Exotic Broadleaved Trees and Shrubs

(excluding eucalypts)

Experience in Lesotho and recommendations

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ABBREVIATIONS

IFAD	International Fund for Agricultural Development.
FAO	Food and Agriculture Organisation, United Nations.
FD	Forestry Division, Ministry of Agriculture, Lesotho.
FISC	Farm Improvement with Soil Conservation Project, SIDA and GOL
GOL	Government of Lesotho
LISP	Local Initiatives Support Project (Quthing)
MRDP	Matelile Rural Development Project.
OFS	Orange Free State, RSA
RSA	Republic of South Africa
SIDA	Swedish International Development Agency
SOWACO	Soil and Water Conservation Project (Phase I), FAO/ Netherlands
SRDP	Semonkong Rural Development Project
SWaCAP	Soil and Water Conservation and Agroforestry Programme, IFAD and GOL.

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1. INTRODUCTION

This report summarises research on exotic broadleaved trees and shrubs in Lesotho, excluding eucalypts which are covered in a separate review. It covers both formal research undertaken by the FD, the informal investigations of various projects, notably MRDP, Semonkong RDP, SOWACO, PLENTY and SWaCAP and field observations. Fruit trees and trees or shrubs that are purely ornamental are not discussed in this report.

In recent years there has been an expansion in forestry in Lesotho. Social forestry is now promoted, in addition to Government forestry to control soil erosion and to establish plantations for the production of fuelwood and poles. This requires greater involvement of people in individual or group tree planting. Interest has been renewed in trees that are suitable for a number of uses, known as multi-purpose trees. The great majority of these multi-purpose trees are broadleaved ie. non-conifers.

It is only recently that formal research into non-conifer and non-eucalypt trees and shrubs has begun. Most of the results discussed in this report are therefore preliminary, although several species can now be recommended for general planting. In contrast there has been considerable research work undertaken on conifers and eucalypts to support the Forest Reserve programme.

2. ESTABLISHED EXOTIC BROADLEAVED TREES AND SHRUBS IN LESOTHO (EXCLUDING EUCALYPTS)

There are a number of exotic broadleaved trees or shrubs in addition to eucalypts that have become widely established in Lesotho. These include species or hybrids of poplars, species of willows and wattles and the Black Locust (Robinia pseudoacacia). Most of these can be found in stands belonging to individuals or communities in degraded areas such as erosion gullies (known as dongas) or badly eroded hill sides. All these trees or shrubs are relatively easy to propagate.

2.1 Poplars and Willows

There are a small number of poplar hybrids and species in Lesotho. A report by Wilkinson (1990) records five main species (Table 1) or hybrids. Of these, Dr Wilkinson felt only the Grey Poplar (Populus x canescens) should continue to receive attention. This hybrid is thought to have a very narrow genetic base, possibly being represented by one clone only. Poynton, (undated a) also described P. wislizenii as being in Lesotho.

Wilkinson (1990) also describes the willows in Lesotho. Apart from the two main exotic willows (Table 2) he recorded there is also an indigenous tree willow, Salix mucronata (syn. S. capensis).

Table 1 Main Poplar Plantings in Lesotho (Wilkinson, 1991)

P. x canescens	One Male Clone
P. deltoides ssp angulata "Carolinensis"	Male Clones
P. fremontii	One Clone
P. nigra "Italica"	Male Clones
P. euroamericana	

Table 2 Main Willow Plantings in Lesotho (Wilkinson, 1991)

S. babylonica	Female Clone
S. fragilis	Two? Clones Planted as S. viminalis

In the past both poplars and willows have been used extensively in soil conservation schemes. At the bottom of eroded slopes P. deltoides was planted, whereas on the higher slopes, P. wislizenii (thought to be P. fremontii in Wilkinson, 1991) was favoured (Poynton, 1966). In donga plantings willows and P x canescens were widely planted on the donga floor. The most commonly used willow was S. babylonica, but Poynton (1966) noted that an increasing proportion of basket willows: S. purpurea and S. viminalis (now thought to be S. fragilis) were being used. It was hoped this would stimulate a basket weaving industry. Some planting of donga sides was attempted with S. babylonica by driving 5 to 7.5 cm thick truncheons into the ground until only a short piece protruded above ground level (Poynton, 1966).

2.2 Wattles

These have been planted in Lesotho for decades and three species were described in Heywood (1908): Acacia dealbata, A. mearnsii and, planted to a lesser extent, A. melanoxylon.

The most common wattle in Lesotho is the Silver Wattle (A. dealbata), which in some areas in the lowlands and foothills has formed dense stands. Other wattles include the Green Wattle (A. decurrens), the Black Wattle (A. mearnsii), A. melanoxylon, A. baileyana and the rare A. podalyriifolia. Recently Port Jackson Willow (A. saligna) has been introduced to Lesotho. One indigenous Acacia species, Acacia karoo grows in Lesotho.

2.3 Black Locust

The Black Locust (Robinia pseudoacacia) has been planted in Lesotho for many decades, primarily for control of soil erosion in dongas. Poynton (1966) stated that use of this species had stopped and P. x canescens was favoured due to its faster growth. However, Heywood (1908) commenting on a donga planting at Morija described Robinia as "doing better service than the small leaved poplar".

R. pseudoacacia has several other uses, as its wood is hard and

durable and the leaves have fodder value. Phillips (undated) reviewed the genus robinia and examined the potential of R. pseudoacacia as a fodder tree in Lesotho.

An adaptable tree, found from the lowlands up into sheltered mountain valleys, such as at Molimo Nthuse Pass. Until recently there was a 3 to 4m tall tree in Semonkong, although generally this species is not well suited to extreme mountain sites. One seedling survived it's first winter at Letseng la Terrai (3080m).

2.4 Honey Locust

The Honey Locust (Gleditsia triacanthos) is found in many areas in the lowlands, particularly in towns and villages. It was introduced in the 1930s by the Protectorate Administration for donga reclamation (May, pers. comm.).

2.5 Others

A wide range of other exotics have been established in Lesotho. Introductions have accelerated in recent years with the work of MRDP. However, few of the species tested by MRDP have been in Lesotho for a sufficient time to have reliable information on their long-term performance.

There are several oak species that have been grown in Lesotho for decades. These include Q. robur and Q. acutissima, which can be found in the lowlands and in some areas in the foothills.

Reasonably old examples of the Green Ash (Fraxinus pennsylvanica) can be found from the lowlands up into sheltered mountain valleys and even in Mokhotlong (May, pers. comm.). Other trees planted in small numbers are Acer negundo, Ailanthus altissima, Casuarina cunninghamiana, Melia azedarach, Schinus molle and Tamarix gallica. These are not found in the mountains, but would be suitable for areas in the foothills and lowlands.

Two elms have been introduced: Ulmus parvifolia and U. procera, the latter originally for donga stabilisation. Poynton (1966) noted that because of slow growth U. procera was replaced by P. canescens for donga planting. Elms are now planted generally as amenity trees although they do have palatable foliage.

On eroded slopes the cherry, Prunus serotina was used by the Protectorate Administration in limited numbers. It was planted on slightly more eroded sites, higher up slopes than Populus deltoides (Poynton, 1966). However few of these cherry trees now remain.

Walnuts, (Juglans nigra and J. regia) and Chestnut trees, Castanea sativa have also been planted in Lesotho for many decades. Heywood (1908) describes trees of C. sativa and J. regia large enough to be bearing nuts on his tour of Lesotho in 1908. Poynton (1966) describes healthy specimens of C. sativa and J. nigra in the District Commissioner's house at Butha Buthe.

Several species have proven to be suitable for hedging:

Cotoneaster franchetii, C. lacteus, Ligustrum ibota, L. lucidum, Pyracantha angustifolia, and P. coccinea.

3. GENERAL DESIRABLE CHARACTERISTICS OF TREES AND SHRUBS FOR LESOTHO

3.1 Soil Organic Matter Accumulation

For rehabilitation of degraded areas the ability of a tree or shrub to increase soil organic matter is possibly most important. This improves soil structure, soil fertility and water retention. The most important factors affecting this process is the amount of leaf fall and the chemical composition of the leaves.

3.2 Nitrogen Fixation

Nitrogen fixing trees or shrubs are often considered desirable for rehabilitating degraded land. However, nitrogen fixation is primarily for the plants' own benefit and the nitrogen fixed may only be released into the soil slowly. Boring et al in Phillips (undated) examined stands of R. pseudoacacia at ages 4, 17 and 38 years. Only the 38 year-old stand showed an increase in soil nitrogen. The fixed nitrogen had been efficiently stored within the trees' tissues.

FAO (1988) lists six main characteristics that make nitrogen fixing trees desirable:

(1) They are often suitable fodder species as they contain high proportions of nitrogen compounds, especially in leaves, pods and seeds. In addition they do not require expensive inputs of organic fertiliser and can provide green manure for crops.

(2) Many exhibit rapid growth, especially on short rotations.

(3) They can provide available nitrogen to other plants.

(4) Many are multi-purpose trees.

(5) There is considerable potential for genetic improvement as many have short seed cycles, many are outcrossing and there is generally much variation within a species.

(6) Most are easily propagated from seed, which generally remains viable for many years.

Many trees in the legume family have the ability to fix atmospheric nitrogen, as well as casuarinas and alders.

3.3 Pioneer Species

Trees and shrubs that are pioneers should be favoured, as they are able to thrive in the harsh open conditions that characterise many planting sites in Lesotho.

3.4 Method of Regeneration

Those species that coppice, root sucker or produce copious seed should be favoured if simple management is required or if they are planted for environmental protection. The need for replanting after felling or damage by stock or fire is then avoided.

3.5 "Loppability"

Trees that produce firewood or fodder should be able to withstand repeated lopping of branches. Harvesting of firewood is much more commonly done in this manner than by felling the whole tree.

3.6 Fast growth

The tree or shrub should provide products or services in a short time. As a general characteristic, fast growth is important so that there is some sort of early economic return. In addition to economic considerations, fast growth is required to minimise the time trees or shrubs are liable to browsing damage.

3.7 Social Acceptability

Products or services provided by the trees or shrubs should be acceptable within the local context. For instance trees which provide useful products but which are poisonous to livestock (as opposed to unpalatable) are unlikely to be accepted. Similarly trees whose wood produces irritating smoke when burnt will not be favoured as firewood producers. Calorific value of wood may be of secondary importance to its flammability (for ease of lighting) and how easy it is to split the wood. More information must be generated through research on how people use trees and shrubs and why in order to guide forestry research and extension.

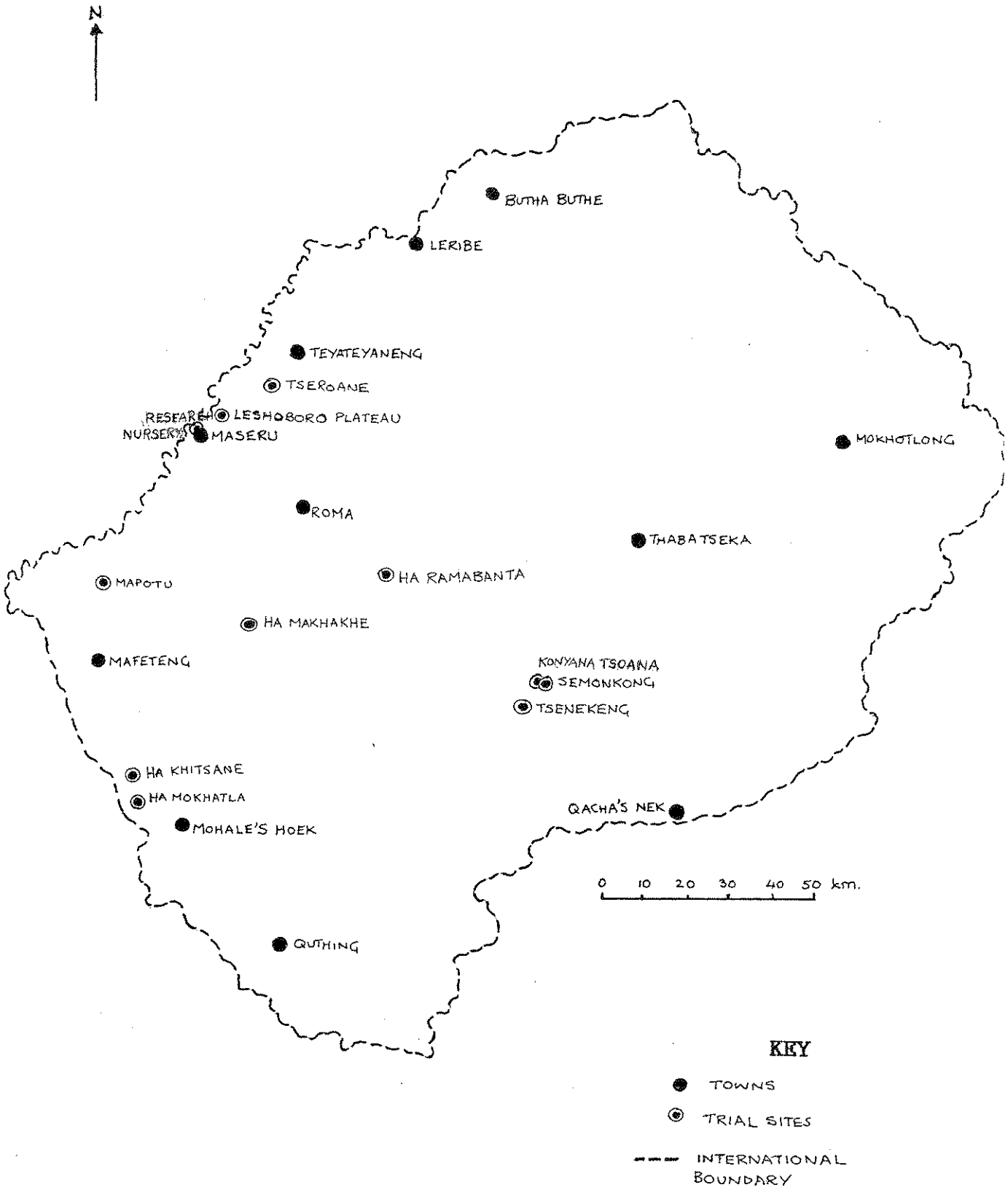
Some trees, including exotics, have superstitions associated with them. Willows, for example, are thought to attract lightning and so are generally not planted close to the house. Also, Populus nigra is thought to bring death in a family, particularly of men (Matekane, pers. comm)

3.8 Resistance to browsing

Whilst in theory there can be control of browsing by livestock through traditional law, generally, even when areas are fenced trees are subject to heavy levels of browsing. Either low palatability, thorns or ability to survive intensive browsing are desirable traits, providing fodder production is not the main objective.

4. RESEARCH TRIALS

There are very few formal trials of non-conifer and non-eucalypt trees and shrubs and those that do exist were only established recently. Those established by the FD are described below and shown on Map 1 and results of some are discussed in Appendix 1.



Map 1: Location Map for Trial Sites.

Species have generally been chosen for uses other than fuelwood and poles. This is because there has been considerable research undertaken on species suited for these uses. Emphasis was placed on species used for soil improvement, fodder and those that have been incorporated into agroforestry practices in other countries.

Research Nursery (1500m)

A small trial of atleast five seedlots from OFI of Sesbania sesban was established at the Research Nursery. None survived the winter. Details of the trial were not available.

