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BIOMASS INITIATIVE - APPENDIX 1
NATIONAL ENERGY COUNCIL:
ENERGY FOR DEVELOPMENT DIVISION

POLICIES AND APPROACHES TOWARDS AFFORESTATION AND THE PROVISION OF FUELWOOD IN DEVELOPING COUNTRIES

LESSONS FOR SOUTH AFRICA

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PREFACE

Fuelwood provision has often been ignored in developing countries and no more so than in South Africa. Fuelwood, in comparison with other forms of energy, plays a minor economic development role in a country like South Africa which produces 60% of Africa's electricity. National issues such as oil and electricity have great economic implications particularly towards industrialisation, and as a result, policies for these have been formulated.

In spite of this high level of development, many people, notably the poor, use wood as their main source of fuel. Many organisations have recognised the need to address this problem but no general policy has been formulated. The problem has been compounded by the differing viewpoints of the large number of government bodies within the homeland system; this is itself inhibits any collective effort.

Most of these government departments have attempted afforestation programmes and have mainly concentrated on the Eucalyptus woodlot model. There has been little thought of alternatives in spite of a generally poor response to the programmes. Most have resulted in expensive failures and there is apparently no viable solution to the problem. Most of these issues are discussed in an accompanying volume on the status of afforestation and woodfuel provision in South Africa.

As pointed out in this report, the absence of reliable sources of cheap energy for the poor have much wider implications to the country than is generally recognised. Shortages of energy adversely affect agricultural production, health of the poor and the environment which together not only entrench poverty but also have dire implications for the national economy. Poor people tend to be under-productive and generally a burden on a developing economy. For South Africa to attain a satisfactory growth rate, a stable and productive rural economy must first be created. This cannot be achieved in the face of severe energy shortages and environmental destruction.

Therefore, the energy crisis of the poor can no longer be belittled in comparison with other energy issues and a national policy is urgently required.

This report was commissioned by the National Energy Council which has recognised the need for a national policy for fuelwood provision for South Africa. It also deals with afforestation issues because of its close association with fuelwood provision. The wealth of experience in other developing countries which amounts to many years of combined exposure is also investigated. The reason for doing this is to identify the key ingredients for both success and failure so that a policy for South African conditions can be formulated with a sound basis for success.

It is not within the terms of reference to create an actual policy since this must involve a wide range of specialists and organisations. The report will lay the foundation from which this can be achieved.

The report is based on both the author's direct experience together with a comprehensive literature study of relevant publications.

EXECUTIVE SUMMARY

The developing world is experiencing rapid rates of deforestation and with it, high rates of desertification, soil erosion, and river and dam siltation. All forest types are affected, but particularly open savanna vegetation.

Deforestation can be a result of excessive commercial extraction of forest products, clearance for agriculture, overgrazing or harvesting for woodfuel.

Woodfuel is often termed the survival fuel since most poor people of the third world rely heavily on it simply because it is usually freely or cheaply obtained from surrounding woodland areas.

Some 90% of the third world population relies on wood as a source of fuel and deforestation is undermining this major source. Fuelwood shortages have accompanying environmental and social implications that mainly effect the poor. These implications result in entrenched poverty which is of both national and international concern.

In spite of the fact that agriculture contributes up to 90% of the GNP in many third world countries, most international aid has been directed at industrial development. Afforestation has only received a small proportion of the total agricultural component.

Initial attempts at rural afforestation and woodfuel provision by international aid and funding organisations suffered a high incidence of failure. These initial attempts were based on western approaches to commercial afforestation, namely plantation forestry.

Many projects suffered from low yields and low returns and had little community involvement. They also competed with other land uses particularly agriculture which adversely affected local communities. Not only did the projects have little community participation but they generally created much animosity among the people they were meant to help. Other major contributing factors leading to the high failure rate were the over-estimation of fuelwood demand and over-prioritising the fuelwood crisis in rural life. In addition, the monopurpose role of plantation forestry was not appropriate to rural needs.

In response to this high failure rate, many organisations altered their overall strategies and concentrated more on farm and community forestry together with agroforestry. In addition, greater emphasis was directed at individuals rather than communities. A higher proportion of aid (30%) was directed at farmer and extension training and institution building.

These changes in approach are beginning to pay dividends in the form of greater response amongst rural communities. Selected projects in Africa, Asian-Pacific and Central America are discussed and compared.

The major lesson to be learned from these case studies is that it takes many years to obtain any degree of sustainability, particularly in difficult climatic conditions. Many project staff are under pressure to obtain rapid results for sponsors but this can adversely affect the overall success of the project.

Projects must also respond to local needs and must incorporate communities in all stages of a project, particularly in the planning and implementation stages.

Many afforestation programmes have been designed on the presumption that the high demand for woodfuel is the major cause of deforestation. Deforestation rates have been estimated and large timber plantations planned. However, recent information has revealed that clearance for agriculture is the main cause of deforestation and therefore many programmes have dramatically over-exaggerated the required area necessary for woodfuel provision.

Another problem is that foresters normally view woodfuel production in terms of wood per hectare and take no account of individual farm trees which, in most cases are more than five times more productive than closely spaced individual plantation trees.

People will not plant trees just because there is a fuelwood shortage or because environmental degradation threatens their existence. The most important motivation for tree planting by rural communities and individuals is rapid financial benefit. One of the main problems is that growing trees where they are most needed, in harsh degraded conditions, is often not financially viable, particularly in the short term. To compound this problem, woodfuel often fetches low prices on the open market and in most countries woodfuel prices have deteriorated in spite of increasing shortages. It is therefore no wonder that rural communities and individuals do not plant trees under such circumstances.

Only where there is a large urban population nearby with a high demand for fuelwood, can woodfuel production become commercially attractive.

It is now very clear that an indirect rather than a direct approach is required to solve the woodfuel crisis. Agriculture is a major economic or survival activity in most rural communities. Therefore, if as a result of tree planting, agricultural production can be increased, the project has a much greater chance of success. Agroforestry, which is the cultivation of trees together with crops and animals/pastures, does just this, and is therefore vital for both sustainable agricultural development and rural fuelwood provision.

As a result of recent successes with agroforestry, it is now considered to be the single most important discipline for sustainable development in Africa. Unfortunately, agroforestry has not yet received a high level of research support and there are many gaps in existing knowledge on the subject.

Common factors leading to success include a high degree of community involvement which has usually been assured through the creation of institutional structures; appropriate extension techniques involving schools and demonstrations; and incorporation of women into the decision-making and implementation structures.

The level of success or failure of any afforestation programme, should not be gauged solely on the total number of trees planted but on the level of sustainability. The prime aim of any programme should be towards training and infrastructural development so that when the time comes for the withdrawal of programme support, activities will continue on their own.

To date, Africa has fared worse than any other continent in terms of programme failure and there are no clear-cut answers to this problem. Since independence, many African countries have been torn apart by internal feuds and corruption which does nothing for creating a successful medium for coordinated action. In addition, climatic and soil conditions are generally more harsh than in say, Asia, where a higher success rate has been achieved. But the most significant factor contributing towards this depressing situation is the poor communication and road network infrastructure in Africa. Africa is considered to be sparsely populated in comparison with other continents and this has reduced the need for intensive agriculture. In Asia, long ago, high population densities forced people to farm on less land. In most cases where there has been a need to intensify agriculture through high population densities, large number of trees have been planted. This is illustrated in the most populated regions of Africa, such as Rwanda and the Central Highlands of Kenya, where vast numbers of trees are cultivated on individual small farms.

South Africa has much to learn from these experiences because, even today, many people see the answer to solving the fuelwood crisis as the establishment of large eucalyptus plantations. Although South Africa differs considerably from other African countries in its level of economic development basic strategies will still have to be the same. One of the most decisive factors limiting South Africa's potential to become the "Japan" of Africa is rural poverty and the associated degradation of natural resources and the limited supplies of affordable energy for the poor.

Government policies to create the necessary incentives for both sustainable agricultural development and the provision of reliable cheap and renewable energy supplies will go a long way to promoting the necessary medium for the rapid development that South Africa so needs.

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PART 1: BACKGROUND TO THE FUELWOOD CRISIS

1. DEFORESTATION AND THE FUELWOOD CRISIS

1.1 THE RATE OF DEFORESTATION

The rate of world deforestation has been estimated to be approximately 12 million ha per year (Myers, 1985).

Most deforestation is occurring in the tropics and is confined to the third world. Table 1 shows average annual deforestation rates for the 1981-85 period. The table indicates that Africa is in the most serious position.

TABLE 1
AVERAGE ANNUAL DEFORESTATION RATE (1981-85)
('000 ha)

REGION	CLOSED FORESTS	OPEN FORESTS	TOTAL	%	PLANTATION DEFOREST--ATION RATIO
ASIA (EXCL. CHINA)	1 830	190	2 020	0.60	1:4.5
AFRICA	1 380	2 350	3 730	0.52	1:24.5
LATIN AMERICA	4 240	1 270	5 610	0.63	1:9.4
TOTAL	7 500	3 810	11 310	0.53	1:9.4

(Adapted from Gilluson, 1985)

Future projections based on population growth and present deforestation rates are of even greater concern. It has been predicted that by the year 2000,only 7% of the land will be covered by tropical forest compared with 30% in 1950 (Myers, 1985).

1.2 CAUSES OF DEFORESTATION

1.2.1 Commercial Extraction

Approximately 4.5 million ha of forest is cleared and destroyed by commercial logging annually. Most of the loss occurs in S.E. Asia (Myers, 1985).

Logging operations only use about 50% of the timber felled. This is a vast waste of resources. A high proportion of tropical timbers are exported to Japan, which is now coming under considerable pressure from environmentalists. Timber is sold by third world countries to generate much needed foreign exchange.

1.2.2 Clearance for agriculture

The clearance of forest for agricultural development is also a major cause of deforestation, accounting for 2.5 million ha/year in Latin America alone (Myers, 1985). Much of this deforestation is undertaken for extensive cattle range development so that developing countries can supply North America with beef, again, in order to earn foreign exchange (Timberlake, 1987).

1.2.3 Fuelwood Collection

The proportion of deforestation solely for fuelwood use is very difficult to measure but, as an indication, the amount of fuelwood consumed is roughly equal to the total amount (by volume) used for industrial purposes. This is illustrated in Table 2 which shows global wood consumption for developed and developing countries and compares fuelwood and industrial consumption patterns.

TABLE 2
GLOBAL WOOD CONSUMPTION -
TOTAL CONSUMPTION (1980) = 3159 MILLION M3

	DEVELOPED COUNTRIES	DEVELOPING COUNTRIES	TOTAL
INDUSTRIAL WOOD	35%	10%	45%
FUELWOOD	7%	47%	54%
TOTAL	42%	57%	100%

(Source: Adapted from Myers, 1985)

1.2.4 Overgrazing

Overgrazing in the sensitive savanna and open forest regions is an important factor in deforestation since it prevents natural regeneration of trees. In addition, desertification processes which accompany overgrazing seriously affect regrowth and production.

1.3 WOOD AS FUEL

Until the turn of the century, wood was a major source of fuel in the world economy. Today, the importance of fuelwood has somewhat diminished and mostly confined to the third world countries. Table 3 shows the importance of biomass (which is mostly fuelwood) in both developing and developed countries as a source of fuel.

TABLE 3
GLOBAL DISTRIBUTION OF ENERGY USE FOR 1980

	DEVELOPED COUNTRIES	DEVELOPING COUNTRIES
POPULATION (MILLIONS)	1 131	3 284
TOTAL ENERGY CONSUMPTION 10^9GJ (%)	225 (71)	92 (29)
ENERGY CONSUMPTION PER CAPITA (GJ)	199	28
SOURCES OF ENERGY: (%)		
OIL	45	29
NATURAL GAS	21	4
COAL	24	22
HYDRO/NUCLEAR	9	6
BIOMASS	1	39

(Source: Gilliuson, 1985)

Approximately 80% of energy used in developing countries is consumed by households, with agriculture consuming 5%, transport 20% and industry 25% (Gilliuson, 1985). Wood is a vital source of fuel for household purposes and estimates indicate that over 90% of the poor in developing countries use wood as source of fuel (Myers, 1985).

Wood is used by both rural and urban poor where it is used for heating, cooking and lighting. Wood is sometimes transported over great distances to regions of demand such as urban centres. In such cases it is sometimes processed into charcoal in order to reduce transport costs per energy unit.

The cost of firewood varies from country to country and is determined by a complex array of factors such as demand, availability, cost, alternative fuels and their availability. In most rural sectors, however, fuelwood is collected free from natural stands of trees and in most situations it is the cheapest form of energy. Table 4 illustrates this with an example from Kenya.

TABLE 4
FUEL COSTS IN NAIROBI IN 1981

FUEL	$US/GJ
WOODFUEL	1.18
CHARCOAL	2.91
KEROSENE	8.31
LPB (BUTANE)	13.16
ELECTRICITY	21.97

(Source: Gilliuson, 1985)

Very little information exists on consumption, resources, availability and distribution of fuelwood resources. Rough estimates indicate that per capita fuelwood consumption is 0.7-1.5 m3 per annum in developing countries and a "good" average is approximately 1m3 per capita per annum.

In regions with plentiful supplies of wood resources, consumption is considerably greater and conversely, in regions of shortage, consumption is considerably lower (Leach and Mearns, 1988).

Since fuelwood is used by the very poor, it is often referred to as the "people's fuel" or the "survival fuel". Table 5 shows fuelwood in relation to other fuels in terms of preference and efficiency.

TABLE 5 THE "FUEL PREFERENCE LADDER"

	BARRIERS TO CLIMBING LADDER		
FUEL	EQUIPMENT COSTS	FUEL PAYMENTS	ACCESS
Electricity	very high	lumpy	restricted
Bottled gas (natural gas)	high	lumpy	often restricted bulky to transport
Kerosene	medium to high	small	often restricted in low-income areas
Charcoal	medium	small	good dispersed markets and reliable suppliers
Firewood			
Crop residues/ animal wastes	low/zero	small or zero	as above, can usually be collected free

(Source: Leach and Mearns, 1985)

The "fuel ladder" can be complicated in and around urban areas where the rich sectors of society pay premium prices for fuelwood and charcoal for barbecuing (Evans, 1984). This is particularly so in countries such as Brazil and Mexico and is probably also true in South Africa. People are prevented from "climbing" the fuel preference ladder because of limited financial resources together with restricted availability of certain alternatives. Higher forms of energy require expensive appliances which are beyond the reach of the very poor.

This "fuel ladder" does not always operate in the order prescribed above since many communities still resist kerosene because of its foul smell and have a greater preference for wood as is the case in some urban sectors of Botswana (ERL, 1985).

From the current demographic growth patterns and the generally slow trends towards transition to other fuels, it is clear that the poor sectors of third world society will rely on wood as a source of fuel for the foreseeable future (Gilliuson, 1985; Myers, 1985; Leach and Mearns, 1988, Grainger, 1990).

Indications are that wood will play an ever-increasing role in the supply of energy for developing countries since it is unlikely that any other fuel will be able to replace wood, being a local, renewable and cheap fuel (Gilliuson, 1985).

Taking into account the rate of diminishing fuelwood resources and the increase in demand, fuelwood deficits will worsen with time. In 1980, the fuelwood deficit was estimated to be about 450 million m^3. In 2000, it is predicted that the deficit will be about 1000 million m^3 and if we dare to look towards 2025 the deficit will increase to some 2400 million m^3 (Myers, 1985; Gilliuson, 1985).

To overcome these deficits, the present supply of fuelwood (1980 figures) will have to be MORE THAN DOUBLED by the year 2000 in order to meet the demand (Gilliuson, 1985).

Judging by the present situation, this is very unlikely to occur and certain sectors of society will have to bear the consequences of this dilemma.

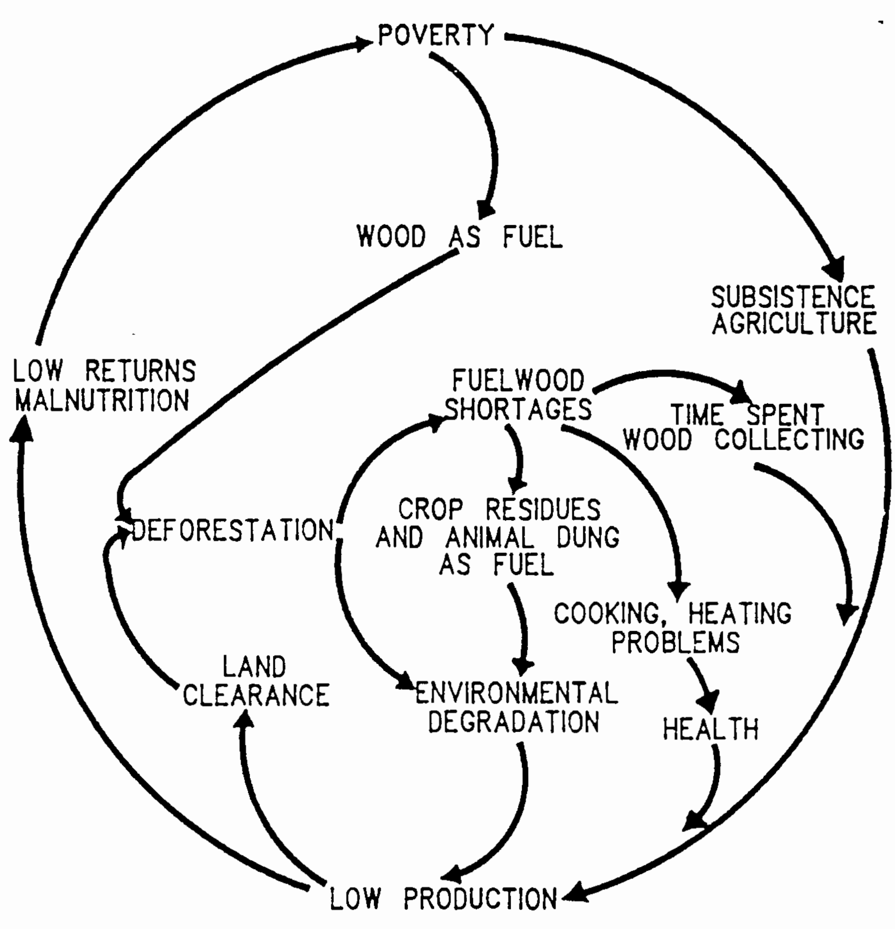
1.4 THE FUELWOOD CRISIS - WHO'S CRISIS?

Of the 2 billion people relying on wood as their primary source of fuel in 1980, some 70% do not have access to secure supplies and over 100 million experience acute shortages (Myers, 1985). This situation is most severe in the arid and semi-arid areas of Africa, the populated regions of Southern Asia and the mountainous regions of South and Central America (Myers, 1985; Canalis, 1985; Kaale, 1985; Charbonmier, 1985).

By the year 2000, about 2,7 million people or half the population of the third world will be dependent on wood as a source of fuel and 24 billion, or 89%, will experience acute shortages (Myers, 1985; Gilliuson, 1985; Leach and Mearns, 1988).

The fuelwood crisis has a cyclic effect in that poor people are continually confined in what is known as the fuelwood trap. Fig. 1 illustrates this cycle.

FIGURE 1: THE "FUELWOOD TRAP" AND IT'S INFLUENCE ON POPULATION DEVELOPMENT



It can be seen that shortages of fuelwood have many social and environmental implications which not only entrench poverty but also adversely affect the environment.

How has this situation continued relatively unnoticed by governments and international aid organisations?

