the household who live or work elsewhwere? Yes........No.........

If yes, how many?.............

11. How many household members have had:

primary education...........secondary/high school education...............

tertiary education.............adult literacy classes...................

12. What are the household's sources of income? salary.........wages..........pension..................

farm products..........small-scale business (e.g. vending)..........others (specify).............

LAND TENURE AND LAND USE TYPES

13. How long have you been settling on this land?..

14. How did you acquire the land you are settling on?

inherited (customary).........................squatted...

rented....................................allocated by traditional chief................................

communal.............................land redistribution..

others(specify ....

15.Do you have access to, and control of any other land? Yes...........No...............

If yes, what do you use it for? cultivation...........grazing..........woodlot..........collecting fuelwood...........source of muthi...........homestead............fallow.........others (specify)..........

16. Do you have any other land where you have only access to, but no control? Yes......No........

If yes, please specify who controls it and under what conditions..

17. Who makes decisions about the household's use of resources, e.g. which parcel of land, tree, crop, livestock, etc., to use, grow or sell?...

18. How does your land use activities compare with your neighbours in the area?

farm plan.......................(state) low.........medium..........high.............

type of activities...........(diversity) low.........medium..........high..............

soil fertility....................(state) low.........medium..........high..............

soil conservation...........(state) low.........medium..........high..............

indigenous trees on the farm (abundance) none.......few........many...........

fruit trees on the farm (abundance) none.......few........many...........

FARMING PRACTICES AND TREE RESOURCE USE

19.What type of farming system do you practice?.

subsistence............commercial...........mixed.............others (specify).....................

20. Which are the most important crops that you grow on your farm?

food crops..

....

cash crops..

....

21. Do you harvest enough crops to use? Yes..............No...............

22. Do you harvest enough crops to sell? Yes..............No...............

23. Do you encounter any problems in crop production? Yes................No............

If yes, how do you solve them?...

....

....

If no, please state the reason(s)...

....

....

24. Do you keep livestock? Yes..........No..........

If yes, please specify by type. cattle..........sheep......goats.........donkeys.........poultry........ pigs..............others (specify)...............

25. How do you feed your cattle, sheep or goats? free range........tethereing.........

zero grazing..........paddocking.........others (specify)...........

26. Do you encounter any problems in keeping livestock? Yes........No........

If yes, list them...

....

....

27. How have you tried to solve the above problems?...

....

....

28. What form of energy do you use for cooking and heating?

Form	Quantity per month	Cost (R)	Source
paraffin (kerosine)......	....	....	....
coal............................	....	....	....
fuelwood....................	....	....	....
charcoal......................	....	....	....
gas (methane).............	....	....	....
agricultural waste........	....	....	....
others (specify)...........	....	....	....

29. What are the common uses of trees in your area and farm?

....

....

....

....

30. Are they readily available in the desired quantities? Yes..........No...........

Please state why..

....

....

31. Do you use indigenous trees as muthi for your medicinal needs? Yes...........No.........

32. Where do you get trees or tree products for your various uses?...

33. How far do you travel to get them (km)?............................

34. What are the most important indigenous tree in your area or farm? Please specify as follows:

Local name (species)	Purpose(s)	Status		
		Decreasing	Same	Increasing
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

35. Rank the species according to importance: 1=most important; 2=very important; 3=important; 4=fairly important; 5 least important.

1........................2......................3........................4........................5........................

6........................7......................8........................9.......................10.......................

36. Do you see any value in planting high value indigenous trees? Yes.........No...........

Please state why..

....

37. Which of the indigenous trees mentioned above would you be willing to plant in your farm if you are advised on how to plant and care for them?

1........2.........3.........4.........5........6........7..........8..........9.........10

38. Have you planted any tree(s) on your farm? Yes...........No............

Please list them and state why as follows:

Local names (species)	Number	Purpose	Where planted

39. Have you deliberately conserved or retained any indigenous tree(s) on your farm?

Yes.........No.........

40. Where do you get seedlings and advice on tree planting and care?

Department of forestry......... Department of agriculture.........Local NGO.........

Commercial farm..........Local tree nursery......... Raised by self........ others (specify).......

41. Do you have any traditional belief or taboo about tree planting, cutting or use?

Yes...........No...........

If yes, please specify those that encourage tree planting and conservation.......................

....

....

And specify those that discourage tree planting and conservation..

....

42. Are the Departments of Agriculture and Forestry aware of your problem in crop production, keeping livestock, need for soil conservation, need for forest products, etc? Yes........No...........

Please state why..