Konyana Tsoana (2265m)

Only one non conifer species, Fraxinus pennsylvanica was tested at this trial (L/25/131), established in 1989.

Mapotu (1550m)

In early 1990 an unreplicated demonstration/trial (L/25/134) of twelve species was planted at Mapotu at the Extension Agent's yard. Species tested were Acacia saligna, Atriplex nummularia, Carya illionensis, Cassia corymbosa, Chamaecytissus palmensis, Gleditsia triacanthos var inermis, Heteromorpha arborescens, Leucaena esculenta, L. esculenta var paniculata, Morus alba, Robinia fertilis, R. pseudoacacia and Simmondsia chinensis.

Ha Mokhatla (1500m)

A small replicated trial (L/25/132) of Casuarina and Allocasuarina species was established in early 1989 on a duplex soil type in the Southern lowlands. The following species were tested: two seedlots of C. cunninghamiana, one seedlot of C. equisetifolia, one seedlot of A. littoralis and one seedlot of A. vetricillata.

Leshoboro Plateau (1800m)

A plateau top near Maseru with a sandy clay loam soil. A trial planting (L/25/128) of several varieties of Leucaena leucocephala was planted in March 1988. It was closed in October 1988 as no plants survived the winter.

A block of 500 plants of Chamaecytissus palmensis was planted in November 1988 but was almost completely grazed out.

A small replicated trial (L/25/129) of Casuarina and Allocasuarina species was planted in late 1988. Species tested comprised three seedlots of C. cunninghamiana, two seedlots of C. equisetifolia, one seedlot of A. littoralis and one seedlot of A. torrulosa.

Ha Ramabanta (1800m)

In early 1991 a replicated trial (L/25/136), with side plantings was established in the foothills at Ha Ramabanta. Five species were tested in the main trial: Acacia albida, A. sieberana var woodii, Eucalyptus rubida (control), Robinia fertilis and Mimosa

scabrella. The following were established in side plantings: Acer pseudoplatanus, Betula pendula, Castanea sativa and J. regia var. carpathia.

Tseroane (1600m)

In late 1989 twelve species were tested at an unreplicated trial on a hill side at Tseroane (L/25/133). These were: Atriplex canescens, A. nummularia, Carya illionensis, Cassia corymbosa, Casuarina cunninghamiana, Chamaecytissus palmensis (3 seedlots), Gleditsia triacanthos, the indigenous Heteromorpha arborescens, Morus alba, M. nigra, Paulownia tomentosa and Robinia pseudoacacia.

Ha Makhakhe (1700m)

A replicated trial of Leucaena species was planted in 1990 on a hill side site. Plants were inoculated and sown in the nursery early in the season in large pots so as to increase their chances of survival. Species planted (in replicated plots) were: L. collinsii, L. diversifolia, L. esculenta, L. esculenta ssp paniculata, L. greggii, L. lanceolata, L. leucocephala, L. macrophylla nelsonii, L. pulverulenta, L. retusa, L. shannonii.

Ha Khitsane (1500m)

This demonstration (L/25/135) planted in 1990, was a joint effort between SOWACO Project and the FD. Species tested were: Acacia abida, Acacia saligna, Albizia lebek, Atriplex nummularia, Carya illionensis, Cassia corymbosa, C. obtusifolia, Casuarina cunninghamiana, the indigenous Celtis africana, Chamaecytissus palmensis, Cytissus monospessulanum, Dalbergia sissoo, Gleditsia triacanthos var inermis, the indigenous Heteromorpha arborescens, Leucaena diversifolia, L. esculenta, L. esculenta var. paniculata, L. greggii, Lupinus arboreus, Medicago arborea, Mimosa scabrella, Morus alba, M. nigra, Prosopis chilensis, Robinia fertilis, R. pseudoacacia, Sapium sebiforum and Simmondsia chinensis. The design was unreplicated with plots of varying size.

Results from the latest assessments of the FD trials are shown in Appendix 1.

Some projects have also established their own trials. SRDP has established two species trials, one at Semonkong and another at Tsenekeng. Both are in cold and dry mountain areas.

Semonkong (c. 2000m)

This small unreplicated trial is situated on flat ground close to the SRDP offices. During summer part of the trial site becomes waterlogged. Species tested at Semonkong and also at Tsenekeng are: Acer campestre, A. platanoides, Ailanthus altissima, Alnus incana, Amelanchier canadencis, Amorpha fruticosa, Betula pendula, Caragna arborescens, Carpinus betulus, Cassia corymbosa, Castanea sativa, Cercidiphylum japonicum, Cornus alba, C. mas, C. sanguinea, Corylus avellana, C. colurna, Crataegus monogyna,

Cytissus monspessulanum, Eleagnus angustifolia, Fraxinus excelsior, Hippophae rhamnoides, Juglans sp., J. nigra, J. regia, Lingustrum lucidum, Liriodendron tulipifera, Lonicera xylosteum, Lycium halimifolium, Malus communis, Medicago arborea, Mespilus macrocarpa, Morus alba, M. nigra, Pawlonia tomentosa, Physocarpus opulifolius, Platanus acerifolia, Populus tremula, Prunus mahaleb, P. serotina, P.spinosa, Pyrus communis, Quercus serris, Q. petraea, Q. robur, Q. rubra, R. cathartica, R. pseudomonophylla, R. pseudoacacia, Rosa rugosa, Rubus tricolor, Salix cinerea, S. purpurea, S. viminalis, Sorbus aucuparia and Symphomyrtus hancock.

Tsenekeng (c. 2000m)

Established in a sheltered, small valley, with relatively deep soils. Growth of species is much faster at this site than at Semonkong.

Other

MRDP have tested over one hundred and fifty tree and shrub species. Generally these have been tested in small scale plantings in the Project area rather than in formal trials. The Project area covers the lowlands and foothills.

5. NOTES ON SPECIES TESTED AND THEIR PERFORMANCE

Acacia albida

Much promoted for planting in fields in arid and semi-arid areas because of its unusual characteristic of retaining its leaves during the dry season and dropping them during the rainy season, when crops are planted. Leaves and pods provide a valuable source of dry season fodder.

A seedlot from Botswana was tested in a small replicated trial at Ha Ramabanta in the foothills. The seedlot was from the southern limit of the trees' natural distribution (Tuli Block). Survival after the first year was only 29%. The original shoots had been frosted back and new shoots had sprouted from the base. This species is too frost sensitive for the foothills. Experience from MRDP confirms this assessment. Seedlings both in the nursery and in the field died during their first winter. Experience of seedlings, raised from seed from Malawi (Buranje Valley) was the same (May, pers. comm.).

Acacia baileyana (Bailey's Wattle)

Examples of large trees in the lowlands in several old donga plantings and in gardens, where it is planted as an ornamental. It does not spread as readily as the other wattles in Lesotho. Also, growth is slower than that of the other common exotic Acacias found in Lesotho - A. decurrens and A. dealbata.

Acacia cultriformis (Knife-Leaf Wattle)

A shrub or small tree, it produces good quality firewood and can

be used for clipped hedges (Poynton, 1984). Has survived one winter in the MRDP nursery and in one field trial.

Acacia dealbata (Silver Wattle)

The most common wattle in Lesotho and very successful in the lowlands and foothills. An excellent species for soil stabilisation, although the dense stands it forms in places discourage any understorey or ground vegetation. The wood is a preferred fuelwood (May pers. comm.) and copious seed production and coppicing makes for easy regeneration. In some areas it is intensively harvested. In the South of France the flowers are used in the perfume and floriculture industries (Boland, 1987). Considered by MRDP to have very good performance in the foothills (MRDP, 1991). Usually a small tree, but in favourable conditions, such as near Ha Khorai it can grow to c. 20m tall.

Seedlots from various provenances have been acquired from Australia, to test against local material.

Acacia decurrens (Green Wattle)

Not uncommon in Lesotho, from the northern lowlands to the Quthing River valley. It has been planted for stabilising dongas and in woodlots for fuel. Thought to hybridise naturally with A. dealbata in Lesotho. Healthy stands can be seen at Tsikoane Plateau. It is noted by MRDP as having very good performance in the foothills (MRDP, 1991). Like A. dealbata can reproduce prolifically, although spreads less readily. Thought to be slightly less frost tolerant than A. dealbata (Poynton, 1984) and tends to produce straighter poles (May, pers. comm).

Acacia farnesiana

This species has been tried by MRDP in the foothills and was found to be damaged severely by frost.

Acacia floribunda

Only introduced in 1991, but has survived the first winter in the nursery and one field trial.

Acacia mearnsii (Black Wattle)

Not common in Lesotho, although there are small stands of old trees, in Maseru, Quthing and at Leshoboro Plateau for example. Grown in Natal for tannin production from the bark. From experience MRDP have found that this species is not very frost-tolerant and in addition requires more soil moisture than A. dealbata and A. decurrens. This is supported by the literature on the species.

Acacia melanoxylon (Australian Blackwood)

Not common, but specimens are found in the central and southern

lowlands. A tree that produces a very valuable and beautiful timber when grown to large size. Often frosted when young, but reported to grow quickly around Maseru, Morija, Roma, Mohale's Hoek and several healthy specimens can be found on Leshoboro Plateau. It was tried by MRDP and in lower sites within the project's area has good survival. Does not coppice well, but suckers (Jackson, 1987).

Acacia pendula (Weeping Myall)

An Australian Acacia, only introduced by MRDP in 1991, but survived its first winter in the nursery and in one field trial. Produces palatable and nutritious fodder and will tolerate heavy soils (NAS, 1979). In its natural range the average number of heavy frosts /year is only 1-20 (Turnbull, 1986). Produces very good quality firewood (Poynton, 1984).

Acacia podalyriifolia (Pearl Acacia, Queensland Silver Wattle)

A rare tree in Lesotho, with examples being found at the FD's Mohale's Hoek nursery and at Leshoboro Plateau. Mainly used as a small ornamental tree. No field trials of this species yet and identity not certain. May be same species as "A. cultriformis".

Acacia saligna (Port Jackson Willow)

A tree native to south western Australia, it is a successful exotic in Mexico, the Middle East and South Africa. In Tunisia it has been successfully established in areas of 300 - 400mm mean annual rainfall, with little irrigation (Tiedeman and Johnson, 1992).

FISC and SOWACO have reported promising results with this species in the southern lowlands. However, at the demonstration at Ha Khitsane mortality was 33% after the winter frosts and after replacement of the dead trees, 50% after drought (SOWACO, 1990). Fast growth during the summer but is frosted back every winter. Of some potential use for production of kindling and fodder.

Acacia sieberana var. woodii (Paperbark Thorn)

An Acacia from neighbouring South Africa. A seedlot was tested at a small replicated trial at Ha Ramabanta. Unfortunately the original shoots were frosted back, although new shoots had sprouted from the base. This species is not sufficiently frost-hardy for the foothills.

Acacia stenophylla (River Cooba)

Although only introduced in 1991, it has survived it's first winter in the MRDP nursery and in one field trial. Only moderately frost-hardy but will grow on heavy and saline soils (Turnbull, 1986), so may be suited to sodic duplex soils in Lesotho. Produces excellent firewood.

Acacia terminalis

Complete failure both in the nursery and in field trials in the MRDP area.

Acacia visite (Visite)

This tree grows well in areas of the Orange Free State and is frost tolerant with reasonably fast growth. It has thorns and provides good bee forage. Considered to be a suitable shade, ornamental and fuelwood tree for the lowlands and foothills. Although survival data is not available MRDP reckon it has potential.

Acacia xeaphylla

There is only information on nursery performance of this species. It has survived one winter in MRDP's nursery.

Acer campestre (Field Maple)

Seen by Semonkong Project as a tree worth further investigation, after reasonable performance in their two species trials after two years. Trees tested were flown in from Germany. Coppices and root suckers. Will grow on a variety of soil types but not drought tolerant (Poynton, 1984).

Acer negundo (Ash-Leaved Maple)

The most widely distributed of all "American" maples, found from Canada to Guatemala. Although generally found on moist sites, it is drought tolerant (Burns and Honkala, 1990). Used in New Zealand in gully planting and for wind-breaks (Bulloch, 1986d). It has also been commonly used as a windbreak around homesteads in the Plains of the USA (Burns and Honkala, 1990). However, foliage can be damaged by strong winds.

This small tree has been planted as an ornamental in Maseru and other towns, including Mokhotlong (May, pers. comm) and in the foothills by MRDP. Those planted in 1988 by MRDP were 2m tall seedlings and have survived, but grown slowly.

Due to its wide natural distribution, material from the higher elevations in Mexico would be worth testing. The origin of the material presently in Lesotho is not known.

Acer platanoides (Norway Maple)

Slightly better height growth than Acer campestre in trials at Semonkong and Tsenekeng. Trees of this species were flown in by MRDP from Germany. Regarded by Semonkong Project and MRDP, as worth further investigation, although MRDP reckon this species needs reasonable soil moisture.

Acer pseudoplatanus (Sycamore)

Grows fairly fast at first into a large tree. Requires some

shelter when young. Will coppice. Produces good quality firewood and palatable fodder (Moro, 1988).

MRDP have limited experience of this species and consider it a good species for planting in the foothills. However, of ten trees planted in a side planting at Ha Ramabanta only three survived after the first year. Deaths seem to have been due to the winter drought rather than frosting. In New Zealand this species is used as a component of wind-breaks, in gully plantings and as a fast growing species for revegetating open areas. However it seeds prolifically and has become a weed on favourable sites in other countries, such as the UK. This is unlikely in Lesotho as regeneration is very palatable to livestock.

Agave americana ("Aloe")

Widely planted in the past as a live-fence and very effective. Locally termed "aloe" but it is a cactus introduced from America. It has had a reputation for harbouring rats and snakes and is considered less "modern" than a barbed wire fence, so in recent years has been planted less as a live fence. The large flowering stem is cut in winter and immature flowers used as fodder, while the sweet mature flowers are eaten by herdboys. The stem is used as a pole despite its' lightness. The dried leaves are used as kindling and fibres from the leaves are used by some to make baskets (N. Maile, pers. comm.). Used also in soil conservation plantings, including along dongas.

De Cock (undated) describes this species as being one of the most important drought-resistant fodder crops in South Africa as it uses very little water for the biomass it produces (30kg of water to produce 1kg of "dry material"). As a fodder its leaves must be chopped up and supplemented with other forage. However, it can to a large extent replace silage, mangels etc as a succulent portion of a fodder ration. Annual yields of 120 tons of leaves per ha are predicted, even on poor soils. The use of the leaves as fodder is common in Mafeteng and Mohale's Hoek Districts (Matekane, pers. comm). De Cock (undated) also notes its use for controlling erosion particularly when planted on contour bunds.

Ailanthus altissima (Tree of Heaven)

Used as an amenity tree in Maseru where it is found naturally regenerating in places. In New Zealand recommended as a tree for erosion control particularly in "semi-amenity situations" (Bulloch, 1986d). In the foothills use in soil erosion control plantings by MRDP have shown slow initial growth but profuse suckering when established. Also a possible species for the mountains. It can be propagated from cuttings. Produces firewood of poor quality (Moro, 1988, Matekane, pers. comm).

Recommended for soil conservation efforts in the foothills. Found by MRDP to be a popular tree with the public, possibly because of its common name.