"The" energy crisis, that of oil, caused a major collapse in world economies particularly in the 1970's. It affected mainly the affluent sectors of society and resulted in rapid reaction from most government departments. Ministries of energy were formed overnight and policies were enacted for fuel saving and alternative energy sources (Foley and Barnard, 1984; Munslow, et al, 1988).

Since the fuelwood crisis affects only the poor who have limited political influence, governments have tended to ignore the problem.

On the surface, it would seem that the fuelwood crisis only affects the poor sectors of society in developing countries or only those countries which have an agricultural economic base. Nothing could be further from the truth. Entrenched poverty which can be strongly linked to fuelwood/energy shortages, places a severe burden on any country's national development (Bennett and George, 1987; Harrison, 1979; Chambers, 1985). Poverty stricken people are more likely to be politically unstable, economically unproductive and have lower education levels. In addition, the environmental effects of fuelwood shortages associated with deforestation and poverty entrenchment have arguably global implications and this is therefore an issue which is not merely restricted to developing countries but which ultimately affects the entire world.

1.5 ENVIRONMENTAL IMPLICATIONS OF WOODFUEL SCARCITIES

The excessive cutting of trees for fuel has dramatic effects on the environment. Loss of tree cover results in greater surface evaporation rates, high runoff and poor water infiltration, high rates of soil erosion and destruction of wildlife and reduction in the diversity of plant species. These factors, in turn, have a negative impact on agricultural production, water supplies (through siltation of dams and rivers) and population development. In extreme cases, these effects lead to desertification and, ultimately, the reduction in the human carrying capacity of the land, which has even more dramatic implications on national development.

Desertification, as a result of deforestation, is particularly evident and widespread in the semi-arid regions of Africa where natural regeneration of indigenous vegetation is slow or irreversible after destruction. In areas with severe fuelwood shortage, the poor often use cow dung and crop residues as fuel. Since these are normally used to maintain soil fertility, if burned, a reduction in soil fertility and hence low crop yields can be expected. This in turn poses further social constraints towards food production. On a global scale, reduction in forest area and burning of forest resources has been linked to the "greenhouse effect" which may have dire repercussions for the whole world.

1.6 SOCIAL IMPLICATIONS OF WOODFUEL SHORTAGES

1.6.1 Labour Expenditure

As fuelwood supplies diminish, people must travel further and hence spend more time collecting wood.

A greater time spent collecting wood means that less time is spend on food production and other activities leading to increased earnings. Less time is thus available for improving agricultural techniques such as soil erosion control and general maintenance such as weeding. Many rural families now devote as much time to find fuelwood as to any other activity (Myers, 1985). These factors have implications leading towards malnutrition and denudation of natural resources.

1.6.2 Health and Malnutrition

Lack of fuelwood influences not only the type of food that is prepared for the family but also its quality. Generally, people will prepare less nutritious food when fuelwood is in short supply (Leach and Mearns, 1988; Grainger, 1988).

In addition, potentially polluted water supplies are not adequately boiled so that the chances of disease increase amongst the already disease-ridden poor.

In certain regions, shortages of wood may inhibit the provision of adequate heat in winter evenings, posing additional health risks.

As previously stated, excessive deforestation adversely affects agricultural production potential through increased soil erosion and poor water infiltration. Lower crop yields leads to less food being produced and hence greater incidences of malnutrition.

1.6.3 Retardation of Development

In situations where fuelwood problems exist, it becomes less likely that rural communities will ever have the opportunity to grow excess produce to sell and thus improve their standard of living. The end result is that fuelwood shortages prevent social development and, with the high population growth rate of poor communities, this situation can only worsen with time.

It is therefore stressed that fuelwood shortages, deforestation and the resulting socio-economic and environmental consequences are not just regional or national problems but are in fact global problems, especially when the recent evidence of the "greenhouse effect" is taken into consideration.

PART II : EXPERIENCE IN AFFORESTATION

2. HISTORY OF AFFORESTATION

Very little attention was paid to forest development before the 1970's. Before this period, colonial administrations were mainly concerned with timber extraction from indigenous forests and protection from "illegal" cutting by local peasants (Dumont, 1988). Foresters and forestry extension officers acted as policemen and were regarded as such by local peasants. At the end of colonial rule, which occurred in most of Africa in the early to mid 1960's, newly formed governments tended to adopt the same policies as their colonial masters (Dumont, 1988; Timberlake, 1986).

Both agricultural and forestry development was later based on Western technologies with high inputs through the use of fertilizers, pesticides and machinery, and high outputs in terms of crop yield. Monocultural plantations of both crops and trees were seen to be the answer to the third world's problem of under development (Richards, 1985; Dumont, 1988).

Sustainable forest management and home garden agriculture which was, and still is in some cases, the indigenous agricultural system, was seen by western experts as "untidy" and unproductive (Richards, 1985).

International aid organisations began to pump massive infusions of aid for development, although agriculture and forestry, typically rural development actions, received less attention than urban and industrial development (Chambers, 1985; Lipton, 1982).

Most rural development initiatives rarely considered local participation or consultation. Aid money was spend on capital requirements involving western machinery and agricultural and forestry technologies. As the funds ran out, so the projects soon collapsed. The third world consequently became even less developed - poverty and incidents of mass starvation increased as well as environmental catastrophes such as desertification and soil erosion. The rate of deforestation became uncontrollable and there was no sign of improvement (Timberlake, 1985; Harrison, 1987).

The western approach to agriculture and forestry can thus be seen to have failed, especially in Africa (Timberlake, 1985; Harrison, 1987). International aid organisations such as development banks persisted with plantation forest policies until the late 1970's (Spears, 1987).

Much of the blame for this present state of affairs must lie with the forestry training of both expatriate and local forestry officers. Training was given only in plantation forestry and subsequent recommendations from so trained specialists have proven to be inappropriate, especially for African conditions.

A certain degree of success was recorded in Asia, but little in Africa. In an attempt to reverse this trend, development agencies began to investigate indigenous agricultural systems and to work on methods to improve these systems.

Agroforestry was thus "born" and many agricultural and forestry programmes included agroforestry components. However, most funds allocated to forestry development were still spent on plantation forestry methodologies such as village community woodlots. Even today, many people still regard plantation forestry as the sole answer to solving fuelwood problems in developing countries.

During the last decade, forestry orientated programmes have received ever increasing amounts of aid, particularly for social forestry and agroforestry. In the Asia-Pacific region alone, there is in excess of US$665 million invested in community forestry programmes (Anon, 1988).

A higher proportion of the allocated aid is spent on extension training, research, natural resources, social surveys and farmer training than ever before (Spears, 1987). Forestry programmes now tend to be totally integrated as a component of rural development programmes instead of being implemented in isolation.

Another noteworthy trend is the greater flexibility of programme objectives allowing changes to accommodate reaction from local participants. Appendix 1 provides details of selected forestry and agroforestry projects worldwide, which highlight this change in emphasis on "development" forestry.

2.1 THE WORLD BANK EXPERIENCE

Since the World Bank is probably the largest single investor in third world forestry development, some discussion on policy changes of World Bank action is relevant.

The World Bank has had a very checkered history of afforestation development. During the last decade it has been accused of financing deforestation in the Brazilian Amazon and rainforests of Panama which has resulted in catastrophic environmental degradation

(Timberlake, 1987; Channel 4 T.V., 1990) and threatens national development in both countries. The World Bank has also been severely criticized for its lending policy towards developing countries. Great emphasis is placed on cash crops for export to generate foreign exchange so that the same loans can be paid off. Production of industrial cash crops therefore takes precedence over food crops. This can result in increased poverty amongst the already poor sectors of the population.

Criticism has also been made of the World Bank's general policy of only financing bankable programmes; in most cases this only benefits the wealthy sectors of third world society and can even negatively affect the poor (Bennett, 1987).

Because of this negative criticism, the World Bank has recently amended its policy, and, in future it will only finance sustainable programmes (Timberlake, 1987; Channel 4 T.V., 1990). This is reflected in increased financing of agroforestry projects from 6% to 37% of total Bank forestry investment (Spears, 1987). Criteria for the Bank's appraisal of agroforestry projects now goes beyond the project's economic return and includes sociological aspects, land tenure issues and ecological sustainability (Spears, 1987).

Of the US$750 million invested by the World Bank in agroforestry during the last decade, about 70% has been used for farm forestry or woodland management and 30% for education, training, extension and institution building activity (Spears, 1987).

The Bank does not now recommend the financing of woodlot development in African regions receiving less than 1 000 mm annual rainfall (Timberlake, 1985).

The Bank still recognises problem areas in its forestry development strategy such as cost recovery in marginal areas, forestry extension and in ensuring that the benefits reach the poorer sectors of the population.

Some of the World Bank sponsored forestry projects that have failed occur in semi-arid regions of central and West Africa. In Niger, 779 ha of fuelwood plantations were established between 1979 and 1981, consisting of 70% of neem (*Azadirachta indica*) and 30% *Eucalyptus camuldulensis*. Very low growth rates were attained because of poor soils (Grainger, 1990). No preliminary soil survey was undertaken for the project site!

Irrigated forestry was also tried in an attempt to supplement the urban fuelwood demand of Niamey, Niger. Problems with irrigation equipment and high costs of maintenance resulted in project failure (Grainger, 1990). In addition, it was estimated that the established irrigated *Eucalyptus* plantations produced less timber than the indigenous bushland that they had replaced (Timberlake, 1985).

During the period 1980-85, the World Bank funded another fuelwood programme for urban supplies, this time for the capital of Mali, Bamako. Only two-thirds of the intended area was planted and only uneconomic yields were ever attained (Grainger, 1990).

On the positive side, the World Bank has funded successful projects in the Philippines, India, Nepal, Zimbabwe and Sudan (Spears, 1987; Kerkhof, 1990).

The experience of the World Bank is immense and, although there has been much criticism and a high incidence of failures with some of its programmes, learning from mistakes and what to avoid is part-and-parcel of the process leading to the formulation of successful strategies.

The response by the World Bank towards past experience, has been not only to extend a greater emphasis towards training and extension but also to act upon the incorporation of forest technologies into, what are primarily, agricultural projects. Today the definition of what constitutes an agricultural project is becoming less clearly definable because of a more holistic approach to both forestry and agricultural development. This is clearly shown in Appendix 2 which is a list of the latest World Bank projects which include some degree of forest technology input. Forest initiatives are being incorporated into irrigation, land management, watershed protection and environmental programmes as a response to this new approach. The listed projects are at various planning stages at the time of writing.

3. REGIONAL EXPERIENCE

Many of the following country profiles and project descriptions have been previously reported elsewhere in numerous publications. The views expressed here are a combination of the author's field experience together with a combination of the various views expressed by other reporters. Some projects receive more than 2000 visitors per year. The duplications in reporting are therefore not surprising.

The degree to which each reporter considers a project to be successful also varies but the opinions expressed here summarise the overall opinion.

Case studies included in this report are based on relevance to South Africa in terms of climatic and social conditions and extension techniques. Many of the projects discussed are situated outside the African continent. Most of the project reviews are also discussed in Part III : Lessons from Experience.

3.1 AFRICA

3.1.1 Kenya - Agroforestry Development and Tree Planting

Kenya is the "home" of the International Council for Research in Agroforestry (ICRAF). Agroforestry as in many other African countries, is an indigenous practice in Kenya and the role of ICRAF has been to improve the state of knowledge on agroforestry and to coordinate information exchange.

The ICRAF agroforestry demonstration farm in the Machakos district is where much of the research takes place. It acts as a demonstration medium for decision-makers and overseas visitors and its impact has been relatively insignificant as far as the promotion of agroforestry to subsistence farmers is concerned.

However, with support from international aid organisations, regional demonstration centres, demonstrating a variety of agroforestry systems suited to each region, have been established for this purpose. These demonstrations have been designed on the basis of information from the ICRAF demonstration farm; there is thus a link between national and regional research. The impact of these demonstrations has been encouraging since many farmers surrounding the demonstration areas have adopted various agroforestry practices and have even developed some of their own (Fenn, 1986).

Farmers are not only able to see a whole variety of agroforestry systems for themselves but they are also able to purchase multipurpose trees at low cost.

In fact, agroforestry and tree planting have been widely publicised throughout the whole of Kenya with demonstrations at agricultural shows, posters, radio broadcasts and even statements from the president that every school in Kenya must have a tree nursery. Much of this promotion was carried out under the Kenya Woodfuel Development Programme (KWDP) which is primarily concerned with promoting tree planting through extension.

The results achieved through all these efforts have been encouraging. Tree planting amongst rural communities has been tremendous and many farmers have their own nurseries. Tree planting for purposes other than fuelwood has developed into a major practice and KWDP has responded by recently changing its name to "Kenya Woodfuel and Agroforestry Project" (Kerkhof, 1990).

Kenya has now reached the stage where the rate of tree planting by individuals is greater than the rate of trees being cut down (Harrison, 1987) a goal which very few countries in Africa can even hope to achieve within the next decade.

3.1.2 Rwanda - Project Agropastoral de Nyabisinda

Rwanda is one of the most densely-populated countries in Africa and is also very mountainous. Together these factors have placed enormous strain on the agricultural systems required to support the volume of people.

The project Agropastoral de Nyabisinda has been running since 1969 and is therefore on of the oldest agroforestry projects in Africa (Kerkhof, 1990; Cook and Grut, 1989).

The main aim of the project has been to promote tree planting and organic farming which was initially undertaken using model farms. However, these were found to have limited impact on surrounding communities. The project was then changed to village visits by extension officers. Coloured pictures depicting hedgerow planting, contour hedgerows, zero grazing, green manuring and mulching were shown to villagers. Nurseries were also decentralised and run under private management by local individuals (Kerkhof, 1990).

Intercropping with trees particularly *Grevillia robusta* is now common practice. Surveys revealed that before 1975 virtually no intercropping was practised. By 1983, the majority of farmers intercropped with trees (Kerkhof, 1990). Farmer surveys also revealed that 72% of farmers planted trees in cropland, 80% on contour lines and 73% in woodlots. A greater number of trees were planted per farmer in woodlots (Corsten, 1989).

Leguminous trees, however, have not been a popular choice amongst farmers, possibly because the high value of timber exceeds any benefits that leguminous trees can offer. (Trials on leguminous trees have shown significant increases in maize and potato yields).

Since most farmers have easy access to decentralised nurseries and have begun to reap the benefits of agroforestry, the sustainability of the project is almost secured.

Research into improved techniques is still underway as part of the project and it is likely that sustainability will further increase with time.

3.1.3 Egypt - Incorporation of Forestry into Irrigated Agriculture

Egypt is one of the poorest countries in the world in terms of natural forest resources. Most of the country is desert and the only areas of forest potential are those occupied by irrigated agriculture.

Egypt has been integrating agriculture and forestry for many years and has one of the most extensive windbreak systems of any developing country. Trees, mainly *Eucalyptus*, *Casuarina* and *Acacia* have been planted as windbreaks around cultivated fields, along irrigation and drainage canals as well as along roads and highways (El-Lakany, 1985).

This extensive network of trees began in the early 1800's to protect crops and irrigation canals from the desiccating winds and wind-blown sand. Trees grown on canal banks and on roadsides are public property and cannot be cut by individuals. However, trees on farm and field boundaries can be utilised by property owners.

Farmers have long appreciated the need for trees, and either buy seedlings or produce them themselves for planting on and around their cultivated lands (El-Lakany, 1985).

Although trees do compete for nutrients and water, there is an overall beneficial effect on arable production and it is highly probable that most irrigated land in Egypt relies heavily for it's existence on the presence of windbreaks.

Increasing local demand for the manufacture of chip-board has resulted in the controlled harvesting of wind breaks and also the establishment of irrigated forest plantations.

Irrigation schemes around the world should take note of the Egyptian experience since it demonstrates the optimal use of irrigated land for forestry development.

3.1.4 Malawi - Taxation of Forest Reserves

Much of Africa is still covered by various types of forest vegetation giving rise to a large natural forest resource from which fuelwood can be harvested without cost. In spite of rapid deforestation rates, it is very difficult to encourage tree planting where this large natural fuelwood source exists.

Malawi is covered by approximately 80% forest, but it has been predicted that this resource, at the present deforestation rate, will be exhausted early in the 21st century (Foley and Barnard 1984)

A wood energy programme (funded by the World Bank) was initiated in 1980 and designed to promote nationwide planting for fuelwood and poles. The main species used were *Eucalyptus*. Lack of incentive for large-scale tree planting has resulted in this project failing to meet its objectives.

Under the direction of the World Bank, the Malawi Government initiated a programme of raising the stumpage royalty at a rate of 15% per year for commercial fuelwood from both indigenous and plantation forests owned by the government (Leach and Mearns, 1988). The theory behind this measure is to create a situation where fuelwood costs increase to such an extent that it becomes more favourable to establish fuelwood plantations. It is also envisaged that fuelwood will be harvested more efficiently and that ultimately the deforestation rate will be decreased.

However, there has been much criticism of this approach which is mainly centered around the fact that a large "forestry" police force will be necessary to implement this tax system. It places an additional burden on the already stretched forestry department and forestry officials run the risk of ostracising themselves from the community.

The effect which this policy will have on reducing deforestation and creating incentives for fuelwood plantation establishment is also questionable, especially if the prime cause of deforestation is agricultural expansion as discussed in Section 4.1.

3.1.5 Zimbabwe - Natural Forest Management

Zimbabwe, like Malawi, is well-endowed with natural forest resources which too are suffering from over-exploitation. The main thrust for reversing this trend has been the development of a number of natural resource management programmes.

Project Campfire (Communal Areas Management Programme for Indigenous Resources) is one such programme implemented by the Department of Wildlife. Extension workers approach communities and encourage them to join the programme where they are given assistance in organisations, technical and financial matters (Munslow, **et al**, 1988; Leach and Mearns, 1988; Harrison, 1987). Each community defines community and individual assets and with technical help, decides on management of shared resources.

A similar one-off programme was run in Zvisharane in Central Zimbabwe by ENDA-Zimbabwe which is a non profit environmental group. Discussions with communities revealed that local knowledge of indigenous trees was very extensive. Community organisational discussion groups were then encouraged to determine the various woodland management options such as fuelwood and timber harvesting, tree planting and protection, trees around homesteads and arable lands and live fencing. With minimal inputs, local communities are able to build on their existing knowledge and manage their woodlands in a sustainable manner (Munslow **et al**, 1988; Scoones, 1989).

Communities have commonly suggested the following approaches to sustained woodland management:

(i) To fell trees in a dispersed fashion.

(ii) To cut branches rather than whole trees.

(iii) Not to cut browse trees that are below 1-2 meters in height.

(iv) Not to burn stumps so as to allow for coppicing.

(v) Not to cut whole trees just to provide leaves for dry season fodder.

The programme has also involved the training of selected community members in nursery establishment to provide seedlings for indigenous tree woodlots.

In the same region (Mwensei district) communities implemented a paddock system for livestock to reduce environmental destruction through overgrazing. Grazing camps are sequentially grazed for 21 days each. Live fences have been established to fence off some of the paddocks and areas of different land use such as arable areas (Munslow, et al, 1988).

Farmers are now appreciating the financial value as well as the social value of cattle especially after the promotion of zero grazing techniques (Scoones, 1989).

3.1.6 Zambia - Soil Conservation and Agroforestry Project

Zambia is well-endowed with natural woodland but clearance for agricultural development is beginning to take its toll. Soil erosion and declining crop yields are major problems in many regions, particularly in the lower rainfall areas.

A soil conservation and agroforestry project was launched in 1986 in the Mazabuka region of southern Zambia to combat these problems (Kerkhof, 1990). It is a small project in comparison with other projects discussed and receives support from the Zambian government, United Church of Canada Aid and a grant of US$14, 800 from German Agro-Action (Kerkhof, 1990). The project has been directed to promoting the planting of *Acacia albida* amongst crops and the establishment of live fences and windbreaks.