....

LINKING HOUSEHOLDS TO AGROFORESTRY

43. Have you ever heard of a land use system referred to as "agroforestry"? Yes........No.........

44. If no, would you like to learn about agroforestry? Yes.........No..........

If yes, from whom?...

45. How do you feel about growing your most important indigenous trees within your farm in the open spaces as you grow food and cash crops, graze your livestock, improve the productivity of your land and diversify your production from the farm by using agroforestry practices?..

....

46. Do you see any difficulties in practising agroforestry on your farm? Yes ....No..........

Please state why..

....

....

47. Would you recommend agroforestry to your neighbours? Yes.........No...........

Please state why...

....

....

48. Suggest how agroforestry can be promoted if more people are to practice it.

....

....

Thank you

11.0 APPENDIX II: FIELD SURVEY QUESTIONNAIRE (ORGANISATION/KEY INFORMANT)

GENERAL INFORMATION

1. Date.......................... 2. Interviewee...............................

3. Organisation/Department..

4. Position...5. Gender: Male.............Female............

6. Postal Address...

7. Tel:.................................8. Fax:.................................9. e-mail...........................

STATUS AND PROSPECTS

11. What is the nature and aim(s) of your organisation?...

....

....

....

12. What activities does your organisation do to achieve its stated aim(s)?

....

....

....

13. Is agroforestry one of your programmes? Yes.............No..................

If no, does your organisation see any value in promoting agroforestry in your region/South Africa among the:

a) resource-poor rural communities?...

....

....

b) relevant government departments/institutions (e.g. agriculture, forestry, colleges) etc.?...

c) relevant private, non-governmental and community based organisations?

....

If yes, please specify the strategies you are using to achieve this goal.................................

....

....

14. Does your organisation have an outreach programme/project or study area to demonstrate research and development activities in agroforestry? Yes...........No...........

Please state why.

....

....

....

15. Are there any non-governmental organisations (NGOs) or community based organisations (CBOs) you are aware of involved in promoting agroforestry (or social forestry, community forestry, agriculture, energy conservation, permaculture, soil and water conservation, etc.)?. Yes...................No.....................

If yes, please list (since 1994) as following: (or attach any useful references)

Organisation Activities Location Year Comment (if any)

....

....

....

....

16. Does your organisation see any value in using agroforestry practices to promote planting, management, conservation and sustainable use of high value indigenous trees around homesteads/yards/gardens in the rural areas? Yes...........No.............

Please state

why..

....

....

17. Are there any factors your are aware of that are constraining the willingness and ability of your organisation or others relevant organisations to promote agroforestry?

Yes...........No..........

Please state why..

18. Are there any factors your are aware of that are constraining the willingness and ability of farmers, particularly in the rural areas to practice agroforestry? Yes..........No............

Please state why...

....

....

19. Please suggest how you are or would like to see the stated constraints addressed.

....

....

....

20. Does your organisation conduct short intensive in-service courses, workshops, seminars, or promotional events in agroforestry for staff or other relevant groups (teachers, farmers etc.) at professional, technical and grassroots level? Yes.......No.......

Please state which important aspects of agroforestry are covered or you would like them to be exposed to.

....

....

....

....

21. Are you aware of other organisation(s)/institution(s) which are involved in conducting courses at degree, diploma or certificate level?. Yes.........No........

Please list them...

....

....

22. Is your organisation/institution a member of any international or national agricultural/forestry/agroforestry related organisations? Yes..........No...........

If yes, please list the organisation(s)/institution(s) and area of collaboration.

....

....

23. Are there any policy reforms in place or proposed by your organisation that will ensure a

strong performance of agroforestry among resource-poor farmers in the rural areas in Eastern Cape/South Africa? Yes.............No..............

Please specify..

....

....

24. Does agroforestry have a "home" or a specific lead organisation to oversee its promotion and development in Eastern Cape/South Africa?. Yes...............No...............

If yes, please specify (name the organisation(s))..

....

....

If no, please suggest how it should be institutionalised (established, mission, activities, coordination, funding and evaluated)..

....

....

....

25. Any other comments on agroforestry..

....

....

Thank you.

12.0 APPENDIX III: ECOLOGICAL SURVEY DATA

Summary of data on seedlings, saplings and mature trees of *E. natalense* in MTFR derived from Modified Whittaker Plot Design.