Albizia julibrissin (Silk Tree)

MRDP have planted this species in small numbers and have found

it to be more frost tolerant than the other albizias tried. This is borne out by Jackson (1987), who states that it grows at higher elevations than any other Nepalese albizias. Survival is acceptable, but it has very slow growth and is frosted back in winter, but becomes more frost-resistant with age. A possible tree for moister sites in the lowlands, especially if seed from high elevation provenances can be obtained. Coppices and produces root suckers but firewood is of low quality (Poynton, 1984).

A variety rosea is used as an ornamental in central Europe and may be worth testing.

Albizia lebbek (Lebbek)

A species successful in the arid and semi-arid tropics it is not sufficiently cold-tolerant for the Lesotho winters. Badly frosted according to MRDP and complete mortality after one winter at Ha Khitsane (SOWACO, 1990).

Albizia lecanthum

MRDP found it was not frost hardy.

Albizia lophanta

Planted by MRDP in dongas in the foothills and will survive on sheltered microsites. Possibly useful for lowland donga reclamation.

Allocasuarina littoralis

Poorest growth and survival of the four Casuarina or Allocasuarina species on the duplex site at Ha Mokhatla. No survival after four years at Leshoboro Plateau.

Allocasuarina torulosa

Survival in plots at Leshoboro Plateau varied from 25 to 45% and height growth was less than half that of seedlots of Casuarina cunninghamiana.

Allocasuarina verticilata

Growth and survival better than A. littoralis on a duplex at Ha Mokhatla but survival poorer than the two Casuarina species.

Alnus cordata (Italian Alder)

Only tested by MRDP in the nursery and in one field trial. From the trial it appears to be promising in moist areas.

Alnus formosana

Failed in the MRDP nursery during winter. Not frost tolerant enough for Lesotho.

Alnus glutinosa (Black Alder)

Grows well on acid soils but growth is retarded on alkaline or near neutral soils. Optimum pH for nodulation appears to be between 5.5 and 7. Will grow in areas of mean annual rainfall just above 500mm, but growth is better on moister sites (Funk, 1990).

A useful tree for acid, degraded sites, because of its ability to fix nitrogen, its rapid growth and abundant production of litter. Nitrogen fixation by this species has not been confirmed in Lesotho. Biomass production on certain sites is impressive: on a river terrace in Alabama, six year old alder produced six times the biomass of sycamore of the same age (de Souza Goncalves, Paulo and Kellison, 1980 in Funk, 1990). When dried the firewood burns well and the tree also produces fodder for livestock. It coppices well (Moro, 1988).

There would appear to be considerable provenance variation; in a provenance trial in Pennsylvania, seedlots from the central part of the species distribution were fastest growing (De Wald and Stiener, 1986 in Funk, 1990).

Planted by MRDP for soil stabilisation in dongas. Has shown best results on the basalt derived soils in the foothills, but performance reasonable on sandy soils and tolerates waterlogging. However it has been found to be highly palatable and is severely damaged by livestock and grasshoppers.

Alnus incana (Grey Alder)

Tested in trials at Matelile, Semonkong and Tsenekeng; it was considered worth further study.

Alnus nepalensis

Proved not to be sufficiently frost-tolerant for the foothills and has poor survival in dongas.

Alnus rubra (Red Alder)

Grows in humid to super-humid climates with precipitation ranging from 400 to 5600mm. However, for healthy growth, precipitation should be greater than 630mm or tree roots should have access to ground water (Harrington, 1990).

It will tolerate a wide range of soils (Harrington, 1990) though is apparently not as tolerant of wet soils as other alders (Hibberd, 1989). MRDP have recently acquired seed and growth looks promising in the nursery.

Alnus viridis (Green Alder)

At the MRDP nursery there were problems obtaining good germination. When seed germinated, growth of seedlings was very slow.

Amelanchier canadiensis

Poor survival, presumably due to drought in MRDP field trials in the lowlands and foothills, but considered worth further study after promising results in SRDP trials in the mountains.

Amorpha fruticosa

There were early failures in the nursery when MRDP first tested this species. However, this year it has grown well in the nursery. Results from testing in the mountains are not promising.

Atriplex canescens (Four Wing Saltbush)

At Tseroane this species survived the first eight months, including one winter. Growth was poor and about two years later none were surviving.

Atriplex lentiformis

Known to be a good fodder bush (De Cock, pers. comm.), with similar performance to A. nummularia in the foothills (MRDP, 1991).

Atriplex nummularia (Old Man Saltbush)

De Cock (undated) recommends this shrub as a drought-resistant fodder crop for arid and semi-arid areas of South Africa. Experience by MRDP of planting this species in the foothills has been favourable (MRDP, 1991) and it does have reasonable frost tolerance. Suitable for sodic duplex soils. Its excellent growth and survival at Ha Khitsane indicate it could be particularly useful for fodder production in the southern lowlands.

Atriplex semibaccata

Reasonably successful in lower altitude MRDP plantings, but produces less fodder than A. nummularia. A creeping plant, it seldom reaches one metre in height.

Betula pendula (Silver Birch)

A much used synonym for this species is B. verucosa. Grows quickly in Europe, producing good quality, fast burning firewood and with good soil amelioration properties. Seeds profusely but the seeds soon lose viability. Will coppice but not vigorously if cut in Autumn (May, pers. comm).

Likely to withstand the cold conditions found in the mountains in Lesotho but possibly not the droughts. However, a tree has survived ten years in the Mohale's Hoek Arboretum. Also a few large, old trees exist at Thaba Phatsoa near Leribe and in Maseru. In addition the species has been tried in small trials in the mountains by Semonkong Project and is considered to have excellent potential. Twelve trees were planted in 1990 as a small block at Ha Ramabanta and after the first year only one had survived. However, this was a drought year and furthermore the planting material was not good.

Not successful in MRDP plantings and problems with germination in the nursery. Also there have been problems in getting locally collected seed to germinate in the FD Nursery.

Brachychiton populineus (Kurrajong)

A slow-growing tree mainly of interest because of its fodder production. It can be propagated vegetatively (Poynton, 1984). Few survived their first winter in the MRDP nursery and growth and survival in the field has been poor. There are however some examples growing at BEDCO, Maseru (May, pers. comm.)

Caesalpinia spinosa

In a field trial there was no survival but at the MRDP nursery some seedlings are still alive.

Cajanus cajan (Pigeon Pea)

The pigeon pea was included in some seedlots sown for SWaCAP in the Research Nursery in 1991/92. In the nursery growth was fast. In warmer semi arid regions it is a very useful annual or short lived perennial, providing both a food crop and small quantities of fuelwood in a short period of 3-9 months. Unfortunately it is noted in NAS (1980) that it is killed by frost. During the winter of 1992, this species was badly frosted in the Research Nursery. If grown as an annual, could have potential.

Caragana arborescens (Siberian Pea Tree)

A SWaCAP seedlot grew quickly in the FD Research Nursery. Survives especially at higher altitudes in the MRDP area and at Semonkong, but grows slowly, with little biomass production. Also palatable and so damaged by livestock and insects.

Carpinus betulus (Hornbeam)

The Common Hornbeam had performed well enough at Semonkong and Tsenekeng for it to be worth further testing. However, poor results at plantings by MRDP. Tolerates heavy soils (Hibberd, 1989), although it's tolerance to drought on such soils is not known.

Carya illionensis (Pecan)

The Pecan, a nut and timber tree native to the Southern USA and Northeastern and Central Mexico. The climate in its range is described as humid, with precipitation between 760mm and 2010mm. More than 510mm of rain falls during the growing season. Summer temperatures in its range can peak at 46°C and winter temperatures reach -29°C (Peterson, 1990).

There was poor growth but reasonable survival at a FD trial on a moderate slope at Tseroane and MRDP plantings have shown little or no growth. However at Agricultural Research in Maseru where it was tended as a horticultural crop with intensive management, on good soils it produced nuts within four years (May

pers. comm.). Said by Poynton (1984) to grow fast; on a dry site at Ha Khitsane six of seven pecan trees planted survived and grew reasonably quickly. Probably needs fertile, high rainfall sites for successful establishment and growth.

Cassia "corymbosa"

The true identity of this common ornamental is not known. In Maseru it has performed reasonably, with high survival and rapid growth in various plantings in the lowlands and foothills. Thought to be suitable for fodder, hedging and soil conservation.

Cassia sturtii

Failed completely, due to frost at plantings by MRDP. Still surviving at PLENTY's nursery, although they too have found it frost sensitive (Matekane, pers. comm).

Cassia obtusifolia

From limited experience of this species in Lesotho it does not appear to be frost-tolerant. At Ha Khitsane none survived. However in other low altitude plantings on light soils in the MRDP area it had quite good survival.

Castanea sativa (Sweet Chestnut)

Produces edible nuts which are eaten raw, roasted or cooked. The wood is valued for carpentry but is not an ideal firewood (Moro, 1988). Produces good quality poles from coppice stools. Also an attractive ornamental tree.

This tree has been planted in Lesotho since early this century. Heywood (1908) felt this species had potential:

> "Should be more extensively planted. Natives might be encouraged to take up the industry. Nuts would supply food and find ready sale"

Large specimens can be seen at the Christ the King School in Roma and at Molimo Nthuse.

In 1991 it was planted in a trial in the foothills at Ha Ramabanta, where survival was 44% after the first year. Deaths appear to be attributable more to drought than frost, as several of the dead trees had produced leaves this year. Survivors had grown very slowly, if at all since planting. Also tried at Semonkong and Tsenekeng where it survived, although growth was not impressive. However on good soils in the foothills and in Qachas Nek district it may have potential as the nuts are a high value, easily stored and transported product.

Casuarina cunninghamiana (River She-Oak)

A nitrogen-fixer, although there is no evidence of fixation by this species in Lesotho. It has performed well on several sites, survival and initial growth being very encouraging. Large trees are found in the centre of Mohale's Hoek and Maseru. Plantings in the foothills by MRDP have shown promise. The tree is suitable for fuelwood, windbreaks, soil conservation and emergency fodder. Produces a very durable, hard wood, which would make good poles as well as excellent firewood.

This species has a wide natural distribution, from Southern New South Wales to the Northern Territory. Some areas are without frosts whilst others experience over 50 frosts per year and temperatures as low as -8°C (Turnbull et al, 1986 in Turnbull, 1990). Provenance trials in California have shown a wide variation in frost-resistance, with the most frost resistant provenances originating from inland mountain areas (Merwin, 1990)

A year after planting, the best performing species in terms of height x survival of two Casuarina and two Allocasuarina species on a duplex site at Ha Mokhatla. At another trial of two Allocasuarina and two Casuarina spp. this species had best height growth and survival.

Casuarina equisetifolia (Beach She-Oak)

Possibly the most widely used casuarina in the world (NAS, 1980) it produces very high quality fuelwood, is a useful windbreak tree and the bark is suitable for tanning.

Unfortunately, this is not a frost hardy species (NAS, 1980) and so probably has limited potential in Lesotho, where even in the lowlands temperatures of -10°C frequently occur in winter. At MRDP's nursery and PLENTY's nursery there was complete mortality of this species during winter. Seedlings planted at the beginning of 1991 in dongas showed poor survival, possibly due to drought. However in the trial at Ha Mokhatla on a duplex soil, a year after planting the one seedlot of this species had better survival than Casuarina cunninghamiana, Allocasuarina littoralis and A. vetricilata. At Leshoboro Plateau, four years after planting one seedlot of this species had complete mortality, while the other showed less than 30% survival.

Casuarina glauca

Planted by MRDP in a few dongas, but survival has been poor. Nursery survival was good.

Celtis australis (Nettle Tree)

Native to the Mediterranean region. A slow initial grower, it produces edible fruits, good quality firewood and fodder. Fairly drought resistant but not very cold tolerant (Moro, 1988). Will coppice and root sucker. Planted in a trial at Tsikoane this species failed completely. As it grows in equally cold areas of Nepal this failure is unlikely to be due to drought.

Celtis sinensis (Chinese Nettle Tree)

Apparently has good frost tolerance and its leaves can be used for fodder (Poynton, 1984). Unfortunately MRDP had no survival in any plantings of this species.

Ceratonia siliqua (Carob)

A slow-growing Mediterranean tree, produces pods which are used for human and animal food. Complete failure of this species in MRDP plantings may be due to low levels of Ca in the soil and possibly pH.

Cercidiphyllum japonicum

At Semonkong and Tsenekeng and in MRDP plantings this species failed completely. In Mitchell and Wilkinson (1988) it is noted that it suffers during droughts and requires a damp soil.

Chamaecytissus palmensis (Tagasaste)

It was hoped that this fodder bush, Tagasaste, would be suitable for the lowlands of Lesotho. Unfortunately it has not proved to be sufficiently frost hardy and also it has not thrived on heavy soils (it is susceptible to root rot on poorly drained soils). At Leshoboro Plateau a small area of about 0.25 ha was planted with 500 plants in 1990. Initial survival of stock raised in large pots was better (90%) than bare-rooted stock (75%). Two unhealthy looking bushes survive today. There are several other instances of complete or almost complete failure of this species, such as a few stunted seedlings that remain from plantings around PLENTY's nursery. However, healthy individuals do exist in Lesotho, such as that at the MRDP nursery and in plantings by SWaCAP. Seed has been collected from the two specimens at MRDP nursery and is being used in field plantings.

In 1991 seedlots of Tagasaste were sent from the Canary Islands. These had been collected from cooler areas and will be tested. Hopefully plants from these seedlots will be more frost resistant than previous material. If a more frost-resistant provenance can be found, it would be worthwhile promoting Tagasaste, as it provides a good fodder for livestock, builds up organic matter on poor sites quickly and is a good source of nectar for bee forage (Sheppard and Bulloch, 1986b). Unfortunately, being palatable, protection while young is essential, the few surviving shrubs at Leshoboro were heavily browsed.

Chilopsis linearius

Survives but biomass production very low through stunted growth. Not recommended by MRDP.

Colutea arborescens

Recently tested by MRDP and found to be extremely fast growing

and good survival even on heavy soils.

Combretum erythrophyllum (River Bush-Willow)

MRDP have tested seedlings bought from the Provincial Nursery in Bloemfontein. It has shown promising growth even on heavy soils and is sufficiently frost-resistant for the MRDP area.

Cornus alba

Unimpressive growth in MRDP plantings and Semonkong. Survival good however at Semonkong and so considered worth further investigation in the mountains.

Cornus mas

Growth at Semonkong and Tsenekeng was not particularly fast but survival was good. MRDP found it to be slow growing. Warrants further research in mountain trials.

Cornus sanguinea

Marginally faster growth than the other two Cornus spp. tested by Semonkong Project and survived the extreme conditions at Semonkong and Tsenekeng but poor growth in the foothills in MRDP plantings. Further testing in the mountains is worthwhile.

Corylus avellana (Hazel)

A shrub which produces valued hazel nuts, in addition to flexible stems used for a variety of purposes and reasonable firewood (Moro, 1988). It will coppice readily.

After poor performance at Semonkong and Tsenekeng it was rejected as a species for planting in the mountains. In the plantings in MRDP it was found to need moisture and shade and most of their trees died 2-3 years after planting. Also found to be susceptible to hail damage.

Corylus colurna (Turkish Hazel)

Considered by Mitchell and Wilkinson (1988) to be "leafy and vigorous in difficult places" and tolerates a wide range of soil types in the UK (Hibberd, 1989). It is reportedly used for planting on dry sites and for land rehabilitation in Hungary (Ghimessy, 1980). However, has shown unimpressive growth at Tsenekeng and no growth at Semonkong. Same performance as C. avellana at MRDP.