Although the project cannot boast large numbers of trees being planted, farmers in the region now show a higher degree of appreciation towards existing *Acacia albida* trees and have shown a keen interest in planting fruit trees (Kerkhof, 1990).

Alley cropping and tree planting for firewood and animal fodder has not been popular (Kerkhof, 1990).

The project has only been running for a short time so it is too early to speculate to any extent on results, but it does demonstrate that tree planting and tree conservation and utilisation can be rapidly appreciated by rural farmers, even through small programmes with limited budgets.

3.1.7 Tanzania - Village Afforestation and Agroforestry

The village afforestation programme of Tanzania is one of the longest-running programmes in Africa. It was initiated soon after Tanzania gained independence and was designed primarily to stop the rapid rate of deforestation and environmental degradation.

Vast numbers of trees, mainly *Eucalyptus* and pines were distributed free to communities and great pressure was exerted by forestry extension officers on people to plant trees (Mnzava, 1983). In many cases, trees were never planted and in others, planted trees were subsequently neglected. Only a small minority of woodlots were ever successful (Mnzava, 1983).

The main reasons for this total failure include:

(i) Fuelwood supply problems were over-exaggerated.

(ii) A community approach to woodlot establishment was unpopular.

(iii) Lack of community institutionalisation.

(iv) The transport of seedlings from centralised nurseries was costly and inefficient.

Like so many other programmes in Africa, a dramatic change in approach was made in the early 1980's. Individuals rather than communities were targeted for tree planting, together with schools. Decentralised nurseries were also promoted. Tree planting by individual farmers is now becoming the core of Tanzania's forestry extension (Kerkhof, 1990). Farmers are also showing a keen interest in fruit trees.

Another similar but more locally-orientated programme was initiated in the Kondoa district of Tanzania which has long been known for its extensive soil erosion. Again the programme began with woodlot establishment and conventional soil conservation measures and again it become evident that the programme was having little impact.

The government took dramatic action and enforced a strict destocking policy under severe local resistance and actually removed 46 000 cattle, 29 000 goats and 11 000 sheep from the area (Kerkhof, 1990). The results of the destocking have been very noticeable; grass cover has been restored and woody vegetation has regenerated and many local inhabitants now appreciate the beneficial effects. There has been a considerable increase in agricultural output and the area no longer needs overseas aid (Kerkhof, 1990). Multipurpose trees have also been promoted with individual farmers who are reacting positively to these efforts.

3.1.8 **Botswana - Failure of Hightech Nurseries**

Since Botswana shares a large border area with South Africa, strategies and approaches exercised there have great relevance to much of South Africa.

Before 1970, Botswana paid little attention to fuelwood provision but later, a series of woodlot plantations were established for this purpose. Very little attention was directed towards local involvement and needs.

This policy has now been used in other regions in Tanzania but more effort has been placed on discussion with communities and in encouraging stall feeding so that these programmes have run more smoothly than in Kondoa (Kerkhof, 1990).

Similar future strategies elsewhere in Africa will also have to concentrate on obtaining local cooperation so as to lessen the trauma, associated with forced removal of livestock.

Government nurseries were established in order to provide seedlings for plantations. They are based on the South African hightech approach to nursery development and were mainly situated in large centres (ERL, 1985). This hightech approach consisted of expensive equipment such as tractors, nylon shade netting, large on-site houses/offices with a large staff compliment.

Because these nurseries were mainly concerned with the production of *Eucalyptus* seedlings for plantation establishment and that only 237 ha were ever planted, they have produced some of the most expensive seedlings in Africa (ERL, 1985).

The Botswana people consider *Eucalyptus* mainly for pole production rather than as a source of fuelwood and because these nurseries paid little attention to multipurpose trees and fruit trees, it is no wonder that they contributed little towards solving the fuelwood crisis in Botswana.

Again, the western style approach towards rural tree planting and fuelwood provision can be seen as an expensive failure.

3.1.9 Sahel Region

The Sahel Region stretches from the Sudan in the east to Senegal in the west of the African continent. It includes other countries such as Mali, Chad, Burkino Faso, Niger and far northern Cameroon. It is a highly sensitive area since it forms the southerly portion of the Sahara desert. Rainfall ranges from 150 - 300 mm in the northern Sahel to 400 - 700mm in the southern region.

Because of the high sensitivity of the region and the fear of the Sahara moving southwards, major international aid organisations injected massive inputs of aid into the region in both agricultural and forestry programmes. By 1984, a USAID review of forestry projects concluded that no large scale plantations or even village woodlots had been successful (Harrison, 1987). The World Bank has also experienced an unusually high failure rate of its projects in the region.

On the positive side, new approaches towards tree planting and fuelwood provision do seem to have achieved a fair degree of success. Probably the most successful and well- known is the Majjia Valley windbreak project in Niger.

The Majjia Valley is situated in southern Niger and has deep alluvial soils with high water tables which together with an annual rainfall of 400 - 600mm provides a high potential, according to Niger standards, for cultivation. A major problem in the valley is the occurrence of strong dry prevailing winds which not only result in severe soil erosion but also adversely affect crop yields.

A windbreak project began in 1974 and the species chosen was neem, a deep rooted evergreen multi-purpose tree for Asia. Trees were planted in double rooms, three meters apart and 100 meters between windbreaks (Harrison, 1987; Cook and Grut, 1989). By 1988, over 4 600 ha have been protected by a total of 463 km of double row windbreaks (Kerkhof, 1990).

Although trees take up space that was previously cultivated, many farmers state that they have experienced increases (72%) in overall crop yields (Harrison, 1987). In addition, fuelwood is now being harvested from earlier-planted trees. This has brought in a significant amount of revenue which is dispersed amongst farmers and cooperatives. Measurement of windspeeds and humidity have shown that significant improvements have been achieved (Kerkhof, 1990).

However, actual crop yields from individual fields are more difficult to measure since trees not only take up space but also have an adverse effect on crops immediately adjacent to them. Initial estimates indicated that yield increases were 23% compared with surrounding unprotected areas (Bognettean-Verlinden,

1980) but more recent evaluations have suggested smaller yield increases of only 6% (CARE, 1986).

Another potential problem with the project was the limited community involvement during the initial stages. Farmers were not consulted on the positions of the windbreaks and suggestions have been made that dispersed trees amongst cropland are just as effective at reducing wind speeds as windbreaks (Kerkhof, 1990). The project has now begun to incorporate greater community participation including the establishment of decentralised nurseries and the encouragement of intercropping with *Acacia albida* (Kerkhof, 1990).

In spite of these problems, the project does demonstrate that success can be achieved with appropriate forest technology even under severe environmental and social constraints.

The windbreak project in Niger was duplicated in neighbouring Mali. Initial progress was slow because the local community resented having windbreaks imposed on them (Kerkhof, 1990). The strategy has now changed towards greater community involvement with the promotion of privately planted windbreaks, decentralised nurseries and tree growing by individual farmers (Kerkhof, 1990). The project has also included an element of natural woodland regeneration and the promotion of *Acacia albida*. With this change of approach, there is renewed hope that the project will be a success.

In Burkina Faso, an agroforestry project was initiated with aid from Oxfam. The initial plan was to create microcatchments using rock bunds and then subsequently plant multipurpose trees. However, the local community resisted all attempts to encourage tree planting but instead found the rock bunds resulted in significant crop yield increases as a result of improved water infiltration. They subsequently showed great interest in microcatchment building for this purpose.

The project staff, wanting to meet local demands, quickly adopted a total change in strategy (Kerkhof, 1990). Rock bunds were established by the villagers themselves, without payment, and by 1988 about 2 500 ha had been developed. A further 3 500 ha were established by farmers in surrounding areas (Kerkhof, 1990).

Many farmers have recently taken to tree planting which indicates that once the primary concern of food security has been addressed, farmers begin to show interest in other less pressing demands such as fuelwood provision.

In some villages, communities have decided that all animals be stall-fed so as to make tree growing easier (Kerkhof, 1990). Fodder is collected from cultivated lands to feed the stall-fed stock.

In Senegal, deep water wells were sunk to provide drinking water during the dry season but the concentration of livestock and humans began to cause extensive environmental damage. Initial attempts at combating this destruction were to plant woodlots of Acacia Senegal aimed at not only providing fuelwood and livestock fodder but also at generating revenue from gum arabic. However, it was later found that the high costs of establishment together with poor returns meant that the plantations were uneconomic (kerkhof, 1990). Plantations also had a high failure rate and some so-called plantations had fewer trees than uncleared natural vegetation.

The Project strategy was then changed to encourage greater community participation, only establishing trees where communities provided some cash inputs (Kerkhof, 1990). Fencing material was provided and a greater range of trees was made available. Farmers appreciated the provision of fencing material and contributed approximately 11% of the total costs and planted trees amongst their cropland (Kerkhof, 1990).

There is now a strong component of natural woodland regeneration and pasture management. New initiatives include the use of live fences to replace wire fencing thereby reducing some of the capital costs. This project demonstrates that local farmers are willing to invest heavily in their future if given the correct and appropriate technology.

Many other similar programmes have been implemented in the Sahel region. Since it is a very dry area most communities rely heavily on pastoral activity. There has been a dramatic change in approach over the years from plantation forestry to woodland management involving natural regeneration and intercropping with indigenous trees such as *Acacia albida* in particular.

It is clear that when the technical package is right, people respond positively. This allows for more time to be spent on appropriate extension methodologies so that the programme can reach a greater number of people.

3.2 ASIAN-PACIFIC

3.2.1 Korea - Community Fuelwood Project

South Korea is a mountainous country with a humid mid latitude climate of warm to hot summers and cold winters with rainfall expected in all seasons.

Korea used to be rich in forest resources but after many years of over exploitation, it was faced with a formidable fuelwood deficiency problem. Vast areas of steeply sloping land became deforested and barren, and environmental catastrophe loomed. There were increased instances of floods and droughts as well as high rates of soil erosion. Low agricultural production and poverty became widespread (Oh Ho-Sung, 1986).

The high demand for fuelwood was a result of the traditional under-floor heating system used by Koreans.

This precarious state of affairs was recognised by the government as a major hindrance to Korea's future development so it enacted policies to combat deforestation and ensure fuelwood supplies for rural communities (Oh Ho-Sung, 1986; Foley and Barnard, 1984; Chambonnier, 1985).

3.2.1.1 Project design

Rural village communities were mobilized to plant fuelwood plantations through a national movement called Saemul Undong whose main aim was to improve and modernise rural life. Through this movement, villagers discussed matters directly relating to themselves and made collective decisions on what action to take and methods of implementation. Village

Forest Associations (VFA) were established consisting of all members of the community. The VFA would then approach the County Forest Association (FAU) which provides advice on species selection for the plantation. FAU's were non governmental organisations which were organised at city level to bridge the gap between the villagers and central government (Oh Ho-Sung, 1986).

The government then provided capital for the provision of seedlings and the VFA undertook the maintenance of plantations. VFA's were empowered to select any suitable pieces of land for fuelwood plantations. This even included private land. Proceeds from the fuelwood plantations after harvesting were dispersed amongst the villages (90%) and landowner (10%) (Oh-Ho-Sung, 1986).

Trees used in fuelwood plantations included *Robinia pseudocacia*, *Alnus hirsta* and *Pinus hybrids*.

3.2.1.2 Project achievements

Over 1 million ha of fruit, fuel and timber trees were planted between 1973 and 1977. By 1985 about 85% of Korea's trees were less than 20 years old (Oh Ho-Sung, 1986).

The rate of soil erosion which had been a big problem in the past was more than halved. The occurrence of landslides was also reduced. Reduced peak flows in rivers subsequently allowed the construction of domestic water systems which had not been previously possible.

Agricultural production and irrigation prospects have also been dramatically increased. Drought conditions are less frequent and greater rainwater infiltration accounts for the increased agricultural production potential.

Less time is now spent collecting fuelwood and this allows for more time for other activities such as food production.

3.2.1.3. Discussion

There is no doubt that Korea's community fuelwood project has provided a major contribution to uplifting rural village communities from poverty and has also contributed to the remarkable growth rate of Korea's economy.

Project success can be directly attributed to:

(i) Social organisational ability of Korean villagers.

(ii) Supportive rather than administrative role of central government.

(iii) An efficient non-governmental organisation which linked "on the ground" village organisations with central government.

Whether this degree of success can be repeated elsewhere is extremely unlikely since this highly sophisticated organisational ability is rarely seen in other cultures. However, the project does emphasize the importance of institution building within rural communities and also the necessity of bridging the gap between funding bodies and project participants. In addition, the project ensured that decisions relating to fuelwood provision were entirely in the hands of the villagers themselves. "Outside influence" was limited to the provision of technical advice which was required to ensure that optimal production was attained.

3.2.2 The Philippines - Wood energy plantations

The Philippines government launched a dendrothermal power generation policy aimed at reducing oil imports for energy production. *Leucaena leucocephala* plantations have been established by poor farmers on government land. These plantations have been managed on a communal basis and farmers are subsidised for their labour inputs to compensate for the lack of food production (Foley and Barnard, 1984; Denton, 1982).

The programme has been supported by British and French aid and a total of 34 projects have been initiated (Foley and Barnard 1984). The results, like many in Asia, have been spectacular. A total of 2 500 ha of *leucaena* were planted in the space of 3 years (Denton 1982) and 10 000 ha after 5 years (Foley and Barnard 1984).

However, *leucaena* has fared badly on acidic soils and some farmers are concerned about the low prices for their wood (Denton 1982). Sustainability of this programme will surely be reliant on the price fixed by the National Electrification Administration and based on world oil prices.

In spite of these potential problems, many low income farmers have benefited from employment generated by the programme, and other trees are being tested so as to reduce the reliance on *leucaena*.

3.2.3. Taiwan- Taiwan's Private Tree Farmers

3.2.3.1 Background

The rapid economic growth rate of Taiwan resulted in an increase in the amount of board products required. Due to Taiwan's limited amount of domestic pulpwood, local firms had to import pulpwood, mainly from South east Asia. In 1980, pulpwood prices reached an all-time high of $51.80/t which prompted the Taiwanese Forestry Research Institute to investigate techniques to improve local production (Pao-chang and Jen, 1986; Hu Ta-Wei and Tao Kiang 1983). Information on *Leucaena* plantations from nearby Philippines aroused great interest in Taiwan at that time.

After a series of trials, *Leucaena leucocephala* was promoted as a pulpwood species to farmers.

3.2.3.2 Programme design

Government departments and local paper manufacturing companies worked together to develop incentive packages to encourage farmers to plant *Leucaena* for pulpwood production.

Three private companies were involved in the scheme and all drew up agreements with small farmers involving differing loan and subsidy arrangements and a guarantee package price for the wood. The government provided extension and research services to support the programme.

Leucaena trees were established on mostly less fertile steep sloping lands which were not used for intensive agriculture. Planting density ranged from

5000 to 7000 plants per ha. The plantations were mostly established by direct seeding techniques.

After approximately 30 months, the plantations were harvested for pulpwood and *Leucaena* was then left to coppice and begin the next cycle (Pao-Chang and Jen 1986).

3.2.3.3 Programme achievements

In excess of 12 000 ha of *Leucaena* pulpwood plantations were established between 1980 and 1986 by small-scale farmers. 90% of plantations were situated on steep sloping land, 8% on river bottoms and 2% on rice paddies. A much greater area would have been planted if it had not been for the restrictive government regulations preventing planting in river bottoms and forest areas. This 12 000 ha provided only 20% of the total pulpwood requirement for the paper industry. A further 50-60 000 ha of plantations would have been required to fully satisfy the total domestic demand. This objective could not have been reached with the government regulations in effect (Pao-Chang and Jen 1986).

However, not only did the programme supplement pulp supplies but it also provided much needed employment in rural areas. Farmers began to appreciate the fodder potential of Leucaena leaves and this encouraged greater interest in livestock. In addition, soil erosion and water supply were improved in some areas because of the ameliorating effect of the plantations on runoff and water infiltration

The *Leucaena* wood proved to be an excellent source of pulp for paper manufacture, and produced between 15 and 25 tonnes per ha per year. The programme, however, did not proceed without problems. In 1984, the world price for pulp plummeted to $34/t. This severely affected the economic viability of the project and caused many farmers to lose interest in their tree farms (Pao-Chang and Jen 1986).

3.2.3.4 Discussion

The extension and forestry techniques promoted in this programme proved to be highly successful and resulted in large number of tree farms being established over a relatively short space of time. It is a good example of how government departments, private companies and small scale farmers can cooperate and reach development objectives.

In spite of the overall success, outside influences such as the international price for pulpwood, severely affected the viability of the farms. Central government action was required to subsidise local pulpwood producers. Unfortunately the government did not recognise the importance of the *Leucaena* plantations and their beneficial role on both the national economy and local environments.

Steps are now being taken to improve the production potential of *Leucaena* in order to combat the low pulp prices. Indications are that a greater proportion of flat land will have to be used to reach this objective, which is at present restricted by government policies. Other strategies include higher planting densities and shorter rotations. Another option is to place greater emphasis on fodder production which is of higher value than wood.

3.2.4 China-China's green wall

China is experiencing some of the highest soil erosion rates in the world (Brown and Wolf 1984). China's main river, the Yellow River, is so called because of its high sediment load resulting from extensive erosion in its catchment.

Once fertile land has been transformed into gully eroded wastelands. Some gullies are over 200m deep. This has occurred within a period of less than 30 years as a result of overgrazing and over-cultivation.

Roughly parallel to the famous Great Wall of China, which was built to keep out the Barbarian warriors to the north, a new wall is being established. This time it is a green wall of trees that is designed to prevent the southward expansion of the Gobi desert. The shelterbelt is some 1500 km long and 12 km wide and was established by 700 000 farmers in just two years! (Foley and Barnard 1984, Grainger 1990). In addition, 5 billion trees have been planted under the "four sides" slogan along roads; along rivers and canals; around houses; and around villages (Foley and Barnard 1984).

Work is carried out by the country's collective working units or peoples' communes; it is obligatory and is paid for in cash or kind from community resources.

Elsewhere in China, estimates have been made that over 1.5 million ha of trees have been planted per year thus increasing China's forest cover by over 60% in less than 30 years (Myers 1985).

China aims to further increase forest areas from the present total of 12% to 20% by the turn of the century (Foley and Barnard 1984).

3.2.4.1 Discussion

The spectacular achievements in afforestation in China are unmatched in the developing world and, in most probability, will never be in the future.

China's ability to mobilise its massive human resource accounts for these achievements.

However, there have been reports of plantation failures on an equally impressive scale-700 000 ha in one plantation alone through fire damage! (Foley and Barnard 1984). Considering that vast numbers of trees are planted in such short spaces of time, caring for the trees is a mammoth task in itself and which has obviously been neglected in some instances.

Repeating these achievements may not be possible simply because few countries have the necessary large mass of population. Having a large population may also not be enough since mobilising this number of people requires a very strong central power and massive social commitment.

3.2.5 India-Social forestry in India

India, like China, has a huge population resource with a population rapidly approaching 900 million. However, India's population is strongly divided by both religion and the cast system.

In spite of these constraints, India is now one of the leading countries in the promotion of farm and community forestry. Over 2 billion trees on 2 million ha have been established along roadsides, around field boundaries, on previously barren wasteland and on irrigated agricultural land (Foley and Barnard 1984, Myers 1985, Chatterjee 1986).