Table 1a. Zone 1: Moderately exploited or near forest office

Location Attributes		Sub-Plot values								Hectare values		
Forest Block	Plot No.	No. of SE 1 m^2 subplots		No. of SA 10 m^2 subplots		No. of MT in 1000 m^2plot	SA dbh (cm)	MT dbh (cm)	Stump dia. (cm)	No. of SE ha^{-1}	No. of SA ha^{-1}	No. of MT ha^{-1}
		10	$\bar{x}$	2	$\bar{x}$							
Pembeni	1	28	2.8	4	2	11	6.8	13.8	0	28000	2000	110
Pembeni	3	15	1.5	1	0.5	7	7.2	13.5	0	15000	500	70
Silaka	4	21	2.1	0	0	0	0	0	0	21000	0	0
Sonkwe	5	22	2.2	2	1	5	5.2	19.5	0	22000	1000	50
Sonkwe	6	42	4.2	1	0.5	16	9.6	20.5	0	42000	500	160
Pungane	7	67	6.7	2	1	8	6.4	22.5	0	67000	1000	80
Pungane	17	38	3.8	1	0.5	8	5.1	18.2	0	38000	500	80
Ntswentswe	10	12	1.2	1	0.5	5	6.5	24	0	12000	500	50
Ntswentswe	14	44	4.4	1	0.5	16	8.5	19.3	14.9	44000	500	160
Ntswentswe	24	15	1.5	4	2	6	7.6	14.6	0	15000	2000	60
Ntswentswe	29	13	1.3	2	1	18	7.5	13	0	13000	1000	180
Ntswentswe	30	21	2.1	3	1.5	10	7.1	13.1	0	21000	1500	100

(Cont./d)

Zagwitye	12	52	5.2	1	0.5	5	5.1	15.4	0	52000	500	50
Nositemu	13	27	2.7	2	1	6	7.5	12.7	0	27000	1000	60
Nositemu	33	14	1.4	0	0	0	0	0	0	14000	0	0
Bulolo	25	27	2.7	5	2.5	13	6.6	15.1	0	27000	2500	130
Bulolo	26	15	1.5	5	2.5	18	7.5	19	0	15000	2500	180
TOTAL [1]		473	47.3	35	17.5	152	-	-	-	473000	17500	1520
Mean values		27.8	2.78	2.1	1	8.9	6.9	16.9		27823.5	1029.4	89.4

Table 1b. Zone 2: Heavily exploited or areas adjacent to the villages

Location Attributes		Sub-Plot values								Hectare values		
Forest Block	Plot No.	No. of SE 1 m^2 subplots		No. of SA 10 m^2 subplots		No. of MT in 1000 m^{2}plot	SA dbh (cm)	MT dbh (cm)	Stump dia. (cm)	No. of SE ha^{-1}	No. of SA ha^{-1}	No. of MT ha^{-1}
		10	$\bar{x}$	2	$\bar{x}$							
Gxwaleni	2*	117*	11.7	1	0.5	22	5.1	21.2		117000	500	220
Gxwaleni	18	45	4.5	0	0	1	0	25	0	45000	0	10
Gxwaleni	19	17	1.7	1	0.5	7	8.8	23.2	12.7	17000	500	70
Gxwaleni	21*	24	2.4	8*	4	36*	9.3	15.7	11.3	24000	4000	360
Ntsonga	8	34	3.4	2	1	4	5.3	19.6		34000	1000	40

(Cont./d)

Ntsonga	9	10	1	0	0	1	0	18.1		10000	0	10
Sonkwe	11	14	1.4	0	0	6	0	18.9		14000	0	60
Sonkwe	20	8	0.8	1	0.5	1	7.4	21.1	0	8000	500	10
Sonkwe	28	4	0.4	1	0.5	5	5	17	0	4000	500	50
Ngogo	15	21	2.1	0	0	15	0	17.7	12.7	21000	0	150
Ngogo	16	14	1.4	1	0.5	10	5.1	22.2	14.8	14000	500	100
Peshlua Dip	22	4	0.4	1	0.5	1	5.1	11.1	0	4000	500	10
Khovoti	23	6	0.6	0	0	0	0	0	0	6000	0	0
Mbiza	27	0	0	1	0.5	0	7	0	0	0	500	0
Bulolo	31	0	0	0	0	1	0	11	0	0	0	10
Bulolo	32	4	0.4	0	0	6	0	13.2	0	4000	0	60
Kobemnyango	34*	0	0	0	0	0	0	0	0	0	0	0
TOTAL [2]		322	32.2	17	8.5	116	-	-	-	322000	8500	1160
Mean values		18.9		1	0.5	6.8	6.5	19.6		18941.2	500	68.2

* unusual observations