Cotoneaster spp.

Excellent hedging species for the lowlands and rated very good for the foothills by MRDP (MRDP, 1991).

Crataegus spp. (Hawthorn)

As a live fence or hedge this thorny shrub or small tree has much potential. In Europe it is used to form livestock-proof hedgerows between fields, through laying of the branches. Will coppice; leaves are eaten by goats (Moro, 1988).

Several old trees can be found in Maseru and there is one large specimen of Crataegus sp. at Ladybrand Plantation. In the mountains C. monogyna has only been tested in small trials at Semonkong and Tsenekeng, where, from early results it was thought to have excellent potential. In MRDP plantings growth has generally been slow, but also considered to have potential.

Cydonia oblonga (Quince, Kweper)

Though strictly speaking a fruit tree it has been generally ignored by horticulturalists in Lesotho and is therefore included here. Produces a large acidic fruit which makes excellent jams and conserves and is even eaten raw by some people. A large shrub, it can be propagated from seeds or cuttings. It is found in gardens throughout the lowlands. It prefers heavy soils (Moro, 1988). The quince can also be used as root-stock for grafting pear cultivars.

Cytissus monspessulanum (Teline monspessulana)

Common in towns in the lowlands it has potential as a shrub for soil protection and rehabilitation and for fodder and hedging. Has excellent survival and growth in MRDP plantings. However not very drought tolerant (Feldner, pers comm). Failed at the mountain trials at Semonkong and Tsenekeng but this may be due to the severe, cold conditions rather than drought. Further testing worthwhile in the lowlands and foothills.

Cytissus praecox

A small shrub which survives but shows very slow growth. Not recommended.

Cytissus scoparius

Excellent survival and growth in the MRDP area. Considered suitable as an ornamental and has potential as a fodder bush and hedging. Worth further testing.

Dalbergia sissoo (Sissoo)

Produces excellent firewood and exhibits moderately fast growth in the Indian sub-continent, also produces useful fodder. Good survival but little growth so far of seedlings planted in the Ha Khitsane trial. Indicated by Poynton (1984) as suitable for donga reclamation in South Africa.

Dovyalis caffra (Kei Apple)

A native tree to South Africa. Produces an edible fruit and can be propagated vegetatively. Said to be moderately drought and

frost tolerant but slow growing by Poynton (1984). Discarded as a species with potential because of poor survival and growth in field trials.

Eleagnus angustifolia (Russian Olive)

A tough and hardy thorny small tree, noted surviving below -40°C. Tolerates a wide range of soil types from sands to clays but is not suitable on soils below pH 6 (Sheppard, 1986b). Its wood is of poor quality; it will coppice (Moro, 1988).

Experience in Lesotho confirms this is a hardy species, having shown good performance in extreme mountain conditions at Semonkong and Tsenekeng and very good performance in foothill plantings by MRDP (MRDP, 1991).

Eleagnus umbellata (Autumn Olive)

Another large shrub or small tree, also very cold-resistant, surviving temperatures of about -35°C. Surprisingly poor performance at Semonkong, but could be due to waterlogging. Also poorer growth than E. angustifolia. General opinion is that this species is not as well suited to Lesotho conditions as E. angustifolia.

Ficus carica (Fig)

The main product obtained from this tree is the fruit. However in Lesotho's summer rainfall climate the figs often swell and burst before ripening. It will reproduce from cuttings. Not a good firewood. Sap from the leaves is said to eliminate warts! (Moro, 1988).

The fig tree has been widely planted in the lowlands and has been present in the country long enough to be recommended as an amenity and fruit tree.

Fraxinus americana (White Ash)

The climate within the natural range of this species varies greatly, with length of frost free period ranging from 90 to 270 days. Average precipitation varies from 760mm to 1520mm. Mean annual minimum temperatures vary from -34°C to - 5°C (Schlesinger, 1990).

It is a species known to have demanding soil moisture and nutrient requirements. Surprisingly 100 seedlings of this species bought from the Provincial Nursery, Bloemfontein have shown reasonable performance in MRDP trial plantings.

Fraxinus excelsior

The Ash produces a quality timber and leaves can be used as animal fodder (Moro, 1988). It generally requires moist sites.

Described in Lesotho by Heywood in 1908 (Heywood, 1908). It has

been tested in several areas of Lesotho. Unexpectedly, at Semonkong and Tsenekeng it was damaged by frost.

Fraxinus pennsylvanica (Green Ash)

This is the most widely distributed of the American ashes. It is also considered one of the most adaptable when considering soils, as it will grow on substrates from waterlogged clays to sandy or silty soils (Burns and Honkala, 1990). It can tolerate a wide range of climatic conditions. The firewood is not of a very high quality but the leaves are palatable and it can be propagated vegetatively.

Growth at the FD trial at Konyana Tsoana, Semonkong (1850m) was disappointing. In the MRDP area survival was reasonable, but growth was slow. The species was planted in several woodlots in Qachas Nek, where it grew well on a slope at 1750m but was frosted back in a frost hollow at the same elevation. Specimens can be seen in Maseru and northern lowland towns.

Gleditsia caspica

Only recently introduced by MRDP. In raised beds in the nursery has shown good germination, survival and growth in its first season.

Gleditsia triacanthos (Honey Locust)

Although in the Leguminosae, there is no evidence that this species fixes nitrogen (Halliday, 1984). It is deep rooted and can survive dry sites, however Jurriaanse, (1973) in Phillips, (undated b), suggests that pod production will decline with rainfall less than 760mm. Southern provenances are noted as being damaged by out of season frosts and so should be avoided in Lesotho. It is tolerant of a wide range of soils, although grows best on soils of pH between 6 and 8. It will grow quickly provided that competing vegetation is controlled. Unfortunately if growth is stopped, for example because of drought it will not recommence that season (Phillips, undated b).

A fairly common tree in the lowlands it has a variety of uses. In South Africa and the USA, pods, seeds and foliage have been used for fodder. Toxic compounds are present, however they do not prevent using G. triacanthos as fodder, provided it is mixed with feed from other sources. The seeds, when milled, are a particularly good source of protein. If they are not milled they pass undigested through livestock and their protein content is therefore not utilised. The sugary inner part of the pod is eaten by children. The wood is hard, dense and durable and makes good firewood. Bulloch (1986b) believes that this trees main attraction is that it can be used in a system combining fodder production with pasture grazing and soil conservation. The light nature of the canopy allows grass growth up to the boles of the trees. A spreading, deep, root system assists soil stabilisation.

Honey Locust is represented in only the Ha Khitsane trail where survival was excellent but growth slow (Table A1.2). In foothill

plantings MRDP feel that this tree performed well, although again growth was slow (MRDP, 1991). Bare-rooted planting material, 1.5 to 2m tall has been used successfully by MRDP, but it needs good spring rains for establishment. In Semonkong bare-rooted stock showed heavy die-back and soil moisture must be high before planting. From his review of the literature, Phillips (undated b) felt it may not be suitable for the heavy black clays found in the mountains.

There has been some concern that the sharp spines on this tree may discourage it being planted. Possibly the thorn less variety G. triacanthos var inermis has more potential. There is conflicting evidence whether thorn less trees give rise to generally thorn less progeny (Kulygin, 1980 in Phillips undated b; Michener, 1986 in Phillips, undated b).

There is another thorn less variety that may be suitable for planting in Lesotho: G. triacanthos var. elegantissima. This grows as a small dense bush (Blair, 1990).

Grevillea robusta (Silky Oak)

There are a few trees of a Grevillea species in Maseru (eg LAC), although they are not very vigorous and look a bit ragged. There is debate as to whether they are G. robusta or another species.

In Harwood and Getahun (1990) G. robusta is described as growing best over a wide range of climates: mean annual temperatures from 15°C to 18°C and mean annual rainfall 1000mm to 2000mm. However, it is noted that frosts below -5°C will kill or severely damage young seedlings. At the MRDP nursery, all the seedlings of G. robusta died during winter. However, PLENTY has found that seedlings survive the winter by becoming dormant. Growth in the PLENTY project area was slower in the field than in the nursery (Matekane, pers. comm.).

Hippophae rhamnoides (Sea Buckthorn)

In its natural habitat it is found on leeward side of coastal dunes or on gravel and sandbanks inland. Its suckering habit makes it particularly suitable for erosion control on gravelly and sandy soils. In addition it is noted as being palatable to animals. Shepard (1986) suggests using only male plants as the seeds are easily spread by birds which eat the berries and this shrub may spread to areas where it is not wanted.

Given a "good" rating by MRDP in foothill plantings (MRDP, 1991) and considered by Semonkong Project to have excellent potential, after performing well at two mountain trials. Could be used as a hedge plant or for soil conservation plantings from the lowlands to the mountains. In addition, the berries are edible.

Jacaranda mimosifolia (Jacaranda)

There are several trees of this species planted as ornamental around Maseru. It has not been tested in trials but is thought to be at the extreme limit of its cold tolerance in the lowlands

of Lesotho.

Juglans nigra (Black Walnut)

A prize timber in its natural habitat of North America and elsewhere. The nuts are edible and tasty. However it is very sensitive to soil conditions, growing most favourably on those that are deep, moist, fertile, neutral and well-drained. Growth on good to moderate sites is reasonably fast (Williams, 1990).

Must be planted on good sheltered sites in the lowlands and foothills, where it can show excellent growth. The mountain climate appears to be too severe for this species: trees grow in summer and die back to ground level every winter.

Juglans regia (Common Walnut)

There are several trees of this species in Lesotho. It produces very valuable timber as well as nutritious nuts but is not a fodder tree. Seedlings planted in the mountains have not performed well being frosted back to ground level during winter. At Ha Ramabanta, in the foothills one of two trees survived the first year although it grew little, if at all. However there are mature trees at Paray Mission, Thaba Tseka.

Leucaena collinsii

Slow growth, but healthy in the nursery (Bazill, 1989). Trial results are inconclusive, as there was uncertainty whether trees died because of browsing or frost. Mortality was 100%.

Leucaena diversifolia

Reasonable performance in the FD Research Nursery (Bazill, 1989), but complete failure over winter at the MRDP nursery. At the Ha Makhakhe trial the results were inconclusive as it was not certain whether cold or browsing or both that killed the trees. However, at Ha Khitsane there was only 8% survival after the first winter (SOWACO, 1990). The drought that followed did not increase mortality and this species would appear to be killed by the cold rather than dry conditions.

Leucaena esculenta

Best species of leucaena in terms of nursery performance at the FD Research Nursery, with greatest height growth and healthy looking plants. The nursery performance of variety paniculata was almost as good (Bazill, 1989). It is not known if these were overwintered, and the winter cold killed all seedlings in the MRDP nursery.

Unfortunately field results from the Ha Makhakhe trial are difficult to interpret as it is not known whether browsing or frosting killed all the trees. The results from Ha Khitsane show however, that this species is not frost-tolerant with no survival after the first winter (SOWACO, 1990).

Leucaena greggii

Good nursery performance in the FD Research Nursery (Bazill, 1989), but winter frosts killed all plants in the MRDP nursery. There was no survival in a trial near Matelile, but cause of death uncertain, being either frosting or excessive browsing or both. Results from Ha Khitsane indicate that this species may be more frost resistant than the other leucaenas tested at the trial: after the first winter survival was 79%.

Leucaena lanceolata

All died in the MRDP nursery over winter after performing very poorly during the summer. Also varieties sausae and lanceolata

Leucaena leucocephala

At Leshoboro Plateau seedlots of this species were planted in a small trial. Growth during the summer was good, but they were all killed by frosts in the winter. Nursery experience also showed this species to be frost-sensitive with complete mortality in the MRDP nursery over winter.

Leucaena macrophylla var nelsonii

Poor growth, survival and vigour in the nursery and all died in the MRDP nursery over the winter. No survival at a trial at Matelile.

Leucaena pulverulenta

Reasonable performance in the FD Research Nursery (Bazill, 1989), but when over-wintered all died. No survival in a trial near Matelile.

Leucaena retusa

Found to be fairly slow growing in the nursery, but healthy (Bazill, 1989). In the Matelile Leucaena trial survival after a year was very poor. Whether this was due to frosting, browsing or both is not known.

Leucaena salvadorensis

Poor growth and vigour at the FD Research Nursery (Bazill, 1989), whilst winter cold killed all the trees at MRDP's nursery. No survival at the Matelile trial.

Leucaena shannonii

Poor growth and vigour in the FD Research Nursery (Bazill, 1989) and no survival over winter in the MRDP nursery. Complete mortality in the Matelile trial.

Ligustrum ibota (Small-Leaved Privet)

The small leaved privet has been much planted as a hedge in the lowlands and also in the foothills and generally grows quickly. A recommended hedge species, particularly for the foothills where it's survival is better than L. lucidum.

Ligustrum lucidum (Broad-leaved privet)

Used extensively as a hedge in the lowlands it has also shown promising growth and survival in the mountains at Semonkong and Tsenekeng. In the lowlands will form a small tree and has shown very good growth also in the foothills, although survival of L. ibota is better. A recommended species for hedging.

Liquidambar styraciflua (Sweet Gum)

A pioneer with a valuable timber. The mean annual rainfall in its wide natural range in Eastern USA varies from 1020mm to 1520mm, although growing season rainfall is about half this. Winter coldness and the incidence of frosts varies greatly (Kormanik, 1990). In the USA considered as being one of "the most adaptable hardwood species in its tolerance to different soil and site conditions" (Kormanik, 1990). Regenerates from seed and root sprouts. Produces moderate quality firewood and poles (Poynton, 1984).

Generally experience of this species in Lesotho has been disappointing. There was no survival after the first winter in the MRDP nursery. However, a few healthy individuals exist in gardens and also at the National University of Lesotho at Roma (May, pers. comm.).

Liriodendron tulipifera (Tulip Tree)

A high value timber tree, it also provides shade and bee forage and some fodder. This species has a wide distribution in the east of the USA and grows under a wide range of climatic conditions. Rainfall ranges from 760 to more than 2030 mm and frost free days from 150 to more than 310 days. Growth is best when rainfall is fairly evenly distributed over a long growing season (Beck, 1990).

None survived at Semonkong, however survived and attained a reasonable height at Tsenekeng. Unfortunately it dies back every winter. At the MRDP nursery no trees survived their first winter. One or two ornamental specimens can be seen in Maseru gardens.

Lonicera xylosteum

Was considered by Semonkong as a possible hedging plant. However was unable to survive the extreme conditions at Semonkong and Tsenekeng. In the MRDP area survival was reasonable but growth poor and severely damaged by grasshoppers.

Lupinus arboreus (Tree Lupin)

There have been rather conflicting results from this species. In the Research Nursery it grew very quickly and appeared healthy. However, when planted it died rapidly, possibly because the root:shoot ratio was too small. However, MRDP have obtained good results with this species in foothill plantings (MRDP, 1991).

This species is used in soil stabilisation and is suitable for any neutral to acid free-draining disturbed substrate (Bulloch 1986c). It is generally used in New Zealand as a nurse crop, improving soil conditions for other species. Although short-lived on fertile sites, prolific seeds are produced, which germinate with ground disturbance or light. It is therefore self-seeding.

Tree lupin is not usually preferred by livestock, except goats. There have been no instances of toxic effects of Tree Lupin (Bulloch, 1986c).