Social forestry was pioneered in India in the state of Gujarat. In 1969, the state forestry department established a separate extension wing to encourage tree planting outside regular forest areas. This section began by establishing trees along roadsides and canals. Villagers had grass cutting rights and protected the trees. In return they shared the profits after tree harvesting. Later, a number of villages were persuaded to establish small plantations (4 ha) on communal grazing land. These plantations consisted of timber, fuel, fruit and fodder trees. Trees were provided free for the programme and again, in return for protecting trees, villagers were rewarded by profit sharing (Foley and Barnard 1984).

Most plantations were protected by ditches or live fences consisting of thorn trees. Fencing with barbed wire proved to be too expensive and provided few employment opportunities. In spite of these forms of protection, a high level of community involvement was necessary to ensure plantation survival. In many cases, plantations failed through livestock damage which was a result of poor community participation (Foley and Barnard 1984).

School children were also involved in programme activities by being encouraged to establish school nurseries. In West Bengal, establishment of school nurseries became a major aspect of the social forestry programme (Chatterjee 1986). The aim was to create dispersed village nurseries to produce trees for the programme. A total of 138 school nurseries were established for this purpose. These nurseries provided over 600 000 seedlings in 1983 alone. Schools were paid approximately US $ 20 for every 1000 seedlings. Nursery management was included in every participating school's curriculum (Chatterjee 1986).

Most teachers, parents and pupils approved of the programme. Teachers stated that it kept pupils out of mischief and parents felt that it did not interfere with academic studies. Children appreciated the additional funds generated by the scheme as they were spent on other school functions (Chatterjee 1986).

The school children's enthusiasm for tree seedling production was not found to be related to sex, religion or caste.

Other regions of India have also developed social forestry programmes with varying degrees of success. In Rajasthan, school children now plant more trees than the local forestry department (Myers 1985).

In some parts of Gujarat, the financial incentives for tree growing are so great that farmers are replacing irrigated crops with irrigated tree plantations (Gupta 1979).

In spite of all these success stories, there has been some criticism that most social forestry programmes only benefit the rich and tend to ignore the plight of the poor and in fact, in some worse case scenarios, have actually degraded their already precarious position (Jayaraman 1987).

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In marginal areas or those where there is only limited incentive, most social forestry development is based on "directed" social forestry approach. The respective forestry department establishes a plantation and the surrounding communities simply supply the labour. True community participation has therefore not been widely adopted in most states.

This factor is of major concern since sustainability of such development programmes is severely hampered by the heavy reliance on infusions of aid.

3.3 CENTRAL AMERICA AND THE CARIBBEAN

3.3.1 Haiti Agroforestry Outreach Project- Institutional Strategy for Successful Development

3.3.1.1 Historical Background

Haiti occupies one third of the island of Hispanola, which it shares with the Dominican Republic. The island is situated in the central Caribbean and lies approximately 100 km south-east of Cuba.

Having established itself as one of the richest French colonies (due to a prosperous sugar cane industry) Haiti eventually became the second colony after the United States to become independent. However, having been governed by a series of tyrants for most of its independent period, Haiti has now become the poorest nation in the western world.

3.3.1.2 Natural Environment

Four fifths of Haiti is mountainous with peaks reaching up to 2500 m.a.s.l. This strongly influences rainfall distribution patterns which varies from over

3000 mm per annum in high altitude regions to less than 350mm in low lying areas. Temperature varies little from season to season but can vary dramatically with altitude.

3.3.1.3 Demography and Economic Activity

Port au Prince, the capital, has a population of 2.2 million representing approximately 30% of the country's total population. Population density in the rural regions is high and consists of smallholder plots of around 1 ha in size together with small dispersed villages.

Industrial activity is practically non-existent and the county relies heavily on industrial crops such as coffee, sugar cane and vetiver oil.

Most of the population is very poor, even by African standards and many have to scrape a living on their meagre plots to survive. Urban dwellers rely heavily on charcoal and wood as their source of fuel for cooking.

3.3.1.4 Devastation and Poverty

Since most people rely on agriculture for survival and wood for fuel, land clearance and hence deforestation has proceeded at unprecedented rates. In 1950, Haiti was covered with 48% forest; by 1980, only 2% remained. Deforestation of steep slopes caused extensive soil erosion which eventually destroyed the agricultural productivity of the land. This has led to the entrenchment of both urban and rural poverty.

3.3.1.5 History of Development Aid

International aid organisations identified deforestation and the resulting high soil erosion rates as major limitations to the development of Haiti. Many attempts were made, particularly by the United States Agency for International Development (USAID) to combat these two factors. Woodlots were promoted with the aim of supplementing fuelwood supplies and stone contour walls were established in "food for work" programmes to reduce soil erosion.

Most of these attempts totally failed to meet their objectives. Woodlots were rarely planted out or suffered from high mortality through livestock and fire damage. The building of stone walls proceeded too slowly to have any impact and even those built were never maintained.

In 1979, USAID contracted an anthropologist to review past projects in order to identify what caused them to fail or succeed. He found that increased income was the prime motivation for participation by small farmers and concluded that agroforestry would have the best chance of success. The result was the establishment of the Haiti Agroforestry Outreach Project.

3.3.1.6 The Haiti Agroforestry Outreach Project.

In 1981, USAID commissioned three non governmental organisations (NGO); Pan American Development Foundation (PADF), Operation Double Harvest (ODH) and CARE. The plan was to move away from conventional systems of soil erosion control, such as terracing or contour bank construction, and to adopt more progressive approaches to fuelwood provision.

The strategy involved providing millions of cheaply produced trees and concurrently actively marketing them to the target population. PADF worked through local NGO's (mainly church organisations), ODH with individual farmers and CARE with its own extension service aimed at subsistence farmers.

PADF was the most successful organisation and their activities are now discussed.

PADF recruited extension officers (animators) from each local NGO and subsequently trained them in nursery management and agroforestry. They were encouraged to establish their own nurseries and to adopt agroforestry techniques on their land and use them for demonstration purposes. Extension officers were paid a salary by PADF, this being determined by the number of trees they "sold" to other farmers, together with the number of demonstrations they undertook and the number of subsequent farm visits they made.

Initially, participating farmers were given US $ 0.10 as an incentive for each surviving tree after one year of planting. This offer was quickly abandoned because of the massive demand for trees demonstrating that incentives were unnecessary.

Approximately 120 000 farmers planted over 26 million trees in the first five years of the project. Well over 300 local village nurseries were established and 700 extension officers were trained during this period.

The rate of tree planting is rapidly increasing annually, so much so that PADF is having problems providing the required number of trees. In order to overcome this problem, PADF is now distributing seeds for direct seeding on cultivated lands.

Throughout the duration of the project, extension officers made it clear to all participating farmers that they could plant the trees anywhere they chose and do with them what they wanted, thereby ensuring that the rights of ownership lay with the farmers.

At first each farmer was given 200 trees but this was found to be too many to ensure high survival since farmers could rarely plant this number of trees at one time. Later, a limit of 50 trees per farmer was set and survival rates dramatically improved.

One surprising aspect of the project was that farmers preferred indigenous hardwood species to exotic species which contradicted pre-implementation predictions.

In addition to the planting of seedlings, farmers have begun to establish contour hedgerows consisting of direct-seeded *Leucaena* . Over 150 km of hedgerows have so far been established on steep cultivated slopes.

3.3.1.7 Reasons for Success

The question must be asked; why has this project been so successful when others have failed? The main reasons are discussed below:

Not only were farmers guaranteed ownership of the trees planted but they also gained considerable benefits from increased production. In reducing soil erosion as a result of hedgerow intercropping, crop yields were automatically increased. Fruit and fodder production resulting from the multipurpose trees, also contributed towards increasing overall production. Many farmers planted trees as a form of savings which could be called upon when required. Charcoal producers also benefited from the increased amounts of available wood supplies.

Another major reason for the remarkable success is the recruitment of local people as extension officers. Although they required much training, their understanding of local conditions and the knowledge of the farmers obviously proved to be very valuable. In addition, they were given the right incentive to perform well, as a result of the payment being commission related. The same incentive is given to all the world's salesmen to encourage performance and results speak for themselves.

3.3.1.8 Conclusions

The Haitian landscape is visibly changing from a barren eroded one to that of a network of hedgerows and trees. According to some USAID officials, the Haiti Agroforestry Outreach Project is the most successful USAID funded project yet. It has exceeded all expectations and the main factors attributed to this success are outlined below:

(i) The formation of a network to channel funds from donor organisations to local NGO's and thence to the target population effectively reduced administration and bureaucratic blockages. Funds were thus more effectively utilised in actual project activity.

(ii) The undertaking of a preliminary study to determine the best method of encouraging people to help themselves which was based on past project experience in the country.

(iii) The project stimulated a demand for seedlings rather than just producing them.

(iv) The project used local people as extension officers rather than expatriates.

(v) The project implemented systems that offered rapid returns for effort which farmers themselves readily appreciated.

(vi) Participating farmers were assured full ownership of any trees planted.

Although the project has had great success, the problems still remaining in Haiti are daunting. In order to prevent deforestation of the remaining 2% of indigenous forest, Haitians must plant 50 million trees per year. The current rate is only 6 million. To arrest the high rate of soil erosion, an even greater number of trees will have to be planted.

It is also evident that if the funds were removed, a substantial number of peasants would not be able to pay for the seedlings and tree planting would have been restricted to the wealthier peasants. In spite of this, with time, many more peasants will be reaping the rewards of their efforts and advancing the economic sustainability of the project.

It might be said that Haiti has different social and environmental conditions to Africa and that this project could not be replicated here. On the contrary, the basic principle of donor agencies, (including central government), using "on the ground" NGO's as development agencies can be applied almost anywhere.

The agroforestry technologies themselves and the extension component of the project could also be successfully applied to the African situation.

3.3.2 Mexico

About 20 million people use wood as a source of fuel in Mexico and many others use inferior fuels such as crop residues (Evans 1984). These forms of energy are used in both urban and rural environments but use is confined to the very poor.

The very people who use wood as fuel are usually those who sell it on the open market as a major source of income.

In the last 40 years, Mexico has lost more than 16 million ha of forest, and deforestation continues at a rate of more than 1000 ha per day (Evans 1984). Most of Mexico (72%) is considered suitable for forestry and range management with only a small proportion suitable for agriculture. Most existing forestry policies have been orientated towards industrial extraction and very little directed at reducing deforestation. As a result, not only is there a high deforestation rate but 7.4 million ha of land has been totally destroyed through soil erosion (Evans 18984).

It is only recently that Mexico has initiated a fuelwood programme with the promotion of social forestry but widespread problems are anticipated in this approach. The main problem is that vast numbers of peasants who rely on wood for fuel have no land even for food production. Therefore, it is unlikely that land will be made available for trees and firewood production unless trees produce some additional products such as fruit and fodder.

Time will tell whether Mexico can avert a national energy crisis.

PART III: LESSONS FROM EXPERIENCE

4. ASSESSMENT OF FUELWOOD DEMAND

It is clear that many afforestation and fuelwood provision projects and policies have been designed with false or limited knowledge of fuelwood demand and use. It is therefore imperative that correct values and assumptions are identified and measured before any strategy is developed.

Fuelwood deficit, often referred to as "fuelwood gap", is the difference between the volume of fuelwood used and the volume that is produced from both man-made tree planting activities and natural woodlands.

Factors determining the formulation of accurate assumptions include causes of deforestation, measured scale of deforestation, fuel switching and fuel savings.

4.1 CAUSES OF DEFORESTATION

The rapid rate of deforestation is often blamed on the use of wood or charcoal for fuel. Measurements of deforestation rates are made and from these, calculations of the number of trees or area of reforestation required to reduce deforestation, are extrapolated.

If fuelwood harvesting is not the major cause of deforestation, then many policies aimed at reducing deforestation based on this assumption, often involving massive tree planting programmesare totally inappropriate and doomed to fail even before they begin. Consequently, even if successful or forcefully implemented, such programmes will do little to curb deforestation.

The assumption that harvesting of fuelwood is the major cause of deforestation relies on the theory that trees are cut down for fuelwood and that no regeneration occurs. However, it has been found that the predominant sources of fuelwood are:

(i) dead branches and twigs from existing woodlands;

(ii) surpluses arising from agricultural land and;

(iii) by-product wood from various tree growing activities such as lops and tops from multi-purpose farm trees.

Tree cutting specifically for fuel is generally limited to regions usually associated with high population densities or close to cities. Most of this wood is converted to charcoal and sold, rather than used for "home consumption".

Given that fuelwood sources from (i) and (iii) are therefore non-destructive and sustainable, the remaining major source of fuelwood is a by-product of land clearing for agriculture. Consequently, the spread of agriculture arising from the need to produce more food, has a greater responsibility for deforestation than harvesting for fuelwood.

Even when trees are directly cut for firewood, the underlying reason is often that failures in agricultural production have forced people to look at other forms of obtaining income. Again, deforestation is directly related to agriculture rather than to fuelwood collection.

It can therefore be argued that deforestation is a result of failures in intensifying agriculture on a sustainable basis rather than fuelwood harvesting.

Obviously, not all deforestation is caused by expansion of agricultural activities. The tropical rainforests are subject to commercial logging and many trees are cut for fuelwood in densely populated regions. Each region will have varying causes of deforestation with varying emphasis on agricultural expansion and firewood collection.

The point is, that deforestation rates alone must not be used as a basis for estimating the fuelwood demand since it is highly likely that they will grossly over-estimate the situation. This will then result in a too great an emphasis on tree planting and ultimately project failure.

4.2 SCALE OF FIREWOOD CRISIS

Many surveys of indigenous woodlands have been undertaken to provide information on possible fuelwood problems. Because of the small mapping scale of these surveys, estimates of actual areas with fuelwood shortages may be misleading. Since the rural poor have limited transport facilities, shortages can, in fact, be very localised. People are rarely capable of hauling fuelwood over distances greater than a 10km radius from their homes which is about the maximum distance that can be walked in one day (allowing time for collection of wood and the return walk home).

Fuelwood shortages and fuel usage will thus vary considerably depending on the distance to available wood supplies. Distance may also influence the type of wood used. More easily available supplies of inferior fuelwood may be selected in preference to other wood sources as a result. The fuelwood crisis is thus highly localised and will vary in extent from village to village.

This fact has obvious implications in selecting the most appropriate strategy, the method of measuring fuelwood shortages and the subsequently design of the afforestation relief package.

4.3 MONITORING DEFORESTATION

Given that deforestation is occurring at localised points over very large areas, quantifying deforestation at national level or even regional levels is somewhat difficult and expensive. However, in order to formulate national or regional strategies for improving fuelwood supplies, assessing fuelwood deficiencies and monitoring changes in availability are of vital importance.

Remote sensing, using aerial photography or satellite imagery is a possible option. Aerial photography has the advantage of high spatial resolution but is expensive and if very large areas require investigation, many photographs will be required.

Satellite imagery has the advantage of allowing vast areas to be surveyed on a regular basis. However, ground truthing is required in order to identify key vegetation types and an added problem is the relatively low resolution of satellite imagery.

Both techniques are, on the whole, adequate for assessing deforestation but have severe limitations regarding the impact of fuelwood collection on deforestation. Satellite imagery is adequate for assessing deforestation of closed forests but is very poor for open woodlands where deforestation is relevant to potential fuelwood shortages (Munslow *et al*, 1988; Millington and Townsend, 1988).

Since a major source of fuelwood is from cuttings and loppings from standing trees, it becomes extremely difficult to assess woodland degradation and standing supplies by remote sensing.

"On-the-ground surveys" are at present the most reliable method of assessing fuelwood shortages and deforestation but are time-consuming and expensive.

4.4 FUEL SWITCHING AND SAVING

Deforestation predictions based on fuelwood demands have rarely taken into account people's initiatives in times of shortage. A decade ago it was predicted that Tanzania would have no trees by 1990 at the measured rate of deforestation;

The fact that there are still many trees left in Tanzania disputes this prediction.

It has been found that, as fuelwood supplies become more difficult to obtain, people tend to use less fuel or switch to other fuel types (Leach and Mearns, 1988). In the case of the very poor, inferior fuels such as animal dung and/or crop residues are the usual substitutes.

5. CONSTRAINTS TO TREE PLANTING

Failure to identify correctly and account for the constraints of tree planting in the programme design, has been a major cause of the demise of many projects. Every individual or community has a series of constraints which must be overcome for successful implementation. The following list of constraints is by no means complete but provides an indication of the main issues. In addition, each constraint does not exist in isolation but in a complex interaction with others.

5.1 LAND TENURE AND TREE OWNERSHIP

In most cases, the poor sectors of society are either land-less or have insecure tenure of land. In many African societies, communal ownership is the norm. Since tree planting is a form of long term investment, people are generally hesitant about spending time and effort on land over which they may have no control in the future.

In some societies, the act of tree planting infers ownership which may cause resentment from other individuals if tree planting is undertaken on communal land (Harrison,1987; Jayarman, 1987)

Since community land is used by a multitude of users, agreements on future land use are problematic if every individual's needs are to be satisfied. In addition, the necessary organisation required to initiate any change in land use status is immense since it is difficult to obtain consensus of opinion. Strong community organisational structures, where collective decisions and actions can be formulated, are necessary to overcome this problem. When successful, as in the case of China and Korea, collective community action can bring about spectacular results.

In some societies, notably Niger, trees belong to the state irrespective of land tenure and permission to cut even branches of trees is required by government authorities (Harrison, 1987; Kerkhof, 1990). There are many other instances where land ownership does not necessarily infer tree ownership (Fortmann, 1985). People will therefore show little interest in tree planting if they are prevented from reaping the rewards of their efforts.

5.2 CONFLICT IN LAND USE

Since conventional tree planting requires that all other land use activities be excluded from the designated area, conflicts of interest invariably emerge. This is the case on both communal and individually owned land.

Tree planting results in land being removed from agricultural production such as crop production and grazing. On community owned land pastoralists resent any land being excluded from grazing use since it is seen as a reduction in their resources.

On individually owned land, removal of the land from the cultivation of food crops tends to inhibit people from planting trees since securing food supplies will be of a higher priority than securing fuelwood supplies.

Agroforestry systems with the incorporation of trees into cropland, are in many cases, able to alleviate this problem as long as the loss of land occupied by the trees is compensated by either increased crop yields or by increased financial benefit through the production of wood products.

5.3 LABOUR AVAILABILITY

Successful tree planting requires a large labour supply, particularly in early establishment.

In rural areas where many of the men work in the cities, most of the day to day chores are left to the women. Therefore, there may not only be a limitation to the number of people avaailable for tree planting and maintenance but also a labour shortage in relation to other more pressing demands such as water collection and food production.

The timing of tree planting usually coincides with cultivation and if there is little spare labour, tree planting will suffer due to priority being given to food production. Further labour demands such as cooking and water collection will also have priority over tree planting. Even if trees are planted, weeding and firebreak maintenance are necessary for successful establishment and these tasks may be neglected in favour of labour demands elsewhere.

It is clear that, even when tree planting programmes offer significant economic benefits, if the labour demand is high and no free labour available, trees will not be planted.

5.4 COMMUNITY NEEDS AND PRIORITIES

The poor have, by nature, a multitude of basic needs which are usually in short supply. Fuelwood shortages may or may not be one of these basic needs. What is important is the priority rating given to fuelwood demands. Many projects have failed because fuelwood needs/shortages have been given a higher priority rating by the project planners than the target communities.

In some cases, fuelwood shortages have not even been identified as a priority especially when the discussions with the community have been undertaken with men who have little to do with fuelwood collection and who have little regard for women's activities. If existing fuelwood supplies are plentiful but rapidly diminishing they will also have a low priority rating by local communities. Therefore, fuelwood generally has a low priority rating compared to other survival activities such as food production and water collection.