Lycium halimifolium

Results from the two Semonkong Project trials were good enough for it to be worth further testing, although it was not vigorous. There was some survival in plantings by MRDP.

Maclura pomifera (Osage Orange)

Planted in very large numbers in North America and supplied most of the poles that fenced the West. Various parts of the tree contain useful chemicals. Used also as a live fence and windbreak and in soil stabilisation activities (Burton, 1990). Sensitive to compaction and reputed to grow less vigorously on soils with a completely eroded A1 horizon. Fairly drought tolerant (Burton, 1990). Osage Orange can be propagated vegetatively (Poynton, 1984).

An invasive species in the USA, the high demand for fuelwood and overstocking of livestock would make it unlikely to be a problem in Lesotho.

MRDP have found this to be an excellent species in terms of growth and survival. Certainly warrants further investigation and also use in small-scale plantings.

Malus communis (Crab Apple)

The wild ancestor of the cultivated apple, it is reputed to be rather slow-growing (Moro, 1988). Its main use is as a rootstock for apple varieties. Reasonable survival in the mountains at Semonkong and Tsenekeng but slow growth in lowland and foothill plantings by MRDP.

Medicago arborea (True Tree Lucerne)

Good survival at Matelile, but poor production, growing slowly into a small shrub. Failed after slow initial growth on a dry southern site at Ha Khitsane. Unsuited for the mountains from experience at Semonkong and Tsenekeng.

Melia azederach (Persian Lilac, Chinaberry)

A common tree in Maseru, it has potential for further use as a shade tree in the lowlands. An interesting characteristic of this tree is that the fruit and leaves have insecticidal properties. Livestock will browse the leaves but the fruits are poisonous (Turnbull, 1986). Growth of this small tree is fairly fast; it will coppice and grow from cuttings. A species for future trials.

Mespilus macrocarpa (germanica)

Showed good potential at Semonkong and Tsenekeng. Survival was reasonable but growth of this low shrub was poor.

Mimosa scabrella (Bracatinga)

A small tree native to the Parana region of Brazil, it is known as a good fuelwood and as a soil improver, through nitrogen fixation and its characteristic of shedding large quantities of nitrogen rich foliage (NAS, 1980).

This species grew extremely fast in the FD Research Nursery and was planted at a trial in the foothills at Ha Ramabanta. After one year survival was very poor, being about 4%. However, those trees that survived looked very healthy and showed no damage from either the drought or from frost. At Ha Khitsane survival was again poor, at 33% after one year. However growth of those individuals that did survive was good, being an average of 66cm in one year. MRDP also found it to grow fast in the nursery and have planted it for the first time in early 1992.

Morus alba (White Mulberry)

A native of China. Popular with farmers in India and Nepal as the species produces edible fruits and useful fodder (Jackson, 1987). Will coppice and can be pollarded and can be propagated from seed or cuttings. Did not survive in the SRDP trials in the mountains. However it has shown excellent early growth and survival in the dry lowland site at Ha Khitsane.

Morus nigra (Black Mulberry)

The Black Mulberry is planted extensively in gardens in the lowlands and foothills. Makes a good shade and fruit tree. Like M. alba has shown excellent growth and survival at the Ha Khitsane trial and is easy to propagate from cuttings. Did not survive in the Semonkong RDP trials in the mountains. Less palatable than M. alba as a fodder due to the rougher texture of the leaves (Moro, 1988). Both M. nigra and M. alba prefer lighter soils.

Olea europaea (European Olive)

There are a few trees of the European Olive in Lesotho. The fruit is a potentially valuable product. The wood is dense and durable, but unfortunately growth is slow. There is therefore a long delay between planting and any returns and at present no local market for the produce. A sub-species of this tree (ssp africana) is indigenous to Lesotho.

Opuntia spp. (Prickly Pear)

Most opuntias are restricted to arid and semi-arid areas. In South Africa there are at least 14 species (Bruch, pers. comm.). The spineless cactus, a recessive mutant of O. ficus-indica is planted extensively as a fodder crop in drier parts of South Africa. It is able to withstand temperatures of -10°C. Although they will grow on a wide range of soils, it is recommended to plant them on good soils' (De Cock, undated). Two varieties of the spineless cactus are described: one with green cladodes and one with blue cladodes. Although less palatable the blue-cladode variety is preferred for fodder production, as it is more resistant to cochineal beetles and cactoblastis and is also more drought tolerant (De Cock, undated). Apart from its' use as an emergency feed during droughts the species produce edible fruits. Various spineless varieties have been developed for fruit production. The fruit nutritional value is comparable to apples (Bruch, pers. comm.)

Spiny opuntia is present in the lowlands of Lesotho where it is mainly used as a live-fence, while children relish the fruits. It has spread naturally and can be found in patches of indigenous forest and shrubland. The FISC project near Mohale's Hoek has promoted spineless varieties.

Parkinsonia aculeata (Jerusalem Thorn)

Grows fast in the nursery. This species was planted by MRDP and although it did not die it was frosted. There are however several healthy specimens in Maseru (eg Sun Cabanas) and so may be suitable for the lowlands. Worth further investigation as it produces firewood of good quality, fodder and bee forage (Poynton, 1984).

Paulownia tomentosa (Royal Paulownia)

A fast growing tree producing quality timber and some fodder, there is much interest in the genus in South Africa. Used in agroforestry systems in China. It is also an attractive ornamental tree and can be propagated from root cuttings.

Planted in a simple trial at Tseroane, it showed no survival. However, noted as being good for the foothills by MRDP (1991). Possibly the trees at Tseroane were killed by poor soil drainage rather than the cold. It has been noted as being sensitive to waterlogging and not tolerating hail damage or strong winds

(Feldner pers. comm.). In the MRDP garden in Maseru where temperatures of -10°C have been experienced there are several healthy trees and growth was very fast. Also on several lowland sites in the MRDP area, growth has been good. The leader does seem to be susceptible to frost damage, causing bifurcation and often a straight single stem is only obtained through pruning. Not suitable for the harsh mountain conditions. No trees survived at the trials at Semonkong and Tsenekeng.

Physocarpus opulifolius

Poor survival and not recommended by MRDP.

Platanus x acerifolia (London Plane)

An amenity tree in Maseru and suitable for lowland plantings and also some large specimens in the foothills, such as at the Frasers store at Makhaleng. Should not be planted in the mountains however as SRDP have found it to be a poor performer.

Heywood (1908) considered that the Oriental Plane (P. orientalis), one of the parents of the London Plane, (P. x acerifolia) would also be suitable for planting in Lesotho.

In New Zealand planes have been successfully established from unrooted poles, in areas with livestock, despite having palatable foliage. This method may be suitable for Lesotho conditions.

Platanus wrightii (Wright's Plane)

Been planted by MRDP and some surviving. Similar in most respects to P. x acerifolia.

Populus x canescens (Grey Poplar)

Believed to be a natural hybrid it is the most promising poplar in Lesotho, according to Wilkinson (1990). The clone in Lesotho has shown itself to be highly adaptable, growing relatively quickly over a wide range of sites. Furthermore the aggressive root suckering, up to 46m from the parent tree (Poynton, undated) of the local clone makes it particularly suitable for soil stabilisation measures. However, this invasive nature makes it unsuitable for planting near fields. Propagated from root suckers rather than stem cuttings. Field measurement in various grey poplar stands in the lowlands have given Mean Annual Increments of between 8 and 18 m^3 per year; these rates are comparable to the growth of Eucalyptus but are usually obtained on poorer sites.

Other Poplar clones

These have only been introduced in the last two years. Those from South Africa look particularly promising due to their long

growing period.

Populus deltoides

This poplar has a very wide distribution in eastern and mid-western USA from 27° to 46°N and 76° to 100°W. Generally it is found near rivers and streams as open groves on banks and valley bottoms. It grows best on well-aerated fine sandy loams and silts and requires a constant supply of moisture through the growing season. There is much variation within the species and three subspecies are defined (Poynton, undated). Noted as being the fastest growing commercial forest species in North America (Haverbeke, 1990).

In Lesotho it is commonly found along streams from the lowlands up into sheltered mountain areas. MRDP have obtained very good results with this species in the foothills. However Wilkinson (1991) felt there were better species and hybrids that could be planted under the same conditions. He also noted that existing material was badly affected by rusts.

Populus fremontii

Common in the lowlands and foothills, especially in valley bottoms. Good growth, but probably bettered by new clones. This species is represented by a single clone in Lesotho. It has mistakenly been termed P. wislezenii in the past in Lesotho (Wilkinson, 1990).

Populus nigra (Lombardy Poplar)

A species with a wide distribution in Eurasia and a limited one in North Africa (Elwes and Henry, 1986; Streets, 1962 in Poynton, undated). Its altitudinal range is also wide, from sea level to 2300m. The geographical distribution is very similar to P. alba.

Planted for many decades in Lesotho in the lowlands and is also found in the mountains. Although it produces root suckers they are generally browsed by livestock, and so is not particularly suitable for erosion control. Superstition makes it unpopular (See Section 3.7).

Populus tremula (Aspen)

Seems well suited to Semonkong and Tsenekeng in the mountains, although slow growing. Poor performance in the MRDP area of the foothills and lowlands.

Prosopis chilensis

NAS (1980) notes that it will survive mild freezes of -5°C, but not lower and will die when subjected to frequent mild frosts. Produces high quality fuelwood and fodder. Thorn less varieties have been identified (NAS, 1979).

In the Research Nursery, two seedlots of this species, sown late 1991 have grown exceptionally quickly and most seedlings have survived the winter. One year old P. chilensis at Ha Khitsane have shown excellent survival and growth.

Prosopis ferox

A little-known species from the Jujuy Province of Argentina. In the Research Nursery this species has grown more slowly than seedlots of three other Prosopis species.

Prosopis flexuosa

Promising early growth in the Research Nursery from seedlots sown in late 1991.

Prosopis sp

There is some uncertainty of the identity of seed collected by MRDP from the OFS. Plantings of the "local" Prosopis sp. have shown it to be slow growing.

Prunus dulcis (Almond)

Wild almonds grown from seed produce bitter-tasting almonds; the almonds eaten as nuts are grown from grafted trees. In addition to producing nuts it is an attractive ornamental tree and the firewood is of very high quality (Moro, 1988). Will grow in heavy soils (Hibberd, 1989). Almonds have been grown in the Quthing District by LISP (May, pers comm).

Prunus mahaleb

Poor growth and survival in Matelile but healthy and good growth in the two mountain trials at Semonkong and Tsenekeng. Used as a rootstock for cherry varieties.

Prunus serotina (Black Cherry, Mexican Cherry)

The largest of the cherry trees native to the USA. Its natural range extends from Canada through the USA to Mexico and Guatemala. It grows well on a wide variety of soils, but needs cool, moist summers. The favoured soils are strongly acid, infertile and are coarse in texture (Burns and Honkala, 1990).

There is considerable variation within the species, in terms of growth habit, growth rate and survival (Marquis, 1990).

In the USA it is considered a fast grower, at least through the seedling, sapling and pole stages (Marquis, 1990). There is little experience of growth rates in Lesotho, however it is known to grow in environments as different as Maseru and Mafeteng Nursery, in the lowlands and Molimo Nthuse Lodge, in the mountains. At the mountain trials at Semonkong and Tsenekeng this species has performed well. MRDP staff consider it has good survival in their area but slow growth. Worth further investigation and limited planting as a soil conservation

species.

Prunus spinosa (Blackthorn)

Blackthorn is used in Europe as a hedge and its berries are edible and used in flavouring a gin liqueur. Best growing prunus in the Matelile area and considered worth further investigation by SRDP.

Pyracantha coccinea and Pyracantha robur

Make a good hedge in the lowlands and foothills. Edible fruits enjoyed in limited quantities by children.

Pyrus communis (Wild Pear)

Slow growth and barely survived in the MRDP plantings but good survival in the mountains at Semonkong and may have potential.

Quercus acutissima (Sawtooth Oak)

A species with a wide distribution in Asia. The climate of its natural range is humid or subhumid and varies from temperate to subtropical. Favoured soils tend to be light and well drained. Although very frost hardy it is not particularly tolerant of drought (Poynton, undated c). In South Africa it has been found to grow fast on good sites, with mean annual height growth of 1m/year at age 10 (Cunliff, 1969b and Kruger, 1973; in Poynton, undated c). Healthy specimens in Maseru and other towns in the lowlands. Worth testing further and limited planting. From experience in South Africa dry sites should be avoided.

Quercus cerris (Turkey Oak)

Naturally distributed from southern and south-central Europe and Asia Minor (Loudon, 1838 and Elwes and Henry, 1906-1913; in Poynton, undated c). Noted as being slow growing in South Africa (Poynton, undated c). However in Lesotho, it has shown reasonable early growth and good survival at the two SRDP trials in the mountains. Needs further testing.

Quercus ilex (Holm Oak)

Recommended as a species worth testing by Heywood (1908). In Lesotho MRDP had complete failure in the nursery. The reason for this mortality was not obvious. Excellent firewood (Poynton, 1984).

Quercus mexicana

Good performance in the nursery and from MRDP field experience a slow grower but good survivor.

Quercus petraea (Sessile Oak)

The sessile oak has a similar natural distribution to its close relative, Q. robur, although it is not found as far east (Camus, 1939-1939 and Bean et al 1970-1980; in Poynton, undated c) and its range extends to higher altitudes (Elwes and Henry, 1906-1913 in Poynton, undated c). Tolerates poorer soil conditions than Q. robur but is less tolerant of heavy soils/ waterlogging (Hibberd, 1989). Despite being apparently better adapted to higher elevations it has not performed better than Q. robur at the two SRDP trials.

Quercus robur (English Oak)

Naturally distributed at low to medium altitudes and mid latitudes in Europe, Western Asia and North Africa. This species has been planted in Lesotho for over a century. Heywood (1908) described trees in the Residency garden in Mohale's Hoek as being fifty feet high (15m) and eighteen inches (45cm) in diameter. A small plantation of this species in Lesotho is found above Qacha's Nek town.

Described under its synonym Q. pendunculata in some trials. Very slow growth in the lowlands and foothills. This species has not been a success in MRDP plantings and barely survives in the lowlands and foothills. Tried in the two Semonkong RDP trials in the mountains, where it was considered worth further testing. Is likely to survive very cold conditions as it has been noted as withstanding temperatures of as low as -37°C (Camus, 1936-1939 in Poynton, undated c).

Quercus rubra (American Red Oak)

This tree is moderate to fast growing in its natural habitat of the eastern USA and Canada, where precipitation varies from 760mm to 2030mm (Burns and Honkala, 1990). In Lesotho there are only a few examples, eg at Mohale's Hoek Hotel. SRDP have found it to be slow growing in their trials.

A beautiful ornamental with a symmetrical crown and spectacular red autumn foliage.

Quercus suber (Cork oak)

Found naturally along the western Mediterranean and the neighbouring Atlantic coast (Poynton, undated c). Mainly grown for the cork it produces. Represented in Lesotho by a few trees in Maseru (Poynton, 1966) but growth is slow.

Rhamnus cathartica

Not recommended for the foothills and lowlands by MRDP. However good survival and reasonable growth in the mountains at Tsenekeng and Semonkong.

Robinia fertilis (Bristly Locust)

Trials in the USA have shown the superiority of this species for erosion control. Experience in other countries show this species will tolerate a wide range of soil conditions, but not waterlogged or poorly drained conditions. In the USA it has survived frosts to -10°C. It has a brittle stem and is therefore susceptible to wind-snap and breakage by livestock. Unlike R. pseudoacacia it does not produce thorns.

Limited experience in Lesotho has shown this to be a promising species. In foothills this species has performed well (MRDP,1991). After the first year, survival was down to 50%, mainly due to drought as the trees had survived their first winter (SOWACO, 1991). At two years the survival of the remaining original trees and the transplants planted in the beating-up operation was good and growth reasonable at a trial at Ha Khitsane.

At Matelile it was found to be suitable in donga reclamation plantings, producing a profusion of root suckers. Does not tolerate competition. Has produced seed at Matelile one year after planting.

Robinia hispida

Grows in the eastern OFS. It is known to sucker profusely and may be suitable for soil conservation measures. Will be planted by MRDP in 1992.

Robinia neomexicana

Difficult to distinguish from R. pseudoacacia. Only a few seedlings have been tested, in a donga in the MRDP area. They have grown and survived well.

Robinia pseudoacacia (Black Locust)

A tree with many uses: fuel, bee forage, fodder, poles, shade and rehabilitation of degraded areas. The wood makes an excellent fuelwood and charcoal and is durable. The honey from robinia nectar is considered to be one of the best in the world. The leaves have a high protein content of 24%, but unfortunately also contain digestion disrupting compounds such as tannins and lectins. Levels of tannins decrease as the leaves age (Hanover and Mebrahtu, 1991). It is used in various parts of the world to control soil erosion, as it readily root suckers and fixes nitrogen, (although not in Lesotho).

In Lesotho it has mainly been planted for erosion control, particularly in dongas in the lowlands. It has been grown elsewhere and until recently there was even one tree growing in the exposed mountains at Semonkong. Initial growth is fast and it is suitable for planting in the lowlands and foothills. It is one of the species considered by MRDP to have very good growth in the foothills. At Ha Khitsane all trees survived their first winter, but 21% died after a period of drought. This year an untimely frost killed the planting stock of this species at Semonkong.

Observations around the country indicate a considerable variation in growth of this species. This is probably related to site conditions and should be further investigated. Dry slopes and shallow soils should be avoided. NAS (1983) states that the species does not grow well in compact soils because of waterlogging. However, PLENTY have had excellent results growing this species on sandy soils close to a river bed (Matekane, pers. comm.). On suitable sites it would appear to be drought tolerant. During the 1991-92 drought there have been far fewer mortalities than species such as A. dealbata.

Provenance testing is recommended.

Robinia pseudoacacia var. monophylla

A grafted ornamental tree from Germany, similar to R. pseudoacacia but almost thorn less. Tested by MRDP and by SRDP.

Rosa rubiginosa

A small, bushy rose that is naturalised in Lesotho. Can be found on disturbed areas, particularly road sides, from the lowlands up into the mountains. Has potential as a live fence or hedge. There is a market for the rose hips, which are made into jelly and exported by Basotho Canners in Mazenod.

Rosa rugosa

Grown by MRDP and SRDP. Survives well, but grows slowly at the mountain trials at Semonkong and Tsenekeng and is thought to have promise as a live fence or hedge.

Salix babylonica (Weeping Willow)

Originally from the Far East, it was introduced into Europe over two hundred years ago (FAO, 1979). By 1908 it was already widespread in Lesotho where it is found mainly along watercourses in the lowlands (Heywood, 1908). It has to a large extent replaced the indigenous S. mucronata that was common on such sites until the middle of last century (Germond, 1967). Rated as a very good species for planting in the foothills by MRDP (MRDP, 1991) and thrives mainly but not exclusively on banks of rivers and streams in the lowlands, foothills and parts of the mountains.

It comes into leaf early in Spring at the end of the dry season and provides a very useful source of supplementary fodder, with a crude protein content at this time of 12.6 %, digestibility of 63.4 % and 65 % moisture content (Forestry Research Section, 1991).

Noted in FAO (1979) as being relatively sensitive to cold and as such, hybrids between this species and S. alba and S. fragilis are preferred as weeping willows in temperate areas. Such hybrids would be worth testing in the mountains.

Salix capraea (Goat Willow)

Used in the mountains at Thaba Tseka as a hedge around houses. Also present in the lowlands and foothills. Experience from MRDP has shown this to be a promising species, with good growth and survival in the foothills and to be particularly suitable for donga plantings. PLENTY have obtained good results in plantings in dongas and along riverbanks (matekane, pers. comm.) Used in basketry and produces fodder which is especially favoured by goats (Moro, 1988).

Noted in FAO (1979) as being difficult to raise from cuttings, so propagate through seed. In the UK it is recommended for clay soils but not for wet soils (Hibbel, 1989).

Salix cinerea (Grey Willow)

Healthy and reasonably vigorous growth at the Semonkong trial site.

Salix fragilis (Crack Willow)

This species has been misnamed "S. viminalis" in FD and Soil Conservation nurseries. This tree is commonly found on riverbanks and wetter areas from the lowlands up into the mountains. Found by MRDP to be particularly suitable for donga planting and by PLENTY for mountain sites.

Salix matsudana and Salix matsudana hybrid clones

A rare tree in Lesotho. A specimen of the female clone S. matsudana "Tortuosa" is growing at the FD Central Nursery, but has been attacked by a leaf spot disease, possibly Marssonina salicicola (Wilkinson, 1991) and by an unknown insect (May, pers. comm.). Also found elsewhere in Maseru.

The recently introduced clones of this species and also of S. matsudana *x* S. alba clones have performed exceptionally well at the nurseries where they have been planted for bulking.

Salix purpurea (Purple Osier)

In the past this species was planted on donga floors (Poynton, 1966) and considered to be probably the most drought tolerant of the osier willows (Hathaway, 1986). MRDP (1991) found this to be a promising species for the foothills in Lesotho and SRDP have had good results from their trials in the mountains, although some damage by grasshoppers has been observed.

In addition to its drought tolerance, recently established clones on waterlogged areas at two FD nurseries have shown complete survival and good growth.

Sambucus nigra (European Elder)

A small temperate tree, produces edible fruits which are made into wine; has many medicinal uses. Will coppice and grow from cuttings. Should require moist sites as it is not very drought tolerant (Poynton, 1984). Small numbers of this tree can be found

in lowland towns.

Sapium sebiforum (Chinese Tallow Tree)

Suckers and can be propagated vegetatively. Planted in RSA where its' growth is moderately fast but it is thought to have limited drought tolerance (Poynton, 1984). It tolerates a wide variety of soil types, including heavy clays (NAS, 1983). Planted at Ha Khitsane in 1991 where most survived the first winter.

Schinus molle (Pepper Tree)

There are old examples of this species throughout the lowlands and Heywood (1908) described it in his early account of tree planting in Lesotho. Unexpectedly he describes this species as being killed or badly damaged by frost and May, (pers. comm) has found it to be frost sensitive.

Planted extensively as a shade tree in the lowlands (especially in Quthing) and used as a medicine to combat influenza and colds. It is a slow grower but produces good quality firewood (Poynton, 1984).

Sesbania grandiflora

This species failed completely in the nursery due to frost.

Sesbania punicea

An invasive, poisonous little shrub, seen by road sides in Maseru and a scheduled weed in South Africa. It is not very frost tolerant and so is only suitable for the lowlands and areas of the foothills. Used by MRDP in donga plantings.

Sesbania sesban

An excellent tree in arid and semi-arid areas, but killed by frost in Lesotho. A number of provenances were planted in a small trial at the FD Research Nursery but after fast growth in the summer all were killed in the winter. MRDP attempted to plant the species early in the season so as to obtain seed before the winter but were unsuccessful.

Simmondsia chinensis (Jojoba)

A shrub grown commercially in desert areas for the production of jojoba oil. It also has some value as a fodder producer. Seedlings grew slowly in the nursery and eventually died in field plantings at Ha Khitsane and MRDP. Insufficiently high summer temperatures and winter frosts probably the reason for poor performance.

Sophora japonica (Japanese Pagoda Tree)

A large leguminous tree, showing reasonable growth and survival in MRDP plantings. A good ornamental and shade tree for the lowlands and foothills, although birds eating these seeds excrete

corrosive droppings (May, pers. comm). Also produces reasonable quality fuelwood. It will reproduce from cuttings and will coppice. Leaves and pods said to be suitable as fodder (Moro, 1988).

Sorbus aucuparia (Rowan)

A small attractive tree with bright red inedible fruits. Produces a hard wood and poor quality fodder. Only half the trees of this species survived and growth was slow at Tsenekeng and Semonkong. In winter the trees died back, probably due to drought and so it has been rejected as a species for the mountains. In the MRDP area has shown good survival but needs favourable conditions before production is adequate. Tolerates wet soils (Hibberd, 1989).

Spartium junceum (Spanish Broom)

Planted widely in gardens in the lowlands and foothills. It has also been planted on less favourable sites by MRDP as a potential fodder bush and hedging plant. Good survival and growth.

Symphoricarpus hancock

Considered to be a suitable species for the mountains, showing good growth and survival at Semonkong and Tsenekeng. In contrast only 20% survival in the MRDP area.

Tamarindus indica (Tamarind)

SWaCAP seedlots raised in the Research Nursery in 1991-92 were healthy but grew slowly and in winter were killed by frost.

Tamarix aphylla

Faster growing than T. gallica and preliminary results of MRDP plantings look promising. Worth further investigation.

Tamarix gallica

Slow growing and shrubby in habit but well adapted to donga conditions. A tough tree for lowland and foothill plantings and used extensively as an ornamental. Also provides a good quality fuelwood. Will coppice and can be propagated from cuttings.

Teline canariensis

A fodder bush only recently tried by MRDP but initial results are promising.

Teline madarensis

As T. canariensis but slower growing on some sites.

Tilia cordata (Small-Leaved Lime)

Slow-growing. Wood has a number of specialist uses. Dried

flowers have medicinal properties (Moro, 1988). Will coppice. Unfortunately there was 100% failure of this species in MRDP plantings.

Ulex europaeus

Tried since 1991 by MRDP. A shrub suitable for hedging and soil conservation, being very thorny. Good survival but slow growth. Has potential as is not generally browsed.

Ulmus parvifolia (Chinese Elm)

A suckering elm used in former times for donga wall stabilisation despite being sensitive to waterlogging. Now extensively used as an ornamental and shade tree in the lowlands and foothills. Abundant natural regeneration from seed has been noted. MRDP believe it is a species that has been neglected as survival is good, often about 80% and growth is reasonable. Excellent performance on sandstone derived soils, even in dongas. Suitable for fuelwood and soil conservation.

Ulmus procera (English Elm)

Used in the past for soil stabilisation, this species produces a profusion of root suckers. Will be tested by MRDP in 1992. Also known in Europe as a fodder tree.

Virgilia oroboides (Fragrant-Bloom Tree)

According to Poynton (1984) the tree's main use is an ornamental. Complete failure in the MRDP nursery due to frost.

Ziziphus mucronata (Buffalo Thorn)

A shrub with heavy thorns, grows (slowly) in neighbouring Transkei and other part of South Africa.

The Z. mucronata at the Research Nursery and PLENTY Nursery has not been frost-tolerant. In winter it was killed back to ground level and produced new shoots in summer. Growth in the field was found to be very slow, although Z. mucronata was able to survive on very shallow soils. MRDP have found poor survival in their plantings of this species (MRDP, 1991).

Ziziphus spina-christi

Failed to germinate in the MRDP nursery. Seed was probably not viable.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 General

There are a number of useful broadleaf species already cultivated in Lesotho. In addition there is quite a large number of promising species which have not been fully tested, many of them have been planted in only one or two areas or have not yet

reached an age at which they can yield useful products. It is important that research should not only develop the "promising" species but also quantify yields and services from the established species and recommend appropriate management methods.

As mentioned in the Introduction, few studies have been made of the uses to which trees are put and people's preferences for products or services. Such studies would help in setting priorities for which species which should be studied more intensively.

On a more general note no popular publication is available on trees of Lesotho. It is hoped that this report shows that enough is known about many species in Lesotho for such a publication to be worthwhile. In addition Forestry Division nurseries and the National Tree Seed Centre should be encouraged to further expand the range of species carried beyond the traditional pines and eucalypts, which make up the bulk of the stock.

Many of the findings on species performance noted in this report are based on observations on project and Forestry Division trials. One district should be mentioned as having great potential for forestry in general and for the cultivation of the more moisture-demanding broadleaves in particular. Unfortunately, because of its' remoteness there has been very little forestry research conducted there to date. The district referred to is Qachas Nek. Some tree and shrub species may show better performance in parts of this district than in other parts of Lesotho, due to higher precipitation.

Appendices 2 to 5, following Section 7 (References) place the species discussed above in various categories: proven species; promising species; species with poor performance but which require further research; species considered unsuitable for Lesotho.

The final Appendix lists some additional species which should be tested in Lesotho. The list is not exhaustive, due to the limited amount of reference material available in Lesotho. It is hoped that a desk study could be undertaken, perhaps as a Forestry BSc project, of other possible species.

6.2 Recommendations on Established and New Species

The recommendations made below are mainly based on biological performance. It is acknowledged in Section 6.2 that more information is needed from local people on utilisation and other aspects.

Nitrogen Fixing Trees

The Black Locust, R. pseudoacacia has been planted in Lesotho for decades and can be recommended in the lowlands and foothills. It will produce good fuelwood and moderate quality fodder, is

nitrogen fixing (although not proven in Lesotho) and suitable for erosion control. It coppices readily and will root sucker if the roots are damaged. Seedlots of R. pseudoacacia have been imported from the USA to test against Lesotho material. Attempts have been made to obtain seed from Hungarian Forest Research Institute, where much work has been done to genetically improve this species. In Korea a tetraploid clone has been developed for fodder production, with much larger leaves containing more protein (Bulloch, 1986e). The thorn less R. fertilis appears to have potential also in Lesotho. Other species in the genus worth investigating would include R. neomexicana and R. hispida. R. neomexicana grows to a small tree and can be found to an altitude of 2500m in New Mexico (Gibson, 1913 in Phillips, undated), while R. hispida is a small shrub normally grown as an ornamental. Plants of R. hispida have recently been acquired by MRDP.

Port Jackson Willow (Acacia saligna) has been very successful in colonising and stabilising poor sandy sites in the Cape (Armstrong, 1992; de Selincourt, 1992). However, the future potential of A. saligna in Lesotho as a tree for the sheltered lowlands is in doubt, as in South Africa a virulent gall-forming fungi, Uromycladium tepperianum has been introduced to control this species. Likewise, three weevils were introduced to South Africa to control Sesbania punicea, another invasive species, so wide scale planting of this species in Lesotho cannot be recommended (de Selincourt, 1992).

The wattles have been part of the Lesotho landscape for almost a century. Of these A. dealbata would appear to be the most adaptable, whilst A. decurrens also has potential. There have been problems in establishing these species with potted seedlings and through direct seeding. The problems with pots may have been due to the use of pots which are too small, as MRDP, who use large (500ml) pots have had good establishment. The main constraint to using direct seeding appears to be insect damage, particularly from grasshoppers defoliating the young seedlings.