5.5 TREE ESTABLISHMENT

In harsh environments, tree growth is very slow. This is unfortunate since, in most cases, it is precisely these regions that are threatened by excessive deforestation and high fuelwood demand. Tree establishment will take much longer and will require more effort on the part of the farmer/community for success. They have to be protected for longer periods against grazing animals in search of fodder and tree growth may be so slow that it will take many years to reap any benefit. Many communities and individuals are put off by this extended time span necessary for tree establishment and tend not to be enthusiastic about spending time planting trees.

5.6 WOODFUEL PRICING TRENDS

A general misconception has been that, as fuelwood supplies diminish, fuelwood prices rise. In most developing countries, the price of fuelwood has remained constant even under severe shortages (Leach and Mearns, 1988). Although exceptions do occur, e.g. Ethiopia and Madagascar. Table 6 shows fuelwood prices over time in some selected developing countries.

TABLE 5.6
FIREWOOD PRICE TRENDS IN AFRICAN CITIES

YEAR	STEADY/ERRATIC					RISING		
	BOTSWANA GABARONE	CAMEROON YAOUNDé	IVORY COAST ABIDJAN	MALAWI BLANTYRE	SUDAN KHARTOUM	ETHIOPIA ADDIS-ABEBA	MADAGASCAR TANANARIVE	ZIMBABWE HARARE
	pula/kg	fr/ stere	fr/kg	tamb/kg	sh/kg	cent/kg	fr/kg	cent/kg
1970						4.2		
1971		2 887				4.3		
1972		3 428		2.8		4.9	6.5	
1973		4 099				4.8	6.2	
1974	1.9	4 075				6.3	6.2	
1975		3 037				8.1	1.3	
1976	4.70	2 572	17.9	2.5		7.0	7.0	
1977		3 038	20.1		7.1	10.6	7.0	
1978		4 288	23.1	4.2	5.0	9.9	1.3	
1979		3 988	16.4	4.0		11.1	8.2	1.9
1980	4.30	5 218	17.0	4.0		10.2	8.7	3.6
1981	3.44	6 022	15.0	2.9	4.5	12.4	10.7	
1982	2.55	5 553	14.8		4.3		10.3	
1983	4.83	4 265	14.0	3.0		14.3	9.3	
1984		4 033	13.4	3.5	3.3		9.8	3.7
1985			13.2					3.7
1986			15.7					5.2

(Source: Leach and Mearns, 1988)

These price trends have important implications for the possible commercial production of fuelwood since growing trees for fuelwood has little chance of success, even with diminishing supplies, simply because fuelwood is a poor investment for the future. An added disadvantage is that any commercial operation must compete with supplies obtained freely from indigenous vegetation, even if it is hard to come by.

Compared with other activities, growing fuelwood is not financially attractive (See section 5.7). Tree planting is generally not favoured because of the long time (5-10 years) before returns on investment can be attained. The poor have a high discount rate, that is, they prefer money now rather than later.

Given the low price and low potential for price increases together with the long term nature of this type of investment, it is hardly surprising that farmers and communities cannot be easily persuaded to grow trees for fuelwood.

5.7 ECONOMICS

The fact that severe fuelwood shortages exist in an area or that deforestation is detrimentally affecting the environment does not necessarily force people to plant trees. To compound this problem, long term detrimental environmental effects with their accompanying long term economic implications, do not have much relevance to resource-poor farmers who are only interested in day to day survival strategies.

Purely economic incentives are not enough simply because the poor are, quite rightly, solely concerned with their own financial situation. Even in cases where financial improvements are attainable, if they require significant increases in labour input and labour shortages are a severe problem, such practices may still not be readily adopted.

In many environments, it must be accepted that tree planting is not financially feasible although it maybe highly desirable both economically and environmentally. Dry, degraded regions are examples where tree growth is extremely slow and establishment and maintenance costs are high. It is no wonder that farmers are uninterested in tree planting programmes under such circumstances.

Under these conditions, additional incentives are required, such as food for work or subsidisation. This however, does not lead to any degree of sustainability of the programme and when programme funds run out, tree planting ceases. However, if the initial tree planting efforts can significantly raise the overall standard of living of project participants, it maybe possible that tree planting will continue due to this improvement.

Short-term proven financial strategies are probably the single most important factor that encourages farmers to plant trees and leads to overall project success.

Given the right financial incentives, as in Gujarat in India where farmers are replacing irrigated agricultural crops with irrigated forestry plantations, farmers and rural communities readily adopt tree planting options.

Project orientation can play a leading role in determining the financial viability of any programme. Growing trees simply for fuelwood production is only viable in specific cases such as close to relatively wealthy urban centres where fuelwood prices and demand are high.

Much of Africa has a plentiful supply of natural woodland and hence free fuelwood resources. In such situations, programmes which are orientated towards the production of fuelwood for either home consumption or for sale, do not pay both in terms of returns on capital or returns on labour. This fact is illustrated by an example taken from Malawi and shown in Table 7.

TABLE 7
A 1984 ANALYSIS OF THE RATE OF RETURN ON CASH, LAND AND LABOUR INVESTED IN DIFFERENT AGRICULTURAL ACTIVITIES IN MALAWI

	RETURNS TO CASH (IRR)	RETURNS TO LAND (Mk/ha*)	RETURNS TO LABOUR (Mk/ha*)
Growing poles	185%	158	8.9
Growing fuelwood	65%	84	1.0
Collecting fuelwood	Over 100%	N/A	0.3
Improved maize with fertilizer	240%	198	1.4
Local maize without fertilizer	3000%	69	0.7

(World Bank, 1984)

* Net present value discounted at 25%

Growing poles is far more attractive than growing fuelwood but may still not be financially feasible in harsh areas.

In most third world countries a high discount rate applies. Traditional forest plantations and woodlots tend to take a long time to mature and benefits only arise after 7-10 years. Shorter rotation "fuel stick" plantations may be more suitable. This is illustrated in table 8.

TABLE 8
PRODUCTION AND CASH FLOW FOR TWO TREE PROJECTS
(Van Gelder, Hovier and van der Donk, 1983)

YEAR	FUELSTICKS		WOODLOTS	
	PRODUCTION (m3)	CASH FLOW (kSM)	PRODUCTION (m3)	CASH FLOW (k.SM)
1	30	2.66		-3.67
2	30	3.43		-1.6
3	30	3.43		-1.6
4	30	3.43		-1.6
5	30	1.23	20	-1.72
6	30	-2.16		-1.6
7	30	3.43	30	3.39
8	30	3.43		-1.6
9	30	3.43		-1.6
10	30	1.23	200	32.08
TOTAL	240	18.22	250	23.92
Net present value at discount rate of:				
0%		18.22		23.92
5%		14.11		13.12
15%		9.04		2.33

The two tree projects above were:

Fuelstick: *Calliandra calothus* planted on a one metre spacing over 1ha. Harvesting was undertaken in Year 2 and each subsequent year. Replanting was done in year 6.

Woodlot: *Eucalyptus saligna* planted at a 2-5 metre spacing thinned in years 5 and 7 harvested in year 10.

The fuelstick approach became part of a technical package promoted by the Kenya Woodfuel development programme. It was found that farmers in some areas were already practising forestry systems that resembled this approach. Added advantages of the fuelstick approach was that expensive harvesting equipment was not needed and fuelwood could be harvested with a simple panga. In addition, the fuelwood produced did not have to be split and was generally the requires size for household use.

Another approach is the incorporation of trees into existing land use systems; generally termed agroforestry. Trees can often be planted in such a way that they provide additional benefits other than fuelwood. Trees used to prevent or reduce soil erosion as undertaken in Haiti produced significant increases in crop production which, in turn, resulted in many farmers opting for tree planting. Even woodlots themselves, when planted as shelterbelts and windbreaks, can lead to increased crop yields by protecting cultivated lands (Anderson, 1987) and thereby increasing the financial viability of tree planting.

Some farmers use trees as a form of investment either for retirement or during ill-health etc. (Chambers and Leach, 1987; Chambers, 1988).

Since trees only require infrequent periodic maintenance, they make an ideal investment for farmers who are unable to spend all their time on agricultural activities i.e. migratory workers. Trees, may be a more viable proposition than say cattle ownership or annual crop production. The only problem with this approach is the large initial capital outlay necessary for establishment.

It is obvious that greater attention ought to be paid to project design and economics so that strategies benefit the financial situation of participating farmers. This is not a simple matter because of the complex interaction between trees and their surroundings, particularly in agroforestry systems.

5.8 AVAILABILITY AND DISTRIBUTION OF TREE SEEDLINGS

Most rural communities in developing countries have poor access to tree seedlings. Apart from Malawi, Kenya and some regions of India, rural communities live far away from nurseries. An added problem is the generally poor transport network which tends to isolate rural settlements from main centres where trees can be purchased from nurseries.

As a result, many people may be willing to plant trees for various purposes but do not have any way of obtaining the seedlings. Even when village nurseries have been established, there is a limit as to how many trees an individual can carry at any one time or can take on a bus or taxi.

In Haiti, this fact has been accounted for and seedlings are grown in small containers enabling an individual to carry up to 500 seedlings at a time. Other options include the development of on-farm nurseries and school nurseries.

5.9 FORESTRY EXTENSION

Forestry extension is an unusual category to include under the heading of constraints for tree planting. However, experience has shown that forestry extension training has, in the past, been solely orientated towards plantation forestry with little or no social content.

In many countries, forestry extension services have been used as a policing force to protect indigenous forest resources and to impose fines on local offenders who cut trees for firewood in protected areas (Foley and Barnard, 1984; Kerkhof, 1990; Leach and Mearns, 1988; Harrison, 1987). Therefore, not only has forestry extension training been inadequate but past forestry roles have not been conducive to encouraging communities to plant trees.

In addition, it has now been recognised that tree planting requires a multi-disciplinary approach so as to coordinate it with other land use activities and to incorporate forestry into the general landscape. With the increasing role of multipurpose trees which produce agricultural commodities such as animal fodder, green manure and shelter, conventionally-trained forestry personnel become even less relevant to rural afforestation. In many instances, agricultural extension officers are more suitable for promoting tree planting in rural communities.

There is therefore a need either to retrain forestry personnel or to train agricultural extension officers in relevant forestry technologies. Retraining is often difficult because preconceived ideas are difficult to change.

6. TECHNICAL TOOL KITS

A great many forestry technical packages or "tool kits" have been promoted around the world. The general trend began with plantation forestry followed by community forestry after which greater emphasis was placed on individuals through farm forestry and agroforestry. Since there is much confusion over the definitions of the various types of forestry systems, they are discussed fully below.

6.1 PLANTATION FORESTRY

Plantation forestry generally refers to large scale monocultural plantations of trees. Trees are planted at densities of between 1000-2000 trees/ha.

Plantation forestry is a western technology designed to maximise production and at the same time ensure ease of harvesting. All trees grow at the same rate which enables mechanised harvesting to be undertaken at one time.

Depending on the climatic conditions and species used, wood production is around 10 to 30 MAI (mean annual increment -m3/ha). It has been calculated that for plantation forestry to be economic, a MAI of at least 12 is required (Anderson, 1987).

Plantations are normally managed entirely by the respective forestry departments and local community participation, apart from job creation, is neither expected nor encouraged.

Plantation forests are generally used for industrial purposes e.g. pulp production. Experience has shown that plantation forestry has little future in fuelwood provision strategies in developing countries although exceptions do occur.

In India, some plantation schemes, instead of establishing monocultural stands, have planted up to 10 tree species in plantations, mainly to appease the environmentalists (Jayaraman, 1987).

Plantation forestry may also be the only viable option for providing adequate supplies of fuelwood for urban centres where the price of fuelwood is high.

6.2 SOCIAL FORESTRY

Social forestry is a collective term used to describe forestry development which has a high degree of local participation. In other words, it is usually plantation forestry with a strong community involvement. Social forestry can be divided into two broad groups; community forestry and farm forestry.

6.2.1 Community Forestry

Community forestry programmes are based on the use of public or community lands for tree growing. They have a strong component of community involvement. In addition they are generally designed to meet the needs of the participating community. Community involvement can be in the form of labour provision, decision making, profit and resource sharing, and land provision. The degree of community involvement varies greatly among the various projects around the world.

In most of the community forestry projects in India and Africa, people are either paid in cash or given food for work incentives, the latter being the norm in Africa. Very few projects involve people supplying free labour for tree planting and maintenance even when assurances are given that the participating communities will be the beneficiaries of the project.

The size of community forestry programmes also varies from massive plantations in China to small community woodlot programmes in Africa (2-100ha).

There has been severe criticism of the community forestry approach in view of the doubtful sustainability of such policies. Since people are usually paid in one form or another to participate, tree planting by communities often ceases when funds run out.

Much depends on how the success or failure of projects is actually measured. Many projects have resulted in vast numbers of trees being planted and a reduction in fuelwood shortage. In addition, many national issues, such as high soil erosion rates, population rates and national development issues (as in Korea) have been tackled at the same time as the fuelwood problem (OH,1986).

Another criticism has been the widespread promotion of single species plantations, particularly of *Eucalyptus*. This is of concern to many environmentalists since these can result in the drying up of rivers and in the reduction of indigenous wildlife (Foley and Barnard, 1984)

For community forestry to succeed, a high consensus of opinion amongst participants is required. This, in itself, often takes a considerable amount of time to secure.

Generally, community forestry programmes are very expensive because a high proportion of the capital is spent on labour provision instead of on resource provision.

Community forestry therefore has a definite future in many specific instances but before proceeding with any development, recognition of the constraints must be taken into account.

In spite of all these problems, community forestry can be an effective measure for the provision of fuelwood and in increasing the awareness of the importance of trees to large numbers of people (Rajora and Nautiya, 1984; Paradeep, Monga and Lakharipal, 1988). In addition, the mere encouragement of community organisation can lead to sustained community action even after the project ends.

6.2.2 Farm Forestry

Farm forestry is the term usually applied to programmes which aim to encourage commercial tree growing by individual farmers on their own private land or land on which they have strong tenure rights (Leach and Mearns, 1988). Farmers are usually given incentives such as cash loans, tree seedlings and technical advice.

Farm forestry is fairly widely practised in the Asian Pacific region where large private companies have been involved in its promotion and also reap some of the rewards. Apart from the dendrothermal programme in the Phillipines, most farm forestry programmes have been orientated towards pulp production. Because of the generally low value given to firewood, farm forestry programmes cannot usually be orientated towards firewood production unless large government incentives are given.

However, there is no doubt that a certain amount of fuelwood is produced as a by-product of tree farming and the local demand for fuelwood is often supplemented in this way.

Although farm forestry entails working with individual farmers, a high level of collective action such as the formation of cooperatives is required in order to attain any degree of success.

Farm forestry development is also subject to the availability of an industrial infrastructure to support these initiatives.

Farm forestry has not been widely practised in Africa. This may possibly be a result of the tribal and social structure in African societies.

As African countries become more developed and communications and industrial activity increase, so farm forestry may have an important future in certain regions.

6.3 AGROFORESTRY

Agroforestry is the collective term for all land use systems and practices in which all woody perennials are deliberately grown on the same land management unit as crops and/or animals (Leach and Mearns, 1988; Jackson,1987; McCracken and Pretty, 1988). In order to qualify as agroforestry, a given system must have a significant economic and/or ecological interaction between the woody and non-woody components (Leach and Mearns, 1988).

Although the term "agroforestry" was only coined in the late 1970s, agroforestry is an old practice which has been used for many centuries, particularly in Africa.

Agroforestry attempts to combine the positive aspects of the stable forest ecosystem with that of the unstable but necessary agricultural system.

Ten hypotheses are put forward by Young (1989):

1. Agroforestry systems can control erosion, thereby reducing losses of soil organic matter and nutrients.

2. Agroforestry systems can maintain soil organic matter at levels satisfactory for soil fertility.

3. Agroforestry systems maintain more favourable soil physical properties than agriculture, through a combination of organic-matter maintenance and the effects of tree roots.

4. Nitrogen-fixing of trees and shrubs can substantially augment nitrogen inputs in agroforestry systems.

5. The tree component in agroforestry systems can increase nutrient inputs from the atmosphere and the B/C soil horizons.

6. Agroforestry systems can lead to more closed nutrient cycling, and so to more efficient use of nutrients.

7. Agroforestry systems offer opportunities to synchronise release of nutrients from decay of plant residues with requirement for uptake by crops.

8. The cycling of bases in tree litter can assist in reducing soil acidity, or checking acidification.

9. Agroforestry can be incorporated in systems for the reclamation of degraded soils.

10. In the maintenance of soil fertility under agroforestry systems, the role of roots is at least as important as that of above-ground elements.

Trees and other woody perennials are incorporated into land use systems to offer extra protection and additional products.

Many trees produce other products besides wood such as fodder, fruit, green manure, shade and shelter. Agroforestry attempts to use these other products to the benefit of the system as a whole.

The inclusion of trees also increases ecological diversity. This is highly important in disease prone tropical environments where farmers are unable to purchase pesticides (Swaminathan, 1987). Crop diversity also enables the work load to be spread more evenly throughout the year.

Most trees have an extensive rooting system which penetrates deep into the soil profile. Therefore, nutrients beyond the reach of shallow rooting annual crops are "tapped" and recycled through the leaf litter of the trees.

Trees are also less drought prone compared to annual crops since they make use of soil moisture deep in the profile and production is maintained in spite of mid season droughts.

Where implemented, agroforestry has shown enormous promise with regards to:

(i) Improving the productivity of subsistence farmers without high capital inputs (Young, 1989).

(ii) Reducing soil erosion in cultivated areas particularly on steep sloping land (Fenn, 1989; Young, 1989; Wenner, 1982).

(iii) Supplementary fuelwood and other wood products in rural regions.

As a result of this promise, agroforestry is now regarded as the single most important discipline for the future of sustainable development in Africa (Harrison, 1987). Agroforestry is seen as a way to solve problems of rural security by increasing total production on a sustainable basis (Jackson, 1987).

However, since agroforestry is such a new discipline, its development is severely suffering from lack of research, support and development experience.

The economics of agroforestry are also often uncertain and made more difficult because of its multidisciplinary nature (Thomas, 1990).

Because of its strong interaction with agricultural activities, agroforestry is only able to tackle the rural fuelwood crisis and in most cases other approaches are required for urban centres.

Some of the most important agroforestry systems are now discussed.

6.3.1 Alley Cropping

Most agroforestry research to date has concentrated on various alley cropping systems. Much of this research has been directed at measuring the sustainability of these systems (Young, 1985, 1989, 1990).

Alley cropping refers to the practice of planting parallel rows of trees and cultivating crops between the rows. In most cases the leaf material from the hedgerows is periodically cut and applied onto the cultivated interrow areas as a green manure/mulch. The main objective of alley cropping is for the trees to provide additional nutrients to increase crop yields.

Alley cropping systems can also be applied to pastoral production either alone or in combination with arable production depending on the tree species used. Hedgerows can be established in pastures so as to increase the total palatability of the animal fodder. Small but significant amounts of fuelwood can also be obtained in an alley cropping systems, especially if several trees within the hedgerow are left to grow unchecked.

Experience with alley cropping has been somewhat indifferent. Results from different parts of the world vary considerably. In some cases, yields of adjacent crops have not been improved or have not been sufficient to warrant the additional labour (Kerkhof, 1990), whereas in others, the opposite is true (Feddan, 1988).

6.3.2 Contour Hedgerows

A similar system to alley cropping is the contour hedgerow where hedgerows consisting of multipurpose trees are planted along the slope contour. Contour hedgerows act as barriers against soil erosion and after several years form a stable terrace system (Young, 1989).

Depending on the slope gradient and species of intercrop, hedgerows should normally be planted at 3-5 metre intervals for optimum soil conservation and crop production. The closer the hedgerow spacing, the more green manure/fodder is produced but less area is planted to the intercrop. Therefore, nutrient deficiencies and crop nutrient demand, in addition to slope gradient, will influence hedgerow spacing.

Contour hedgerows have generally been more successful than alley cropping. This can be attributed to the added benefit of soil erosion control on steep slopes. Contour hedgerows have been extremely successful in Haiti and some parts of Kenya and are likely to be the only successful method of soil erosion control on steep slopes in developing countries.

Trees used in both alley cropping and contour hedgerow systems should preferably have the following attributes:

(i) deep tap root system with few lateral roots;
(ii) tolerate frequent cropping;
(iii) have nitrogen-fixing abilities;
(iv) establishment by direct seeding methods.

The most common tree species used in these systems are *Leucaena leucocephala*, *Gliricidia sepium*, *Cassia siamea*, and *Erythrina spp*.

6.3.3 Live Fences and Boundary Planting

The establishment of live fences and the planting of trees on farm and field boundaries is a technology familiar to many subsistence farmers in Africa. When farmers are given trees, they invariably plant them on field boundaries so as to demarcate their property (Kerkhof, 1990; Leach and Mearns, 1988). The establishment of live fences has been found to be a much cheaper alternative to using wire fencing materials (Munslow, *et al*, 1988).

Live fences not only function as barriers to animal and human movement but are also able to supply significant quantities of fuelwood, fodder and food, depending on the species used.

In preventing livestock damage and reducing labour requirement, live fences allow for significant improvements in agricultural production.

Many of the African thorn trees such as *Acacia* spp are suitable for live fence establishment but to date very little research has been undertaken on this topic.

Live fences have received greater attention in Central America, evolving around the use of *Gliricidia sepium* (Budowski, 1987) which can be propagated vegetatively with ease.

In Africa, *Grevillia robusta* has been predominantly used as a boundary tree for demarcation as well as for other purposes (fuelwood, windbreaks, erosion control). Many more trees, too numerous to mention could be used for both live fences and boundary trees.

6.3.4 Windbreaks and Shelterbelts

In areas with strong prevailing winds, the establishment of windbreaks can result in up to 90% increase in crop yields (Wenner, 1982). This is directly related to reduction in water stress through reduced wind velocities and reduced evapo-transpiration.

In coastal and subcoastal regions, trees such as *Grevillia robusta*, *Casuarina spp* and *Leucaena leucocephala*, make ideal windbreaks. In colder inland areas *Casuarina cunninghamia* and *Grevillia robusta* are more suited.

Windbreak establishment could, to a large degree, replace woodlots. Instead of planting trees in blocks which provide only a monopurpose role of wood production, windbreaks result in dual purpose roles i.e. wood production and crop protection.

Correct windbreak design is important for effective wind control. Windbreaks must not act as a total barrier against air movement since wind eddies form on the leeward side. Windbreaks must filter and gradually uplift air movement which involves planting 2-3 rows of trees. Correctly designed windbreaks offer wind protection to a distance 30 times that of the height of the trees.

Trees can also be planted to protect livestock and man from the elements. Trees planted in this way are normally termed shelterbelts and shade trees. Livestock production is severely reduced when animals are under stress from heat, wind and insects. Shade trees and shelterbelts can reduce this stress, and increases in both live-weight gains and milk production of up to 50% have been recorded with provision of shade (Robinson, 1982). When provided with shade and shelter, livestock feed longer and digestion of food is more efficient, which accounts for the increase in production (Robinson, 1982).

The best example of successful windbreak establishment is that of the Majjia valley windbreak project in Niger where farmers now appreciate significant crop yield increases as a result of windbreak establishment using neem trees (Kerkhof, 1990).

6.3.5 Fodder Banks and Cut and Carry Systems

Fodder banks refer to high density plantings of fodder trees. Trees are usually planted at a density of up to 80000 trees per hectare but are only allowed to reach a height of up to 1,5m. These fodder banks can either be directly grazed by livestock or cut on a regular basis and fodder taken to livestock as in cut and carry systems. Fodder banks form reserves which can be used either to fatten livestock before slaughtering or to ensure survival during drought periods.

Although labour intensive, cut and carry systems offer an opportunity for resource limited farmers to increase their livestock production especially when livestock are contained in zero-grazing units.

Alternatively, fodder banks could also be a source of green manure for cultivated crops especially when there are either no livestock or livestock has plentiful grazing. However, alley cropping would be a better alternative since transportation of green manure increases the labour burden.

Well established fodder banks of *Leucaena* are said to produce up to 100 tons/ha of fodder per year under suitable climatic and management conditions. They are cheap to establish, since trees can be established by direct seeding methods.

Another alternative is the establishment of multipurpose tree woodlots where branches and leaves of certain fodder trees can be used to supplement fodder supplies at critical periods.

6.3.6 Home Gardens

Home garden agriculture is probably the most productive agricultural system in existence. However, it has received virtually no research interest.

Most home garden systems comprise a multi-storied agricultural environment with an infinite number of crop and plant interactions. An example would be Coconut trees used as the upper-most story followed by mangoes, then coffee, *Leucaena*, maize and lastly beans. The system is usually self-contained and each plant has a multitude of functions and uses. The great diversity of plants and products results in the system being highly resistant to pest attack. There are millions of third world farmers who rely totally on home garden agriculture for their survival. Productivity obviously varies considerably and depends on such factors as climate and this affects the degree to which the system can provide adequate supplies of food, fuel and building materials.

6.3.7 Taungya

Taungya refers to the practice of utilising forest plantations for agricultural production during the first few years of tree establishment. This system is popular with the landless poor who are allowed access to newly established plantations to cultivate between the trees until canopy closure is reached.

The plantation owner benefits from reduced weed competition and provision of seedling care, and the farmer benefits from having access to "free" land that is cultivated ready for crop planting. In some rare instances, livestock are grazed in plantations but only for short periods so as to minimise tree damage.

Taungya, in order to be successful, requires a good relationship between the forestry department and local communities.

6.4 RECLAMATION FORESTRY

Reclamation forestry is a broad term used to describe systems where trees are used to reclaim eroded or other waste land. Normally, different techniques are used for establishment compared with traditional methods of commercial forest establishment.

An example is the creation of microcatchments which concentrate runoff to specific points where trees are planted.

Since reclamation forestry involves tree planting in degraded land, productivity is a major constraint as returns of capital and labour investment are likely to be marginal.

Incorporation of leguminous fodder plants and possibly "reclamation grasses" such as vetiver may improve the financial viability of this approach since multiple products can be harvested from such a system.

To have a future, reclamation forestry will require large incentives for it to be implemented.

6.5 IMPROVED FUELWOOD EFFICIENCY

Many developing countries facing fuelwood shortages have invested time and money into developing fuel efficient stoves. Although not a forestry issue, it is worth considering as a strategy option.

Open fires are very inefficient in using wood for energy. Improved stoves can increase this efficiency by up to 10 times (Leach and Mearns, 1988). Experience has shown that improved stoves have the best application in urban and peri-urban communities which rely on fuelwood for energy. Problems with distribution prevent their use being extended into rural regions. In addition, they are bulky to transport and the poor sectors of society living in squatter camps and who may have to move at short notice tend to be disinterested in investing in efficient wood stoves.

Another problem is that wood stoves do not produce light which is another use of the fire and some communities have stated that social family events are hampered by the stove (Leach and Mearns 1988).

Even if improved woodstoves are many times more efficient, and if half the population using wood adopt stoves, it has been estimated that the impact on the rate of deforestation would be negligible (Leach and Mearns, 1988).

Strategies involving the promotion of improved stoves should thus be aimed at improving energy expenditure of urban populations and not towards solving deforestation.

6.6 TREE SPECIES SELECTION

In conventional forestry programmes, tree species selection is a relatively uncomplicated affair. Soil type and climate together with desired end product are all taken into account and a species is selected. In most developing countries today, the choice of species is taken from 2-3 species of *Eucalyptus*, Australian *Acacias* and *Pinus*.

However, in the latest rural afforestation programmes, great care is required in species selection since not only multiple uses but also the effects on the surrounding environment have to be considered. Social aspects such as ease of propagation or local knowledge/preference also have to be taken into account. These factors, combined with the great variety in climate and soil type make tree selection of vital importance and not as simple as conventional forestry.

6.6.1 Multipurpose Trees

In recent years, there has been a trend towards the increased use of multipurpose trees (MPT) in rural development programmes. This is a result of the need to satisfy a number of constraints in rural areas in addition to fuelwood. As previously discussed, fuelwood on its own is rarely seen as a major priority amongst rural communities although severe shortages may still occur.

MPTs are defined as "trees used for humans for more than one purpose, for example fuel (wood or charcoal), timber (for construction and furniture), fodder, food, medicines, fibre, erosion control and shade" (McCracken and Pretty, 1988).

Some trees are included in rural development programmes not so much for their wood qualities but for their more valuable fodder qualities e.g. *Leucaena, Gliricidia, Gleditsia* and *Chaemocytisus*.

Many African savanna trees have recently received much research interest especially in the arid regions of Asia (Hussain, 1989) but extraordinarily, very little has been undertaken in Africa itself. This situation is likely to change in the near future.

Some of the most promising and widely used MPTs are now discussed.

6.6.1.1 Leucaena leucocephala

Leucaena leucocephala is one of the ten recognised species of the *Leucaena genera*. There are over 500 different varieties of this species all with varying forms, production capabilities and uses (Brewbaker, 1987; Pound and Martinez Cairo, 1983 NAS, 1977). The number of varieties increases annually as breeders create additional strains and hybrids.

Leucaena has been termed the miracle tree because of its rapid growth and vast number of uses. Its leaves make exceptionally high protein animal fodder which has been shown to induce better live-weight gains in livestock than even lucerne (see Table 9).

Leucaena wood is also used as fuelwood, pulpwood and timber and many countries exploit the wood for generating electricity in dendro-thermal power plants (Denton, 1982; Bawagan, 1982).

Leucaena is recognised as one of the most promising trees for development purposes and has been widely used around the world. *Leucaena* has been used to reduce soil erosion, improve soil fertility and supply additional fodder. It can also form windbreaks, shade trees, nurse trees and live fences.

Its main limitation lies in its poor tolerance of frost and slow growth under acidic soil conditions. It also requires *Rhizobium* inoculation for optimum growth and some varieties can invade under specific conditions.

TABLE 9
COMPARATIVE COMPOSITION OF LEUCAENA AND LUCERNE

COMPONENT	LEUCAENA	LUCERNE
Total ash %	11.00	16.60
Total N %	4.20	4.30
Crude protein %	25.90	26.90
Calcium	2.36	3.15
Phosphorus %	0.23	0.36
Beta-Carotene mg/kg	526.00	253.00
Gross energy KJ/g	20.10	18.50
Tannin mg/g	10.15	0.13

Source: NAS, 1977

6.6.1.2 Grevillia robusta

Grevillia robusta, or silky oak, was originally imported into Africa from Australia as an ornamental tree. *G. robusta* has shown enormous promise in Africa as a multipurpose tree suitable for incorporation into agroforestry systems (ICRAF, 1989). Its major use has been as a shelter tree in windbreaks for cash crops such as coffee. It rarely competes strongly with surrounding vegetation. It produces excellent firewood and the leaves can be used as mulch for protecting soil from erosion. Until very recently this tree has received little attention with regard to research and incorporation into agroforestry systems. It is ironic that subsistence farmers in Africa were the first to recognise its potential and, on their own initiative, planted the tree on their farms.

6.6.1.3 Robinia pseudo-acacia

Robinia pseudo-acacia or black locust is a small tree which produces pods suitable for livestock feed. It is ideal for land reclamation and is used as such in mine rehabilitation schemes in the United States. It will tolerate a wide range of climatic conditions but has been little used in agroforestry systems. Its main potential lies in soil reclamation of eroded areas, providing additional supplies of fuelwood and increasing agricultural production by supplying supplementary fodder.

6.6.1.4 Gleditsia triacanthos

Gleditsia triacanthos, or honey locust, has been widely planted in the colder regions of South Africa i.e. Orange Free State, Southern Transvaal. Its main attribute is that it produces pods with a high sugar content which can be fed to livestock. The tree originates in North America and has been cultivated in many varied climatic regions as a source of fodder. It also produces a dense hard wood which makes excellent firewood. Honey locust has both thornless and thorny strains.

Much interest was directed towards honey locust in the 1950's in South Africa but this interest practically ceased because of disappointing results. These may have been due to the poor integration techniques applied to honey locust. On their own, honey locust trees are of little use, but when incorporated into agroforestry systems, a great range of benefits is produced. Thorny strains make excellent live fences and others make good windbreaks and shelterbelts. They can also be used as contour hedgerows and form an integral component of multipurpose woodlots.

6.6.1.5 Paulownia

Paulownia originates in China and is the only genus of the family *Scrophulariaceae*. *Paulownia* grows extremely fast and has been reported to grow up to 2m in one year in Australia (Farm Fodder News, 1988). *Paulownia* is deciduous and has large petiolate leaves. The leaves can be used as green manure or animal fodder and the wood for building purposes and also for pulp and paper production (Siddiqi and Khan, 1989).

Paulownia has a moderate to high tolerance of frost but requires at least 700mm of annual rainfall for optimum growth. Because of its deep rooting system, it is highly suited for intercropping with annual crops (Siddiqi and Khan, 1989).

6.6.1.6 Chaemocytisus palmensis

Chaemocytisus palmensis, or Tagasaste, originates in the Canary Isles and is found on rocky, steep sloping volcanic soils. Its leaves produce one of the best tropical animal forages which can also be used as a green manure (Wood, 1989). Table 10 compares the nutritional value of tagasaste with that of conventional pasture.

TABLE 7
NUTRITIONAL VALUE OF TAGASASTE

FEED		DIGEST	PROTEIN	P	S	K	Ca	Mg	Na
Tagastase	leaves	72	22	0,16	0,16	0.97	0,68	0,20	0,06
	stems	40	9	0,07	0,06	0,72	0,21	0,11	0,06
	branches	52	6	0,05	0,03	0,54	0,10	0,06	0,04
Pasture	green	78	22	0,43	0,25	3,39	0,49	0,22	0,37
	dry	55	14	0,23	0,25	2,34	0,70	0,32	0,54

Source: Wood (1989)

It has a deep tap root and is leguminous. it develops into a small to medium sized tree (6-9m at maturity). Tagasaste has a high tolerance of drought and moderate tolerance of frost but it is unable to tolerate waterlogging.

At present, the tree is virtually unknown in Africa but it has a very high potential for incorporation into agroforestry systems and therefore should be promoted especially in coastal regions.

6.6.1.7 Gliricidia sepium

Gliricidia sepium originates in South America and, in its natural form, is a medium sized tree with a height of up to 20 metres. It is intolerant of frost but is able to survive long periods of drought when well established. The leaves make excellent fodder and green manure and promising results have been obtained using this tree in various alley cropping systems (Atta-krah and Sumberg, 1988; Cobbina, Kang and Atta-krah, 1989).

The greatest advantage of *Gliricidia sepium* is that it can be planted as a cutting which not only saves considerable costs of seedling production but also results in rapid establishment. However, trees planted in this way result in lateral root formation which can contribute to aggressive competition for nutrients and water with surrounding crops.

Gliricidia's main role in future afforestation programmes is in contour hedgerow agroforestry systems providing fuelwood, fodder and erosion control.

6.6.1.8 Acacia albida

Acacia albida is native to Africa's dry savannas and riverine basins and occurs in central and Southern Africa (NAS, 1983).

Contrary to usual tree behaviour, *A. albida* sheds its leaves during the rainy season and retains them during the dry season. It is able to survive in regions with only 300mm of annual rainfall but is susceptible to frost damage. It has a deep tap root which enables the tree to have a high tolerance to drought.

A. albida has only received limited attention with regard to its incorporation into agroforestry. Because of its peculiar habit, it is a very attractive proposition for agroforestry development.

Since the tree is leafless in the summer rainy season, it does not shade out underlying crops and in winter it forms shade for animals. The wood makes excellent fuelwood and the pods are used as animal fodder. The leaves are rich in nitrogen and by falling in the spring provide nutrients for underlying crops. It has been observed that crops grown under *A. albida* trees yield over twice as much as to crops grown in the open (Poschen, 1986).

With all these attributes, it has been calculated that an individual tree is worth the equivalent of US$60/yr to the subsistence farmer in terms of wood, animal fodder and plant nutrients (NAS, 1983).

Although the tree is relatively slow growing, some individuals can grow extremely fast. In Kenya, seedling selection trials have been established and have resulted in up to one metre per year growth in some areas (Fenn, 1986).

6.6.1.9 Acacia karoo

Acacia karoo is also native to dry savanna regions of Africa. In South Africa, it is more widespread than *A. albida* since it has a higher tolerance of frost. In many heavily grazed regions it has invaded and formed dense impenetrable thorny thickets.

Acacia karoo is an important source of animal feed and fuelwood in many indigenous woodlands. Like most African savanna trees, it has received very little attention. It is highly adaptable and can tolerate a wide range of climatic conditions.

However, its main use could be in the formation of live fences and hedgerows established around cultivated areas and homesteads to prevent livestock damage to crops.

6.6.1.10 Casuarina spp

The *Casuarina* family originates in Australia and has been widely planted in Africa as windbreaks, particularly for protecting citrus orchards. Although *Casuarina* does not coppice readily, it recovers easily from pollarding. *Casuarina* is highly tolerant to drought, frost and waterlogging.

Casuarina are also reportedly able to fix nitrogen via symbiotic bacteria in spite of not being a legume.

The main disadvantage of *Casuarina* is that it uses large amounts of water and can compete aggressively with surrounding vegetation for nutrients and water.

Trenches dug alongside *Casuarina* trees, cutting through lateral roots, reduce surrounding competition.

6.6.1.11 Other Multipurpose Trees

There are many other trees that have a high potential for incorporation into agroforestry systems. They include *Prosopis genera* together with a wide range of African savanna trees.

The main constraint limiting their future exploitation by man, is the dearth of research information and efforts aimed at improving production. This is unfortunate, since these developments are time consumming and it will be a number of years until we can being to reakise their full potential.

6.6.2 Debate on Eucalyptus

Eucalyptus spp have been widely planted in Africa. They have been planted in both industrial and community forestry programmes. Ethiopia's capital, Addis Abbaba, relies totally on *Eucalyptus* species for its urban fuelwood supplies.

Most *Eucalyptus* spp grow extremely fast even under arid conditions and also on poor sites. Wood from *Eucalyptus* makes excellent firewood, particularly *E. camuldulensis*, and other species are used to provide high quality pulp for paper manufacture.

In spite of all these attributes, *Eucalyptus* spp have come under considerable attack in a number of countries (Foley and Barnard, 1984; Munslow, 1988). They have been criticised for depleting soil fertility, lowering water tables, causing soil erosion, and competing harshly with surrounding vegetation. In addition, many *Eucalyptus* trees are planted in large monocultural plantations, and have come under criticism from environmentalists.

If *Eucalyptus* had not been widely planted, it is highly unlikely that it would have received this amount of criticism. The fault lies not with the tree itself but the method in which it has been planted.

Small clumps of *Eucalyptus* have a limited negative effect on water table levels as demonstrated by the fact that water flow in streams have rarely been affected in such circumstances (Anderson, 1987). In fact, it is possible that, with increased tree cover and hence protection from soil erosion, it is also possible that they have actually improved water table levels in some cases.