A nitrogen-fixing, dioecious species which has grown in Lesotho for many years is Casuarina cunninghamiana. It would appear to have considerable potential in the dry southern lowlands, including the problem duplex soils. Seed of several provenances of Casuarina cunninghamiana has been sent from CSIRO, along with the Frankia inoculum for further testing. It is not known whether trees of this species in Lesotho have been inoculated with Frankia. C. equisetifolia and species of Allocasuarina are being tested in trials, although initial results are not promising. Interestingly Turnbull (1990) notes that casuarinas usually occur on sites that are not poor in nutrients, whereas allocasuarinas are generally found on nutrient deficient sites. Species within the genus allocasuarina that have been tested are A. littoralis, A. torulosa and A. verticillata. These have all shown poorer survival and growth than C. cunninghamiana.

The genus Prosopis contains several frost resistant species from South America, which may have potential in the lowlands of Lesotho. The wood of Prosopis spp. is known as a quality fuelwood, and most species produce large numbers of nutritious

pods. Like those of G. triacanthos the pods need to be crushed or milled to allow most animals to digest the nutritional value of the seeds. Foliage is palatable and forage grasses grow well in association with scattered trees (Poynton, undated b).

Several alders have been tried in Lesotho by MRDP, with promising preliminary results. These include A. cordata, which is noted as tolerating summer drought (Bulloch, 1986a), A. incana, which is described as being suitable for higher areas in New Zealand than A. glutinosa and produces copious suckers (Bulloch, 1986a) is worth further testing and A. rubra which is noted for significantly improving soil fertility (FAO, 1988) should be widely tested. A further species would be A. viridis noted for its suitability in stabilising alpine screes in New Zealand and sand dunes in Denmark (Bulloch, 1986a). MRDP have obtained seed and will be testing this species in 1992.

Poplars and Willows

Poplars are a common feature of the Lesotho landscape. Of the poplars already in Lesotho P. x canescens has been the most adaptable species. Further clones of Populus x canescens should be imported. The clone in Lesotho is excellent for soil stabilisation, due to its aggressive root suckering, but this characteristic makes it unsuitable for planting near farmers' fields. There are clones which produce fewer root suckers (Wilkinson, pers. comm.). Thirty one poplar clones were recently imported from New Zealand in 1990 and 1991 and South Africa in 1991, but it is too early for recommendations. Clones recently imported into Lesotho are shown in Table 3.

Willows are also considered a genus worth further investigation. Wilkinson (1990) felt that new clones would be superior to the willow species in Lesotho. Clones imported into Lesotho are shown in Table 4. Hybrids worth introducing would include those between S. babylonica and two other willows, S. alba and S. fragilis. These hybrids are more frost tolerant then S. babylonica (FAO, 1979).

Birches and Sorbus spp.

Birches would appear to have potential in Lesotho. Species to be tested in formal trials, particularly in the mountains include; B. alnoides, B. papyrifera, B. pendula, B. pubescens and B. utilis. Old trees of B. pendula can be found at Thaba Phatsoa, near Leribe, although seed collected from these trees appears to have short viability. There has been small-scale testing of B. pendula in unreplicated trials at Semonkong, in the mountains. Early results are very promising. At Ha Ramabanta in the foothills small numbers of B. pendula have been planted. In New Zealand birches are recommended for soil conservation and small windbreaks or as a component of multi-species windbreaks (Sheppard and Bulloch, 1986a). In Lesotho both MRDP and FD have experienced problems obtaining good germination from birch seed due to the rapid loss of viability of seeds of these species.

Table 3 Poplar Clones recently imported

Clone	Number	Origin
P. alba x glandulosa	PN895 "Yoegi 1"	New Zealand
P. deltoides x ciliata	83026-12	New Zealand
P. deltoides x ciliata	83017-13	New Zealand
P. deltoides x nigra	80015-31	New Zealand
P. deltoides x nigra	80008-2	New Zealand
P. deltoides x nigra Italica	NZ5010	New Zealand
P. deltoides x szechuanica	87002-29	New Zealand
P. deltoides x szechuanica	87001-6	New Zealand
P. deltoides x szechuanica	87002-5	New Zealand
P. deltoides x szechuanica	87002-6	New Zealand
P. deltoides x szechuanica	87002-10	New Zealand
P. deltoides x szechuanica	87002-11	New Zealand
P. deltoides x szechuanica	87002-12	New Zealand
P. deltoides x szechuanica	87002-16	New Zealand
P. deltoides x szechuanica	87004-16	New Zealand
P. deltoides x szechuanica	87002-21	New Zealand
P. deltoides x szechuanica	87004-32	New Zealand
P. deltoides x szechuanica	87002-35	New Zealand
P. deltoides x szechuanica	87002-42	New Zealand
P. deltoides x szechuanica	87004-43	New Zealand
P. deltoides x szechuanica	87004-46	New Zealand
P. deltoides x trichocarpa	82179-10	New Zealand
P. yunnanensis	88110-12	New Zealand
P. yunnanensis	88110-8	New Zealand
P. deltoides x yunnanensis	NZ5006 "Kawa"	New Zealand
P. euroamericana x yunnanensis	NZ5007	New Zealand
P. deltoides hybrid	36-29	South Africa
P. deltoides hybrid	36-31	South Africa
P. deltoides hybrid	SE1488	South Africa
P. deltoides hybrid	146	South Africa
P. deltoides hybrid	79	South Africa

Another genus that should be investigated is Sorbus. There are a wide range of temperate species which may be suitable for planting in Lesotho, particularly in the mountains. The rowan, Sorbus aucuparia grows to a higher altitude in Britain than any other tree (Mitchell and Wilkinson, 1988). Possibly because of drought, it has not performed well in the mountain trials established by SRDP.

Other

Although slower growing than R. pseudoacacia, the Honey Locust, G. triacanthos is another useful tree, that has been grown in Lesotho for many decades. The wood makes good fuel and is reasonably durable. Pods, when milled are a very good fodder, comparable to grain fodders (Bulloch, 1986b). It is not a nitrogen fixing species but produces a good quality litter. There is a thornless variety, variety inermis, worth investigating. As 80 - 90% of the progeny of G. triacanthos var inermis will be thorn less a seed orchard of this variety should

be planted. A small-scale provenance trial would be useful as there is considerable variation between populations from different origins. The northern populations are described as being hardier, more heavily armed, more aggressive sprouters and less tall. Southern races are more tree-like and yield good crops of pods (Bulloch, 1986).

Table 4 Willow Clones recently imported

Clone	Number	Origin
S. eleagnos	PN225	New Zealand
S. fluviatilis	NZ717	New Zealand
S. glaucophylloides	PN267	New Zealand
S. matsudana	PN227	New Zealand
S. matsudana	PN693	New Zealand
S. matsudana	PN694	New Zealand
S. matsudana	PN695	New Zealand
S. matsudana x alba	NZ1002 "Aokautere"	New Zealand
S. matsudana x alba	NZ1040 "Tangoio"	New Zealand
S. matsudana x alba	NZ1179	New Zealand
S. matsudana x alba	NZ1184 "Montere"	New Zealand
S. purpurea	PN608 "Irette"	New Zealand
S. purpurea	NZ249 "Booth"	New Zealand
S. repens x purpurea	NZ1057	New Zealand
S. hybrid	PN697 "Salinas Bitter"	New Zealand
S. triandra	"Semperflorens"	New Zealand

The elms, particularly U. procera deserve further attention. It has grown in Lesotho for many decades, suckers profusely on certain sites, produces a durable wood and the leaves can be used for fodder.

A tree, Melia azederach common in gardens in the lowland towns is worth small scale planting on harsher sites. It is fast growing, will coppice and is not particularly palatable. Several seedlots should be tested.

Other "shrubs" that have not been tested and deserve investigation are the bamboos. There are runner forming bamboos and clump forming bamboos and both types would fulfil a role in soil stabilisation measures. The clump forming bamboos could be used for quickly established windbreaks, whereas the runner forming species might be included in donga stabilisation. The following exotic temperate bamboos might be considered for testing in Lesotho; Arundinaria hindsii, A. japonica, Bambusa multiplex, Phyllostachys aurea and P. mitis. Further details of growth patterns, uses and site requirements for these species can be found in Van Kraayenoord and Bulloch, (1986). Other species that should be investigated were listed in Bazill, (undated) and comprised; A. amabilis, A. fastuosa, A. gigantea, A. simonii, A. vagans, P. bambasoides, P. dulcoides, P. flexuosa, P. meyeri, P. nigra, P. nuda, P. vivax and Sasa kuritensii.

The indigenous bamboo, Thamnocalmus tesselata would also be worth testing: it is a clump-forming species and initial growth rates of certain individuals are very fast, about 5 to 10cm per day.

(May pers. comm). However experience of MRDP indicates that it requires a moist, shady microclimate, although it does grow on dry slopes. To date this species has failed in MRDP trials.

For fodder, several species of atriplex could be more thoroughly tested: A. canescens, A. halimus and A. semibaccata. Two of these saltbushes, A. canescens and A. halimus have withstood frosts as low as -13°C. The high elevation seedlots of Tagasaste (Chamaecytissus palmensis) acquired in 1992 from the Canary Islands should be tested. Other fodder bushes for formal trials should include Telline spp., particularly T. monospessulana and also Colutea arborescens.

The genus Nothofagus has some potential on the better sites, such as the foothills. Four seedlots of N. obliqua were sent from the UK Forestry Commission, but were found to have very poor germination, having been collected in Chile in 1979 and 1980. This and other species from south America and New Zealand should be investigated.

Nut trees have also been considered worthy of further trials. Various species have been tested in trials and informally. However, the type of sites they have been planted on do not necessarily reflect the areas on which such trees would be established. New formal trials on agricultural quality soils should be established.

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Appendix 1 Results from FD Trials

Ha Ramabanta

In April 1992 this trial received its first assessment, at age 13 months. The fence was still intact and there was no livestock damage or vandalism. Of the species planted, Acacia albida and A. sieberana do not appear to be sufficiently frost-tolerant, although they have sent up new shoots this summer to replace the original stems. The E. rubida has grown well and those that have died appear to have done so recently, presumably because of the severe drought. This summer's drought had also killed some Acer pseudoplatanus. The two nut trees, Juglans regia and Castanea sativa had grown little since planting. Those that have died appear to have survived the frosts of winter to be killed by the prolonged drought. Planting stock of Mimosa scabrella was not good and only two have survived, although their growth was excellent. Four Casuarina cunninghamiana trees were fenced in from the neighbouring woodlot and have grown well despite browsing. However, they have an unhealthy yellowed appearance. Results are summarised in Table A1.1.

Ha Khitsane

In May 1992 the agroforestry trial at Ha Khitsane was assessed at age 26 months. Promising species were Robinia pseudoacacia, Morus alba, M. nigra, Cassia corymbosa and Prosopis chilensis. The best species considering both height and survival was Casuarina cunninghamiana. Two indigenous species Celtis africana and H. arborescens have excellent survival and looked very healthy despite a period of prolonged drought. Results are summarised in Table A1.2

Ha Mokhatla

In August 1992 the Casuarina and Allocasuarina species trial at Ha Mokhatla was visited for assessment. The fence had been cut and the standards removed. Heavy browsing over the whole of the trial meant that there was high mortality. Attempts to identify to which plots the surviving trees belonged were not successful. The trial was closed. Fortunately an assessment was made at age 18 months. The results are presented in Table A1.3. Of the species planted, C. cunninghamiana performed best, with a Kenyan seedlot of C. equisetifolia also showing promise. Growth of the Allocasuarina spp. was not good, although survival of A. vetricilata was excellent.

Leshoboro Plateau

In July 1992 a trial of Casuarina and Allocasuarina species at Leshoboro Plateau was assessed at age 45 months. As in the Ha Mokhatla trial C. cunninghamiana was the best performing species. Unlike, Ha Mokhatla the Kenyan seedlot of C. equisetifolia did not show good survival, although it bettered the other C.

equisetifolia seedlot tested. The two Allocasuarina cannot be recommended. The seedlot of A. littoralis failed completely, while survival and growth of A. torrulosa was poor.

Tseroane

An multi-purpose species trial was assessed at Tsereoane in May 1992 at age 30 months. Unfortunately almost all the trees had died and the only species with reasonable survival was Carya illionensis.

Mapotu

In May 1992 the Mapotu Agroforestry Trial received its first assessment. Despite the fence being intact, there had been considerable grazing and only three Atriplex nummularia bushes, two poplars and two willows had survived. These had been constantly browsed. It was decided that the trial be closed.

Table A1.1 Ha Ramabanta Trial L/25/136, Age 13 months

Species	Height (cm)	Survival	Ht x Survival
Acacia albida	13.6	27	3.67
Acacia siberana	15.5	46	7.13
Eucalyptus rubida	25.1	60	15.06
Mimosa scabrella	50.8	4	2.03
Robinia fertilis	27.3	56	15.29
Block Planting at Ha Ramabanta			
Acer pseudoplatanus	11.5	30	3.45
Betula pendula	14.8	8	1.18
Castanea sativa	14.1	44	6.20
Juglans regia	26.6	50	13.30

Table A1.3
Ha Mokhatla Casuarina Trial Age L/25/132, Age c. 18 months

Species	Seedlot	Height (cm)	Survival	Ht x Surv
Casuarina cunninghamiana	35889	105	55	57.8
Casuarina cunninghamiana	15601	100	58	58.0
Casuarina equisetifolia	ex Kenya	76	65	49.4
Allocasuarina littoralis	?	60	33	19.8
Allocasuarina vetricilata	?	94	37	34.8

Table A1.4
Leshoboro Plateau Casuarina Trial L/25/129, Age 45 months

Species	Seedlot	Height (cm)	Survival	Ht x Surv
C. cunninghamiana	35889	152	88	133.76
C. cunninghamiana	15601	122	50	61
C. cunninghamiana	14919	168	63	105.84
C. equisetifolia	13375	0	0	0
C. equisetifolia	ex Kenya	67	28	18.76
Allocasuarina littoralis	13376	0	0	0
Allocasuarina torrulosa	13126	57	35	19.95

Table A1.2 Ha Khitsane Mutipurpose Tree Species Trial L/25/135, Age 26 months

Species	Height	Survival	Ht x Survival	Comments
Acacia albida*	20 - 43	?	?	plantings in various plots
Acacia sieberana	19.5	100	19.5	
Albizia lebbek	0	0	0.0	
Atriplex nummilaria	23.5	97	22.8	
Carya illionensis	81	83	67.2	
Cassia corymbosa	68	77	52.4	
Cassia obtusifolia	0	0	0.0	
Casuarina cunninghamiana	292	100	292.0	best growing species
Celtis africana	59.5	87	51.8	
Chamaecytissus palmensis**	63	16	10.1	
Cytissus monospessulanum*	50	?	?	number planted not known
Dalbergia sissoo*	17	83	14.1	
Gleditsia triacanthos***	38	100	38.0	
Heteromorpha arborescens	80	100	80.0	
Leucaena esculenta	0	0	0	replaced with A. albida
Leucaena greggii	10	?	?	number planted not known
Medicago arborea	0	0	0.0	
Mimosa scabrella*	66	33	21.8	
Morus alba	113.5	100	113.5	
Morus nigra	102	100	102.0	
Prosopis chilensis	74	100	74.0	
Robinia fertilis*	32	92	29.4	varying ages
Robinia pseudoacacia	93	100	93.0	
Sapium sebiferum	33	?	?	