This also applies to agricultural production. Although *Eucalyptus* competes strongly with other vegetation in the immediate vicinity, if correctly planted in small clumps the overall effect, through the creation of a more beneficial microclimate, may in fact be more favourable in terms of crop production (Ahmed, 1989).

Many farmers, particularly those practising farm forestry, find the establishment of *Eucalyptus* woodlots a highly attractive financial proposition surpassing even agricultural production in some regions.

Any form of monocropping is detrimental to the environment, whether it be trees or crops, and therefore is to be avoided if sustainable development is the prime objective. The problem of *Eucalyptus* being a monopurpose tree, solely based on wood and timber production, can be altered through a more land system orientated approach to planting and establishment. Establishing *Eucalyptus* plantations around villages as windbreaks and shelterbelts enables the plantation to serve more than one purpose. Cultivating crops during the first few years of establishment (see 6.5.7) may also be another viable option.

Eucalyptus is likely to remain an important exotic tree for rural afforestation programmes and silvicultural research should be directed at incorporating it more efficiently into the existing landscape so as to achieve maximum benefit with minimal negative side effects.

6.6.3 Beware the Magic Tree

Leucaena leucocephala has often been referred to as the magic or miracle tree as a result of spectacular growth performances and multiple uses. In the Philippines, *Leucaena* has recorded the fastest rates of any tree previously measured.

In addition, wood products have been put to multiple end uses such as fuelwood, charcoal, building material and pulp. *Leucaena* also produces large quantities of high quality fodder of similar nutritional value to that of lucerne. Experience has shown that improved live weight gains in ruminant livestock have been achieved using *Leucaena* in the diet compared with lucerne (Pound and Martinez-Cairo, 1983).

Although *Leucaena* is highly adaptable and fast growing under suitable conditions, it has been shown to fare poorly in some areas, shattering the expectations of project staff (Kerkhof, 1990). Leucaena fares badly on highly weathered acidic soils, areas of high altitude (above 1000m) and in low rainfall regions (below 500m/yr). Leucaena breeding programmes have been initiated around the world to combat these problems. In Colombia, research is orientated towards increasing the tolerance of Leucaena to acidic soils and higher altitudes (Hutton, 1084). In the U.S. and Australia, efforts have been made to increase the tolerance to frost.

What is clear is that different *Leucaena* strains (there are over 500) show different performances and it is vital to use the improved Hawaiian Giant varieties.

Although *Leucaena* is generally resistant to pests, *Heteropsylla cubana*, the *Leucaena psyllid*, has become the most severe pest on record during the last decade (Brewbaker, 1987). It threatens to destroy many thousands of hectares of established *Leucaena* plantations in both the developed and developing worlds. Both biological and genetic control is seen to be the solution to solving the problem of *Leucaena psyllid*, however, project planners must take precautions against project failure resulting from attack.

Another problem that has been noted, particularly in Africa, is the susceptibility to attack by termites (Kerkhof, 1990; Brewbaker, 1987). Chemical control measures may be necessary in such cases.

If *Leucaena* is planted in ideal conditions, high productivity is practically guaranteed. Project planners must therefore carefully examine the environmental characteristics before attempting to establish *Leucaena*. In addition, selection of high quality seed sources must be used. It is highly probable that new varieties suitable for previously unsuitable environments will come onto the market. These activities should be continuously monitored.

6.7 DECENTRALISED NURSERIES

Centralised government run nurseries have many advantages such as efficient seedling production allow quality and number of seedlings produced to be controlled.

However, distributing seedlings to rural areas, often in remote sites with poor roads, invariably leads to only half the produced seedlings reaching the target population (Kerkhof, 1990) and adds considerable costs to any programme.

Many projects which have begun with centralised nurseries have altered overall project policy and initiated the establishment of nurseries in villages or on individual farms. In many instances, local nurseries have begun as holding depots, receiving trees from centralised nurseries, and after training from project staff, have developed into **bona fide** nurseries in their own right.

Local decentralised nurseries have been established by communities, individuals and at schools. In some areas, particularly in Malawi and Kenya, it was found that a significant number of farmers already had basic forms of nurseries. In these instances, it is far better to develop these nurseries than to create new large centralised ones.

The main attraction of local decentralised nurseries is that tree production, even after programme funds have ended, can be continued, thereby creating a high degree of sustainability.

6.8 SUSTAINABLE FOREST MANAGEMENT

There are only a few examples of community forest management programmes designed to enhance existing resources. Few foresters have extensive knowledge of indigenous woodland and generally see indigenous trees as slow growing and unproductive.

Unproductive in terms of fuelwood production maybe, but indigenous woodlands provide much more than just wood; fodder, food, shelter, wildlife (hunting opportunities) and natural medicines are al produced in various natural forest vegetation types.

In addition, natural woodlands also have the advantage of being totally adapted to the prevailing climatic conditions and local people are familiar with the many attributes of individual plant species.

The establishment of plantation forest projects has sometimes involved the clearing of natural woodlands. Apart from the high cost of establishment, many exotic plantations have failed to perform at expected level and in extreme cases are less productive than the indigenous vegetation that they have replaced (Timberlake,1985; Leach and Mearns, 1988).

Natural woodland management does not involve expensive establishment costs, and by building on existing local knowledge by simply creating community organisational structures, sustainable forest management be achieved.

Natural woodland management could be seen as a phase of development where communities are taught to organise themselves and make their own decisions to improve their environment and begin to greater appreciate the role of trees. Later phases could involve the introduction of exotic trees or nursery technologies.

Another option is to improve genetic material of indigenous trees as has been attempted in Kenya with **Acacia albida** (Fenn, 1986).

Forestry research has, in the past, been biased towards commercial species and very little has been undertaken on improving individual species.

Fuelwood management may possibly be the only suitable option particularly in harsh environments where traditional forestry is uneconomic. Encouraging natural regeneration of forest resources is the most cost effective way of ensuring future fuelwood supplies and reducing deforestation.

6.9 IRRIGATED FORESTRY

The high demand for products, particularly fuelwood, poles and pulp, has led to to the establishment of irrigated plantations (Armitage, 1985; Yahia and Bushara, 1985 Gupta, 1979). In some cases, financial returns are higher than those from irrigated arable crops and have led to many farmers converting to irrigated farm forestry (Gupta, 1979).

However most irrigated schemes have failed when they were orientated solely for the purpose of fuelwood supply. This was due to the generally low prices that fuelwood fetched on local markets and the high cost of establishment and maintenance of irrigated schemes for multi-purpose objectives.

Salinisation of irrigated soils is a major worldwide problem. It has been estimated that over 2,75 million ha of irrigated forestry have so far been destroyed in this way (Myers, 1985).

Excessive irrigation with inadequate drainage, canal seepage, high soil surface evaporation rates and poor irrigation water are the main causes of salinisation.

The incorporation of trees into irrigation schemes can be used for both preventive and reclamation measures. Trees may be planted so that they will utilise excess sub-soil water and hence reduce the chance of rising water tables.

In extreme cases, trees can be used to reclaim salt-affected soil since certain trees have a high tolerance to both waterlogging and high salinity levels (Firmin, 1968). The use of trees to combat salinisation offers a cost-effective solution because the products, such as timber and fodder, can go a long way to offset the costs of reclamation.

It has been calculated that a mature tree causes evaporation of between 50 and 90 m^3 of water annually which is as much as a drain usually collects and discharges for every metre of its length (Kovda, *et al* 1973). As a result, tree planting can lead to a lowering of the water table by 0,7 to 1m after which excessive irrigation applications can be applied to leach out salts from the top-soil.

Trees also reduce soil surface evaporation by reducing surface windspeeds. This has beneficial effects in terms of crop yields and reduced salt accumulation (Armitage, 1985; Ali Ahmen Saleem, 1985; Ball, 1985, El HabibHammad *et al* 1985).

In addition, trees can be periodically cropped to provide green manure which ultimately improves infiltration and leaching.

Most developing countries have large scale irrigation schemes and attempts to incorporate trees should be considered, similar to Egypt and Sudan.

6.10 RESEARCH REQUIREMENTS

Many of the "technical toolkits" are relatively new on the scene of rural afforestation, the agroforestry systems in particular. Agroforestry has only been investigated seriously since 1977 and actual programme implementation has been much more recent. It is still too early, therefore, to indicate to what extent each system will contribute towards rural afforestation and fuelwood provision in the future.

Because most systems are recent developments, they suffer from lack of research back-up and information. The Haiti Agroforestry Outreach Project, for example, was implemented through necessity without any previous experience in the region. Many other programmes have been initiated under the same conditions.

There is thus a dire need to institute intensive research trials in the various ecological and economic conditions as soon as possible.

Many programmes involving the use of **Leucaena leucocephala**, which is perhaps the most researched multipurpose tree, have still failed in spite of pre-implementation estimates based on existing knowledge. In many such cases, it is not that the system has failed to increase productivity but, even worse, that the trees failed to survive. This illustrates how far agroforestry research has to go before concrete predictions can be made, especially if it is considered that most other multipurpose trees have hardly been researched.

Another problem experienced is that research data collected from replicated trials at research centres has, in many cases, yet to be duplicated by farmers in surrounding areas. Lower levels of management may be the main reason but this must be accounted for in future research programmes.

One possible solution to this problem is to include programme participants in future research projects using on-farm trials, thus giving the farmer himself the opportunity to experiment. Although it may be impossible to obtain scientifically sound results, any results will be of high relevance to any future development. At least a "Yes, No" answer would be obtained with such an approach.

Another important priority is research into indigenous trees, existing fuelwood resources and sustainable management strategies. It is simply not feasible financially to plant trees in most arid areas, for a variety of reasons. Some other options include allowing natural regeneration of indigenous woodlands accompanied by sustainable management. Very little research has been done on these aspects and only recently has a comprehensive study been undertaken on the vegetative resources of Southern Africa (excluding South Africa) (Millington and Townsend, 1989).

The economics of agroforestry also requires further research since this is of vital importance in determining overall strategy and selecting the most suitable systems for particular areas. Agroforestry economic models have already been formulated (Thomas, 1990) but their general applicability over a range of situations is questionable.

As time goes on, a great deal more research data will become available as projects mature (Young, 1989). However, this will not be enough and much more is required. This will require large injections of both finance and technical expertise through national and even international research programmes. Many countries will not have the available capital resources for such an undertaking and outside assistance will be required.

All these research objectives must be met in the near future so as to reduce the wasted effort of development and to allow the implementation of sound principles before time runs out.

7. ESSENTIAL CRITERIA FOR PROGRAMME SUCCESS

7.1 PROGRAMME DESIGN

The cumulative time given to rural afforestation in the third world represents many hundreds of years of development experience. Even with this great mass of experience, no definitive package exists that will ensure the success of any programme. On the other hand, given the great variety of environmental and social factors existing in developing countries, a whole variety of techniques should play a beneficial role in afforestation development.

What has emerged is that there is a trend towards greater emphasis on extension and training and community participation in project design.

Building on existing knowledge of the target population is also important since this tends to be underestimated and can lead to incorrect assumptions which will ultimately affect project design and success. As has already been discussed, fuelwood demand and priority must be investigated alongside constraints to tree planting and economic and "survival" activities of target populations in order to create the best chances for success.

All this may take a great deal of time and money which could otherwise have been spent on programme implementation. A method used to overcome this problem is the Rapid Appraisal Technique for rural areas; one such technique is "Rapid Rural Appraisal" (RRA). RRA can be defined as a systematic but semi-structured survey carried out in the field by a multi-disciplinary team and designed to acquire quickly new information on, and hypotheses about, rural life (McCracken and Petty, 1988).

RRA cannot totally replace complete surveys but can identify key issues and possible methods of interaction. It can also be used to include paticipatory "bottom up" approaches, helping rural populations to solve their own problems but, at the same time, provide programme designers with vital information on the extent of knowledge of the target populations.

7.2 COMMUNITY PARTICIPATION AND MOBILISATION

In addition to encouraging populations to participate actively in programme design, all successful projects have also included a strong community participation in the implementation stage.

The provision of adequate incentives is the key to community participation. In Asia, this has been achieved through job creation together with post harvest benefits. In extremely por regions of Africa, food for work has been a significant factor in promoting community participation.

However, paying people in kind to participate in their own development requires massive inputs of financial assistance and is arguably not sustainable because programme activity ceases when funds dry up. In many instances, this method has been the only way to achieve results, especially if the programme was strongly orientated towards supplementing long term national interests.

Many agroforestry programmes have been orientated towards providing significant financial gain through increased production as the primary incentive for participation. The participating individuals and communities would invest time in programme activities with no direct financial reimbursement.

Although this must be seen as the ultimate goal, with aid being spent more effectively on development, the key to attaining this goal is reliant on the specific technologies that are promoted. However, promoting the most appropriate technology has been the most difficult problem since many agroforestry systems work well under experimental conditions but not in real-life situations. More intensive agroforestry research and development will, to a large extent, resolve this problem.

Another common factor in successful afforestation programmes is strong governmental support linked with extensive institutional development. This enables large numbers of people to be able not only to gain information and advice but also to coordinate development programme direction. Without institutional development and government support, afforestation programmes generally remain in isolation, limiting otherwise achievable success.

7.3 EXTENSION TECHNIQUES AND RURAL FORESTRY TRAINING

As previously stated, greater emphasis is now being placed on extension activity and forestry training. Approximately 30% of World Bank funds for forestry development is allocated for these purposes (Spears, 1987). Since many of the new forestry technologies, particularly agroforestry techniques, are unfamiliar to local communities, they must be "sold" to participating communities and individuals (Casey, 1983).

Various approaches have been tried in promoting technical packages.

7.3.1 Demonstrations

Demonstrations have had only limited success in agroforestry and forestry promotion. In Kenya, a high degree of success has been achieved, but generally demonstrations in the form of model farms have been poorly received by target populations and they only served as isolated islands (Kerkhof, 1990).

However, when incorporated into national research and development programmes, they are valuable in training project personnel, extension officers, and schoolchildren and also provide important research results. Initially, agroforestry and forestry trials can be established for research purposes, and later, the promising systems used for demonstration purposes.

For direct promotion and training of target populations, on-farm trials are of great importance. Farmers themselves are encouraged to use their farms to experiment with new technologies. On-farm visits by surrounding farmers can then serve to promote greater awareness of new systems.

To date, only Kenya and possibly Malawi, have managed to develop comprehensive regional demonstration centres together with on-farm trials.

Therefore, both demonstrations and on-farm trials have a role in promoting agroforestry, but recognition of these roles must be considered.

7.3.2 Schools

Since schoolchildren are the future generations, it is of vital importance to include schools in afforestation programmes at both regional and national level. Great success has been achieved by using schools either for providing trees through nursery establishment or by using schools for demonstration purposes.

Incorporating tree planting and nursery production into educational curriculae can make an important contribution to rural life and in addition, get vast numbers of trees planted in target areas.

7.3.3 Audiovisual Aids

Audiovisual aids (AVA) are playing an ever-increasing role in promoting tree planting in rural regions.

They include videos, slides, posters, flannel board pictures, pamphlets and drama.

Video and slide shows require electricity and darkrooms which may not be available in remote rural areas, although they are able to attract large crowds and keen interest. The shortage of facilities has been overcome, particularly in Francophone Africa, with the use of flannel board pictures which depict various tree planting systems (Kerkhof, 1990).

Visual aids should be strongly orientated towards and applicable to local life in the specific area to have real impact.

In some programmes, lack of electricity has been overcome by the use of solar-powered, battery-operated equipment but obviously this entails additional costs.

7.4 PROGRAMME FLEXIBILITY

One of the most overlooked facets of rural development programmes is programme flexibility. Far too many programmes have been initiated with definite plans, targets and objectives with little room for alternatives. Since there is a sharp learning curve for both project staff and project participants, greater flexibility is required so that successful development can take place.

This enables adaptations to be enacted as a result of feedback by participating communities and individuals.

7.5 WOMEN'S ROLE IN AFFORESTATION

Many programmes have failed because they have neglected to take cognisance of the role of women in rural life. Women collect almost all the fuelwood and water and prepare all the food. They also produce most of the food - African women produce 85% of all Africa's food (Timberlake, 1987) and over 50% of all third world farmers are women (Sen and Grown, 1988).

Men, on the other hand, make all the decisions but do little of the everyday work that concerns agriculture and fuelwood provision. They also tend to underestimate the value of women's work (Sen and Grown, 1988) and are generally more interested in activities which generate cash.

Women, therefore, play the major role in managing natural resources and are the hardest hit by environmental mismanagement. Yet they are rarely taken into account by development planners and policy-makers (Dankelman and Davidson, 1985).

Women are likely to play a more important role in the future because a higher proportion of men are becoming migrant labourers. More women than ever before are heads of households and many more are playing major economic roles especially in cases where the men are unemployed (Sen and Grown, 1988).

Many projects have recently increased the number of women extension officers so that programmes can be directed more at women. Women have also been encouraged to participate along with men in decision-making. This is not always easy because men may become threatened by increased women's power - at the expense of the programme.

In some societies, although women are responsible for fuelwood collection, they are not allowed to plant trees because it is associated with pole production and hence cash generation (Leach and Mearns, 1988). This has been overcome by planting fast-growing, woody shrubs which produce fuelsticks, not considered to be trees by men.

There is little doubt that, by not including women in some way in project planning, programmes orientated around fuelwood and fodder production will have little long-term chance of success.

PART IV: CONCLUSIONS

8. CRITERIA FOR ASSESSING PROGRAMME SUCCESS OR FAILURE

Many of the programmes discussed in this report have been previously analysed by various authors at one time or another. What is clear is that it is very difficult to determine whether or not the programme has been successful.

What factors should be monitored to determine project success or failure? Which are most important? Some of the major factors are:

(i) Number of trees planted
(ii) Extent of benefits to participants
(iii) Degree of community participation
(iv) Sustainability of programme
(v) Cost benefit/achievement per unit cost
(vi) Benefit to the environment

In all probability, a combination of all factors will have to be evaluated for individual programmes and, in addition, a component of any negative effects must also be included.

The easiest factor to monitor is the number of trees planted. Far too many programmes have concentrated too heavily on this factor, mainly to be able to provide sponsors with impressive results. Large numbers of trees being planted, however, do not necessarily imply that people benefit. On the contrary, many individuals could actually be suffering as a result, particularly if they have been displaced or have had to experience a loss of resources such as grazing rights.

Comparing total programme costs with achievement can also be misleading, giving false indications of the degree of success of programmes. When evaluating programmes in terms of number of trees, it is important to include whether participants planted trees on their own account or were paid in kind, or were even forced through "strong arm" political tactics.

The extent of community participation can give a valuable indication to the degree of success of a project. However, many programmes have involved either food for work or cash incentives which can produce misleading results, not that these programmes do not deserve merit. There are instances where communities are so poor that they are unable to contribute even their time without these incentives. In any event, this approach must be considered preferable to food aid, as in Ethiopia, which does little to stop future incidences of starvation.

The other determinants mentioned are even more difficult to assess and may not be clearly visible. This is particularly true of long-term benefits which can play a progressively more important role with time. Since most programmes only run for 3-5 years, after which they require extension of funding, these effects may not be apparent and not be accounted for in programme evaluations.

In conclusion, particular care must be taken in programme evaluation since it can also affect actual implementation. Programme designers and managers, forced to achieve short-term impressive results for the sponsors, make it even more difficult.

As can be seen in Appendix 1, many forestry programmes have been running for many years and it is still difficult to evaluate them fully in term of long-term sustainability and community benefit.

9. AFRICA VERSUS ASIAN-PACIFIC

Tree planting in Africa has generally been abysmally poor compared with that in the Asian-Pacific region.

It is not easy to account for this but one possible explanation is that the Asian-Pacific region has a much higher population density, forcing people over the years to farm more intensively. This is also the case in the highly populated African regions such as the central highlands of Kenya and Rwanda where high population densities are accompanied by high tree densities. The sparsely populated areas of Africa are generally the problem areas. In addition, Africa has generally poorer soils, accompanied by a harsher climate, than Asia (Harrison, 1987; Timber Lake, 1985). Many of the forestry programmes in Asia began in 1950's whereas most African programmes only started in the late 1970's and early 1980's.

The impressive results in both China and Korea have had massive political inputs which largely account for their success. In China, programmes have been dictatorial and, in Korea, government input was in the form of support and institution building. It is very doubtful whether these achievements can be duplicated in Africa but Kenya has had it's own impressive achievements which, as with China and Korea, can to some extent be accounted for by strong government support and leadership.

In China, impressive social forestry programmes have been implemented but most of the local input by communities has been paid out of programme funds, hence the large number of trees planted. These early successes in Asia influenced many aid organisations in Africa, but as it turned out, these approaches simply do not work as well in Africa.

In the Pacific region, in countries such as Taiwan and the Phillipines, large incentives from both government and private sector account for their successes, together with a large component of institution building. These governments decided that creating farm forestry enterprises was in the national interest and so extensive effort was made to achieve these objectives.

In Africa, on the other hand, no such incentives exist. Few governments have a national plan for re-afforestation or for the creation of farm forestry nor have they implemented any.

As previously stated, rural communities in Africa have generally been neglected in favour of urban inhabitants and there is little incentive for either agricultural or forestry development.

Much must be said for the organisational ability of the peoples of the Asia-Pacific region. They are able to mobilise many thousands of people in a short space of time to achieve programme objectives. In Africa, this ability is not evident. There is still much tribal conflict and rivalry which does nothing for national interests and especially rural development.

The effects of past colonisation may also be a factor. In Asia, colonial administrators tended to include locals into the system, whereas in Africa, locals were totally excluded (Harrison 1987). During the post independence period, African countries therefore experienced a lag period and some still seem not to have recovered.

Africa thus requires a different approach to that of the Asian-Pacific region to account for these differences. The situation would improve, however, if African farmers were given the same incentives as their Asian-Pacific counterparts. Governments and decision makers in Africa should therefore create these incentives.

10. BASIS FOR AN ACTION PLAN FOR SOUTH AFRICA

At first sight, South Africa may be seen to exhibit large differences compared with other countries in Africa because of the high level of industrial and infrastructural development. This has certainly led to differences in socioeconomic characteristics, particularly in urban areas.

Energy consumption patterns also differ since paraffin, gas and electricity are of much greater importance in South Africa. Fuelwood is no longer the sole available source of energy, even in rural areas. This is especially true of the central Highveld regions where natural forest cover is poor and population density high.

South Africa's greater availability of foreign currency and more developed infrastructure have also facilitated the procurement and distribution of alternative sources of energy.

In addition, there are generally greater opportunities for cash income among the poor sectors of society, which means that these alternative fuels are not necessarily beyond the reach of the vast majority of the population.

However, in terms of climate, soils, vegetation and landscape, South Africa experiences many of the same constraints in relation to development issues such as fuelwood provision and rural development.

Populations in many regions of South Africa rely heavily on wood as a source of fuel. This is particularly the case in the homelands and it has been estimated that approximately 12 million people in the rural areas of South Africa have a high dependence on wood for fuel (Haigh 1984). In these areas, as in so many African countries, agricultural production is abysmally low and is accompanied by high soil erosion rates. Deforestation and subsequent fuelwood shortages are also major problems.

The trends in poverty, malnutrition and energy are therefore comparable in these areas to other countries in Africa. The experiences outside South Africa, therefore, are directly relevant to the situation here and any action agenda should take these into account.

10.1 LESSONS FOR SOUTH AFRICA

Like so many other developing countries, the South African authority's answer to the fuelwood crisis has been the "Eucalyptus woodlot syndrome" which has been widely promoted to ill-effect by most development planners. Most African countries have changed to more appropriate technologies but South Africa has unfortunately continued to pursue this approach. Although not altogether inappropriate, this is by no means the key to solving the fuelwood crisis, as can be seen by the many examples previously discussed.

Afforestation and energy provision strategies for rural areas require a holistic approach and must be incorporated into other rural development activities such as agriculture. Woodlots designed specifically for fuelwood production rarely fit into such an approach and generally lead to land use conflict.

Given the fact that fuelwood, even when scarce, is generally perceived by rural communities as being low priority compared with water supply and food production, approaches directed solely at addressing fuelwood problems have little chance of success. Instead, policies must be primarily concerned with activities of higher priority and only include fuelwood provision as a secondary or even tertiary objective. Various agroforestry technologies with their multidisciplinary structure offer great potential in this regard.

Another major lesson is that marketing afforestation and tree planting must be directed more to individuals than to communities and must be accompanied by a revised extension service. This may have to involve a degree of institutional development which will not be easy under the present socio-political circumstances prevailing in South Africa.

It is also very clear that attempts to promote tree planting must be financially attractive (at high discount rates in most cases) to potential participants. In eroded or semi-arid environments with low potential, tree planting may not be financially viable and individuals and communities will resist attempts aimed at promoting tree planting if they are not given any compensatory incentives. These incentives must either originate from new forest technologies such as agroforestry or, failing that, from government subsidies.

10.2 RECOMMENDATIONS

Based on these experiences, the following recommendations are proposed :

10.2.1 Resource Inventories and Social and Market Surveys

Since many projects have in the past failed as a result of incorrect assumptions concerning natural and social resources and fuelwood use and markets, these types of surveys are urgently required in South Africa.

South Africa's vegetation was last mapped on a nationwide scale in the 1950's; these surveys are therefore totally inadequate for planning fuelwood strategies within a national programme.

Estimates of fuelwood resources, together with a proposal for sustainable management should be included in any future survey. In addition, information on fuelwood use and demand, deforestation rates and existing tree planting will contribute significantly towards the development of successful strategies for the future.

However, the planning and implementation of such strategies is not only time consuming but also very expensive. It is therefore suggested that each region be classified according to broad priority ratings based on population density, severity of poverty and environmental degradation.

These surveys should be accompanied by market surveys to investigate demand and possible pricing structures for fuelwood and timber products.

10.2.2 Agroforestry Development and Training

From experience elsewhere, it is clear that agroforestry has enormous potential to provide a holistic approach to rural development and energy provision. However, it will be difficult to promote without support from both decision makers and research bodies.

There is therefore an urgent need to initiate a coordinated agroforestry research and development programme on a national basis. The best way to achieve this is to establish regional research and demonstration centres which would initially be solely involved in research but would evolve into demonstration projects. These centres would have both short and long term objectives; short term research and long term demonstration and training.

Although demonstrations have had limited impact as an extension tool to farmers and communities, they are ideal for training extension staff and influencing decision makers. Demonstrations could also attract input from the private sector particularly if farm forestry technologies were promoted at each centre.

Centres would consist of trials particularly suited to the region. Both governmental and non-governmental development projects could subsequently rely on support from these centres. Without this level of development and support, agroforestry is highly unlikely to have a major impact in South Africa.

10.2.3 Institutionalisational Development

In order to achieve the required level of interest and development in tree planting in rural areas, some form of local institutional structure is required. This could be associated with the formation of a chain of village development committees.

Young farmers clubs or 4 H clubs are also ideal mediums which should be promoted in order to develop collective action on a large scale. Existing educational infrastructures could be used to initiate such actions together with the involvement of private enterprise.

10.2.4 Government Support

It is clear that success is usually related to strong government support both in terms of financial support and the creation of beneficial mediums for development.

Financial support could be in the form of research grants and subsidies and beneficial mediums could be created through incentives for private sector involvement.

In addition, many farmers and communities are severely restricted though lack of access to capital and providing them with this, together with the most appropriate technologies, will enable development objectives to be obtained.

10.3 CONCLUSIONS

Although it is true that South Africa is more developed than the majority of other African countries, it is very clear that poverty and the fuelwood crisis cannot be overcome using purely western technologies. Electricity and other higher forms of energy **are** likely to be more important in South Africa, particularly in urban areas, **but** a great majority of the population will still not have direct access to these forms of energy in the foreseeable future. The main limitation to this access is the relatively high cost.

Therefore, fuelwood will remain an important energy source in South Africa, particularly for the poor. Afforestation and fuelwood provision strategies will therefore be of vital importance in future development programmes in South Africa. Although alternative forms of energy are readily available, they are relatively expensive, and because of the absence of a cheap fuelwood alternative, the poorest sectors of society have to spend an unacceptably high proportion of their income on fuel. This means that money that could be spent on individual advancement is being used for mere day to day energy provision, which further entrenches poverty.

South Africa is at a crossroads in its future development. Either it will remain a third world country, with a high proportion of its population poor and unproductive, or it must initiate policies to invoke sustainable development on a large scale, transforming the country into the "Japan" of Africa. It is clearly evident from countries such as Brazil that attaining satisfactory levels of development will not be achieved through rapid industrialisation alone (Bennet and George 1987).

The alleviation of poverty, together with the creation of a stable, productive rural economy, is a prerequisite for successful industrialisation, as was shown in the western world and, more recently, in countries such as Korea and Taiwan.

It will not be achieved through the adoption of western technologies such as capital intensive agriculture and forestry. Experience has shown that rural communities in Africa will not readily adopt plantation style forestry developments.

To date, most agricultural and forestry research has been directed at predominantly "white" interests in these fields. It was presumed that developing subsistence black farmers would eventually adopt these capital intensive technologies. Very little research has been undertaken on alternative crops and alternative land use systems more appropriate to subsistence farming. Even today, it is still not accepted that these systems may not be the most appropriate for development purposes.

The fact that there is a massive debt crisis in commercial farming worldwide emphasises that this type of approach is highly unstable and will require permanent government support for its existence.

Rural land use issues must be developed using holistic approaches designed to overcome existing as well as future constraints.

South Africa has many advantages over most other developing countries, particularly in the areas of infrastuctural development, level of industrialisation and technology and availability of capital resources. We must make full use of these if we want to resolve the energy crisis successfully, ultimately leading to the relief of poverty and removing one of the major constraints to national development.

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APPENDIX 1

SUMMARIES OF SELECTED FORESTRY PROJECTS IN DEVLOPING COUNTRIES

SUMMARY OF SELECTED PROJECTS IN AFRICA

PROJECT NAME	COUNTRY	PROJECT AREA (000's Km^2)	RAINFALL (MM/YR)	FUNDING AGENCY	$US (Mil)	LENGTH (YEARS)	COMMENTS
Projet Agro--pastoral De Nyabisindu	Rwanda		1200	GTZ	0.76/yr	22	Grevillia robusta planted as soil cons--ervation strips. -forestry extension and organic farming. Decentralised nurser--ies.
Gituza Forestry Project	Rwanda	36	1000	USAID	1.1/yr	7	Began with fuelwood plantations and later changed to agroforest--ry for soil conserva--tion.
Promotion of Adapted Farming System based on Animal Traction	Cameroon	18	2300	GTZ	0.27 to 0.8/yr	7	On farm agroforestry trials. Conservation farming. Trees planted on contour bunds.
Soil Erosion Control and Agroforestry Project	Tanzania	4.5	1100	GTZ	0.4/yr	10	Trees and grass plant--ed along contours and used for fodder (stall fed livestock) erosion control and fuelwood provision. 18% of farmers grew trees for soil impro--vement but only 2% for fodder.

The Village Afforestation Programme	Tanzania	Nationwide	500 to 1500	SIDA FAO ILO DGIS	0.2/yr	20	General failure of community woodlot policy. Now tree planting promoted to individuals and schools.
Reafforestation Around Wells in Northern Senegal. (New name: Agro-sylvo--pastoral land use models in the fight against desertification)	Senegal		300 to 400	GTZ	0.5 to 2/yr	15	Began with plant--ation forestry which failed. Now orientated towards livestock management on degraded bushland.
Majjia Valley Windbreak Project	Niger	0.05	400 to 400	CARE USAID DANIDA	0.13 to 0.3/yr	14	2 km windbreaks of neem trees established every 100m. Grain yields increased by windbreaks.
Forest Land Use Project Guesselbodi	Niger	0.05	500	USAID	0.3 to 0.6/yr	11	Forest management and micro-catchments and tree planting. Fuel--wood harvesting for sale to cities. Doubtful whether financially viable.
Turkana Rural Development Project	Kenya	72	180 to 400	NORAD	0.12 to 0.27/yr	10	People paid to plant and maintain trees on denuded land. Trees planted in micro--catchments. Manage--ment of riverine forests. Tree planting by schools.

East Pokot Agricultural Project	Kenya		600	GORTA	0.045/yr	15	Range management Limited tree plant--ing at schools.
Kenya Fuelwood Development Programme	Kenya		1500 to 2000	DGIS	2.0/yr	8	Extension programme for promoting tree planting-films, demonstrations and tree seed packages. Also school competitions.
BAT Afforest--ation Scheme	Kenya		1500	BAT		15	Plantation of Eucalyptus and Cyp--ressus for curing tobacco. Trees used for cash rather than for woodfuel. 3600 ha planted.
Rural Afforestation Project	Zimbabwe		500 to 1000	IDC	10.8	5	Began with plant--ation forestry which was abandoned. Now village and school nurseries and sale of friut and indigen--ous trees. Veld man--agement.
Soil Conservation and Agroforestry Project	Zambia	0.5	780			5	Intercropping with Acacia albida, windbreaks, live fences and contour hedgerows. Friut trees

The Hado Project	Tanzania	1.2	600 to 800	SIDA	1.2	17	Destocking eroded areas, distribution of seedlings to individuals and schools. Tree growing for insur--ance purposes.
Projet Agro-forestier	Bukina Faso		400 to 600	OXFAM	0.16	12	Rock bunds for water catchment and runoff control. After increased crop yields tree planting began. Stall fed livestock.
Koro Village Agroforestry Project	Mali	11	300 to 600	CARE USAID NORAD	0.2 to 0.4/yr	7	Windbreaks of neem, 43 per year.
Projet Bois de villages	Burkina Faso and Mali		400 to 1000	Swiss/ Dutch	6.2/yr	7	Village woodlots but low yields. Uneconomic

SUMMARY OF PROJECT EXPERIENCE ELSEWHERE

PROJECT NAME	COUNTRY	PROJECT AREA (000's Km^2)	RAINFALL (MM/YR)	FUNDING AGENCY	$US (Mil)	LENGTH (YEARS)	COMMENTS
West Bengal Forestry Project	India			World Bank	43.5	6	Development of school nurseries for local social forestry projects
Jammu and Kasmir and Harayana social foresty	India			World Bank	33		Community forestry
Haiti Agroforestry Outreach Project	Haiti	Nationwide	400 to 2500	USAID	16	7	Contour hedgerow and tree planting on farms. 6 million trees planted by 120 000 farmers /year
Community Forestry and Training	Nepal			World Bank	17	10	Community woodlot development
Watershed Management and Erosion Control	Philippines		2500	World Bank	38	9	Watershed management Pulpwood, fuelwood Mainly Leucaena tree farms.
Non-conven- -tional energy development	Philippines		2500	USAID	4.5	12	Dendrothermal energy plantations.

CARE= Cooperative for America Relief Everywhere
DANIDA=Danish International Development Agency
DGIS= Directorate General for International Cooperation (Netherlands)
FAO= Food and Agricultural Organisation of the United Nations
GORTA= Irish Freedom from Hunger Council
GTZ = Deutsche Gesellschaft fur Technische Zusammenarbeit
ILO = International Labour Office
SIDA= Swedish International Development Authority
NORAD= Norwegian Agency for International Development
USAID= United States Agency for International Development

APPENDIX 2

LATEST (1991) WORLD BANK FORESTRY/NATURAL RESOURCE MANAGEMNT PROJECTS

LATEST (1991) WORLD BANK FORESTRY/NATURAL RESOURCE MANAGEMENT PROJECTS

COUNTRY	NAME OF PROJECT	CATEGORY	$US (MILLION)	DESCRIPTION
SUB-SAHARAN AFRICA				
Bukina faso	Environmental management I	agriculture	27.3	Improvement of village land and agricultural resource management.
Cameroon	Forestry and Environment	Agriculture	30.0	Support sectoral policies and investments for forest management conservation and environmental protection
Chad	Natural resource management	Environment	25.0	First part of a long term progr-amme to improve natural resource management. Natiowide.
Kenya	Forestry development	Forestry	19.0	Support for dev-elopment of the forestry sector (fuelwood,timber) agroforestry, natural forest conservation and institutional strenthening
Mali	Agricultural research	Agriculture	20.0	Strengthen crop, livestock,forest--ry and natural resource manage--ment research
Mali	Natural resource management	Environment	26.0	Finance a wide range of muti-sector natural resource manage-ment activities at village, de-partmental and national levels

Niger	Natural resource management	Environment	27.0	As above.
Senegal	Natural resource management	Environment	30.0	As above
Somalia	Baardhere establishment	Agriculture	5.0	Resettlement of 2500 families from resevoir area and establish forest reserves.
Tanzania	Forest resources management	Forestry	16.0	Sectoral policy and institutional reforms.Land tenure,tilling land use, pilot woodland manage--ment, agro-forestry charcoal.
Togo	Forestry environment	Forestry	13.6	Protection of natural resources mitigating envir-onmental effects of growth
Zaire	Forestry environment	Environment	35.0	Development of systems for effective protec--tion of parks and reserves, improve management of forestry and other natural resources
LATIN AMERICA				
Brazil	Mato Grosso Resources Management	Agriculture	150.0	Intensification of Natural agriculture, forest management, small farmer projects
Brazil	Rondonia Natural Resource Management	Agriculture	167.0	As above

Brazil	National Forest Development and conservation	Forestry	150.0	Industrial wood production on national forests
Haiti	Forestry and Environmental Protection	Forestry	25.9	Institutional pol- -icy mechanisms addressing problem of forest protect- -ion,wood supplies and energy consum- -ption.
Jamaica	Watershed Protection and Smallholder Development	Agriculture	25.0	Suppport govern- -ment programmes for watershed management,forest environment pro- tection
ASIA				
Bhutan	Third Forestry Project	Forestry	5.0	Environmental pro- -tection and management, aff- -orestation of roadsides.Pro- -tection of forest and grassland areas.
China	Irrigated Agricultural Intensification	Agriculture	300.0	Irrigation impro- -vements,forest shelterbelts,crop improvement
China	Tarin Irrigation	Agriculture	120.0	Upgrading 120000 ha of irrigation Production of cotton wheat fodder, friut and timber.
India	Intergrated Watershed Development -Hills	Agricutlure	88.0	Stabilization of degraded water -sheds, soil and water conservation fuelwood and fodder, enhanced land use capabil- ity.

India	West Bengal Forestry II	Forestry	58.5	Forest resource management, afforesatation horticulture and silvipastoral development. Farm forestry,nursery development and adaptive forestry
India	Maharashtra State forestry	Forestry	150.0	Initiate compre- -hensive approach to forestry re source management in environ- -mentally sound way.
Malaysia	Sabah Forestry II	Forestry	30.0	Institution build- -ing, augumenting capacity in res- -earch, sustainable management of natural forests, support of com- -mercial tree growing by small- -holders on 35000 hectares.
Philippines	Environmental and Natural Resource	Environment	162.0	Sustainable res- -ource management Upgrade extention support in forestry
Thailand	Land Reform and forest protection	Agriculture	40.0	Support to settlers on govern -ment forests
Pakistan	Intergrated Hill Management II	Agriculture	84.5	Increased food and fodder production extention services afforestation of demarcated forests and hillside planting for fuel- -wood.