* planted atleast one year after trial estabished
** original plot did not survive

Appendix 2 Species that can be confidently recommended for planting in Lesotho

Acacia baileyana	Suitable for use as an ornamental in the lowlands.
Acacia dealbata	Particularly suitable for fuelwood production and soil conservation in the foothills and lowlands. Not suitable for planting by fields because of its invasive nature.
Acacia decurrens	As for *A. decurrens* but better for poles. Limit planting to the lowlands.
Acacia mearnsii	Will grow in Lesotho but more delicate than *A. dealbata*. Only reason for planting would be if tanning industries developed in Lesotho.
Acacia melanoxylon	If firewood is the main objective then *A. dealbata* and *A. decurrens* grow faster. Produces a fine timber.
Acer negundo	Used as an ornamental in the lowlands and foothills but may have a place in soil conservation.
Agave americana	Live fence. Lowlands and foothills.
Ailanthus altissima	Suitable for lowland/ foothill planting where suckering is desired.
Atriplex nummularia	Fodder shrub suitable for lowlands and foothills, esp. dry South and sodic soils. May be suitable for mountains but not yet tested there.
Cassia corymbosa	Attractive ornamental for lowlands and foothills. Little known about other uses of this species.
Castanea sativa	Suitable for the lowlands and foothills but growth is slow. Perhaps more potential as an ornamental than as a nut producer.
Casuarina cunninghamiana	Grows fairly fast in the lowlands and is healthy even on duplex soils. Worth planting more extensively especially in the dry South. Must ensure it is inoculated.
Cydonia oblonga	Well-known fruit tree which can be grown from cuttings. Little work done on identification or promotion of high-yielding cultivars.

Cotoneaster franchettii	A fast growing hedging species for the lowlands.
Crataegus sp.	Could be planted more extensively as a hedge plant on moister sites in lowlands.
Ficus carica	An ornamental and fruit tree for gardens in the lowlands and foothills.
Fraxinus pennsylvanica	Attractive shade tree with some fodder and firewood value. Suitable for moister sites in lowlands and foothills.
Gleditsia triacanthos	A fuelwood tree for the lowlands, but relatively slow growing. Pods provide excellent fodder for livestock but require milling for protein to be made available. Suitable for silvo-pastures.
Jacaranda mimosifolia	Suitable only as an ornamental in sheltered lowland gardens.
Juglans nigra	A nut and timber tree for the lowlands and foothills. Needs intensive management for good growth.
Juglans regia	As J. nigra
Ligustrum spp.	Widely and successfully used as hedges in lowlands and foothills. Fast growing.
Melia azederach	Ornamental for the lowlands and foothills with some fuel/ fodder use.
Morus nigra	Fruit tree for lighter soils in the lowlands and foothills.
Olea europaea	Slow growth and no commercial market for the olives confines this species to being for ornamental use only in the lowlands and possibly foothills. If olive fruits are not felt to be important planting of the indigenous olive should be considered.
Opuntia spp.	Use for live fence, fruit or fodder supplement in the lowlands. Spineless varieties available.
Platanus acerifolia	Amenity tree for the lowlands, but could be useful as a shade tree in areas with high livestock populations if established from unrooted poles.

Populus x canescens	Excellent hybrid for soil stabilisation, poles and fuelwood. Recommended for the lowlands, foothills and sheltered mountain valleys.
Populus deltoides	Growth slowed by rust infections. Suited to good sites in the lowlands, foothills and sheltered mountain valleys.
Populus nigra var italica	Of limited usefulness but its vertical habit is liked by some. Suited to lowlands and foothills.
Pyracantha spp.	Excellent hedge plants for the lowlands and foothills.
Quercus acutissima	Attractive shade, amenity and timber tree for the lowlands.
Quercus robur	A shade and amenity tree for the lowlands and foothills.
Robinia pseudoacacia	Excellent tree for soil stabilisation and fuelwood. Also can produce durable poles. For the lowlands, foothills and sheltered mountain sites. Variation in performance on different sites requires investigation. Not suitable for planting near fields as suckers profusely.
Rosa rubiginosa	Suitable for hedging in lowlands up into sheltered mountain valleys.
Salix babylonica	Suited to lowlands through to sheltered mountain valleys. For amenity, fuelwood, fodder and donga planting.
Salix capraea	Used as a hedge in the mountains and widely tested in donga bottoms in the lowlands and foothills. Recommended.
Salix fragilis	Excellent species for soil stabilisation and fuelwood in dongas and for planting along watercourses.
Salix purpurea	Good growth on a variety of sites from the lowlands to sheltered mountain areas.
Sambucus nigra	Found in lowland towns and possibly worth further testing. Medicinal uses and fruits make good wine.
Schinus molle	A shade tree for the lowlands and foothills, especially dry areas.

Sesbania punicea	Invasive, poisonous large shrub. For donga rehabilitation in lowlands and sheltered foothills only.
Sophora japonica	Suitable for use as a shade tree in the lowlands and foothills.
Spartium junceum	Presently planted as an ornamental in the lowlands and foothills. Could be used also for hedging.
Tamarix gallica	Planted generally as an ornamental, but has shown potential on poorer sites in the lowlands and foothills. Produces good fuelwood.
Ulmus parvifolia	Suitable for planting as a shade tree in lowlands and foothills and in donga planting schemes.
Ulmus procera	As U. parvifolia but also known as a fodder tree.

Appendix 3 Species that show early promise in Lesotho but which still require further testing.

Acacia cultiformis	Only recently introduced into the country and not yet field tested. If successful try further plantings in the lowlands and foothills.
Acacia implexa	Only recently introduced into the country and only recently field tested. If promising try more widely in the lowlands and foothills.
Acacia floribunda	A recent introduction and only field tested within this year.
Acacia pendula	Also only field tested this year.
Acacia podalyrifolia	Only a few individuals and only found in the lowlands. Worth testing particularly in the lowlands.
Acacia saligna	Conflicting results and should be further tested in the lowlands only.
Acacia stenophylla	Initial results promising. Test in foothills and lowlands.
Acacia visite	Only field tested this year.
Acacia xeaphylla	Field tested only this year.
Acer campestre	Slow in lowlands and foothills. Test more widely in mountains where performance is reasonable.
Acer platanoides	Test more widely in lowlands, foothills and sheltered mountain areas.
Acer pseudoplatanus	Encouraging early results in the foothills. Test in mountains and lowlands.
Albizia julibrissin	In the lowlands different seed sources should be tested and also variety "rosea", used in Europe.
Allocasuarina littoralis	Inconclusive results and only tested on two sites in the lowlands.
Allocasuarina torulosa	Very early results indicate poor survival but slow growth. Test on more sites.
Allocasuarina verticilata	Good growth, but poor survival on a duplex site. Try on other sites.

Alnus cordata	Reasonable performance on moist sites in the lowlands. Try on drier sites and at higher altitudes.
Alnus glutinosa	Promising performance in the lowlands, particularly in donga bottoms, but also on drier sites. Worth trying elsewhere in the lowlands and in the foothills and mountains.
Alnus incana	Good enough performance in lowlands, foothills and mountains to warrant further investigation.
Alnus viridis	At MRDP seedlings ready for planting next year.
Amelanchier canadiensis	Test further in mountains.
Atriplex lentiformis	Promising initial results. Test more widely.
Atriplex semibaccata	Need to determine what niche, if any, this woody creeping plant can occupy.
Betula pendula	Poor growth in trial plantings in lowlands and foothills. However there are several large trees in lowland and foothill areas. Good growth in the mountains.
Chamaecytissus palmensis	Mixed results, need further testing to determine suitable soils and level of frost tolerance.
Caragana arborescens	Very little production, but good survival, particularly in higher areas. Test more widely in mountains.
Carpinus betulus	Disappointing results in the mountains, but in areas of sufficient rainfall this species should survive. Worth testing in the foothills.
Carya illionensis	Try on good sites in lowlands and foothills. Obtain grafted trees from RSA for good nut production.
Cassia obtusifolia	Reasonable survival on light soils in the lowlands. Test more widely.
Casuarina equisetifolia	Promising species for the lowlands. Test also in foothills. Provenance testing required and comparisons with C. cunninghamiana.
Colutea arborescens	Test further in lowlands, foothills and mountains.

Cornus alba	Species with some potential in the mountains. Poor growth in lowlands and foothills.
Cornus mas	As C. alba.
Cornus sanguinea	As C. alba.
Corylus avellana	Needs shade and moist soils. Test under these conditions.
Corylus colurna	As above.
Cytissus monospessulanum	Good growth and survival in MRDP plantings.
Cytissus scoparius	More widespread testing required.
Dalbergia sissoo	Only tested over one winter. Test in moist sites and obtain cold tolerant provenances, including ones from RSA.
Eleagnus angustifolia	Test more widely in lowlands, foothills and mountains.
Eleagnus umbellata	Not as good growth as E. angustifolia. Still worth testing more widely in lowlands, mountains and foothills.
Fraxinus americana	Test in moister foothill sites.
Fraxinus excelsior	As F. americana.
Gleditsia caspica	Only just introduced. Monitor performance at MRDP.
Hippophae rhamnoides	Promising. Test more widely in lowlands, foothills and mountains. Avoid heavy soils.
Liquidambar styraciflua	Trees even in the lowlands showed frost damage, although some fine specimens at the National University of Lesotho. However the distribution of this species is wide and possibly other seed sources would be more suitable.
Lonicera xylosteum	Imported as a potential hedging plant, it did not perform (survive?) well in the mountains. May still make an attractive ornamental in the lowlands or foothills.
Lupinus arboreus	Test on a wider range of sites.
Lycium halmifolium	Worth further testing in lowlands, foothills and mountains, but not a

	priority species.
Maclura pomifera	Excellent survival and growth in lowlands and foothills. Trial plantings should continue in the lowlands and foothills. Try in the mountains.
Malus communis	Better relative growth in the mountains. Test more widely in uplands. Research should concentrate however on hardy fruit varieties.
Mesipilus macrocarpa	Promising results in the mountains. Test further.
Mimosa scabrella	Mixed results. Test further in lowlands and foothills and obtain cold-tolerant provenances if possible.
Morus alba	Test in lowlands and foothills. Investigate clones from RSA.
Parkinsonia aculeata	Test further in lowlands and foothills.
Paulownia tomentosa	Test further on sheltered lowland sites.
Platanus wrightii	Compare performance to P. x acerifolia.
Populus clones	Test throughout Lesotho. Preliminary results indicate they may be more appropriate for the lowlands and foothills, rather than the mountains.
Populus tremula	Slow growth but best adapted to the mountains. Test on wider range of upland sites.
Prosopis chilensis	Good growth in the Research Nursery. Not yet field tested.
Prosopis ferox	Only sown this year. Growth in the nursery slower than P. chilensis and P. flexuosa but should be more cold-tolerant.
Prosopis flexuosa	As P. chilensis.
Prosopis glandulosa	Thought to be the Prosopis species tested by MRDP. Slow growing but survives in lowlands and foothills.
Prunus dulcis	Test grafted material from the Cape.
Prunus mahaleb	Test further in the mountains.
Prunus serotina	No information on growth rates except

Appendix 4 Species that have failed in trials but which require further testing before they are judged unsuitable for Lesotho.

Acacia albida	Re-test Tuli Block provenance in Southern lowlands before dismissing it.
Acacia farnesiana	Frosted in foothill trials. Try in Southern lowlands.
Acacia sieberana var. *woodii*	As *A. farnesiana*.
Albizia lophanta	Delicate in foothill trials. Test in lowlands.
Alnus rubra	Seed sown at the research nursery but never germinated. Worth testing on a variety of sites.
Alnus nepalensis	Poor survival in the lowlands and foothills. High elevation provenances should be tested.
Amorpha fruticosa	Test in foothills and lowlands.
Caesalpinia spinosa	Failed in foothills but a few survivors. Try in lowlands.
Cajanus cajan	Not frost tolerant. But has potential if grown as an annual.
Celtis australis	Failed in a trial at Tsikoane Plateau but literature indicates it should grow in Lesotho.
Grevillea sp.	There are several unhealthy looking specimens of this tree in Maseru. Does not seem well suited to Lesotho conditions.
Liriodendron tulipifera	Not a priority shade species but provenances from cold dry areas may perform better in Lesotho.
Lonicera xylosteum	Failed in mountain trials but may be worth trying in foothills and lowlands.
Medicago arborea	Failed in the mountains; very slow growth in the lowlands and foothills. May have a niche on specific lowland site types.
Nothofagus obliqua	Very poor germination from old seed obtained from the UK. Worth obtaining fresh seed and testing nationwide.

Sorbus aucuparia	In the mountains slow growth and killed by drought in winter. May however be suited to wetter sites.

Appendix 6. Some other species that should be tested in Lesotho

Acacia neriifolia A fast growing Australian nitrogen-fixing shrub or small tree, it tolerates snow, heavy frosts and moderate droughts. Generally occurs on well drained soils. It is thought to produce a good fuel and is used as emergency fodder for sheep. (Turnbull, 1986).

Alnus formosana An evergreen, fast-growing alder from Taiwan (latitude 22°-25°N), where it is found from sea level up to 2500 m elevation. It has shown good initial performance in the Cape region of South Africa. High elevation provenances should be sought.

Betula alnoides Recommended by Letsipa, (1991) after a study tour to Nepal. The description of it's habitat in Nepal by Jackson, (1987) describes it as having a wide distribution, covering altitudes from 1200 m to 3000 m.

Betula papyifera This species has a wide distribution in northern USA. Tolerates extreme cold and is found in areas with precipitation varying from 300 mm to 1520 mm. Young trees grow rapidly (Safford, Bjorkbom and Zasada,1990).

Betula pubescens Found in Britain on poorer drained sites than B. pendula (Mitchell, 1974). A possible species for boggy mountain areas or stream banks.

Betula utilis Found at higher altitudes in Nepal (Jackson, 1987) than B. alnoides. Also recommended by Letsipa, (1991) for testing.

Buddleia coriacea A small tree which grows from 3200 to 4200 m elevation in Peru and Bolivia. Wood is used for tools and for construction as well as firewood. It appears to have soil improvement properties as it is cultivated in stands in the Western Puno area specifically so that the abundant litter can be collected and placed in arable fields (Reynel, 1988).

Cassina fulvida A small shrub, up to 2 m tall, used for stabilising sandy areas in New Zealand. Performs well on well drained, dry, poor soils. Known to be very drought and frost tolerant. Propagation mainly by cuttings but seed also used (Pollock, 1986).

Casuarina glauca A close relative of C. cunninghamiana this tree will tolerate poorer drainage conditions and longer droughts (NAS, 1984), but is less frost hardy (Poynton, 1984). Produces prolific root suckers.

Cercis siliquastrum (Judas Tree) A leguminous tree, produces good firewood and fodder and is used as an ornamental (Moro, 1988). It will coppice and reproduce from cuttings. Widespread distribution in Europe. Moderate frost tolerance.

Ficus spp. Many fig species are used for fodder in Nepal and some produce an edible fruit. Nepalese species recommended by

Polylepsis incana Grows from 3900 to 5000 m elevation in the Peruvian Andes in conditions similar to Lesotho's. Produces excellent firewood and palatable fodder and has medicinal uses. Used for live fencing (Reynel, 1988).

Populus simonii Noted in Bloemfontein by Wilkinson, (19891) and considered worth trying in lesotho.

Prunus avium A native of Europe, western Asia and north Africa and Asia Minor. Very hardy and fast growing for a temperate broadleaved species (Pryor, 1988).

Prosopis spp. Other Argentinian/ Andean spp.

Robinia neomexicana A possible species for soil conservation.