SELECTION OF APPROPRIATE TREE SPECIES

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BACKGROUND

What kind of forests do we want?

Kenya's forests and of the world, are undergoing profound changes. The natural forests withtheir jumble of sizes and species are giving way to forests of uniform size, unform species, uniform age, all neatly spaced.

The trees themselves are being transformed -

These changes and yet more - to the fungi, the bacteria, to the very soil of the forest - are being brought about by one other change, the most fundamental of all : a change in our relationships to the forest. We have begun to "Manage" the forests, and in so doing, we ourselves are being transformed.

We once were simply wood cutters - harvesters - we are attempting to become as well growers - forest farmers.

Done well, forest management can yield almost incredible benefits. Done badly, the harzards are appalling. The difference will lie in the choice we take.

HISTORY OF SELECTION

The selection of species is still not a precise science and is largely reliant upon personal knowledge, judgements and experience augmented by literature reviews. Thorough knowledge of the planting site, the proposed end-use of the trees and of the range of potentially suitable species available is required.
(Boland 1987).

All tree planting programmes require clearly stated objectives before planting can start with all economic, staff and time-frame constraints carefully analysed and documented. A study of expected goals and final results of similar projects, including personal visits if possible, are desirable pre-planting exercises.

Few individuals or groups have all this knowledge. It is therefore essential that a research component inlvoving species, seed sources, management and silvicultural options be built into new programmes. Although there have been instances where a single species has been chosen and planted widely from the start one should be aware that new 'miracle' species often have not been adequately tested and may not meet the preoject's expectations.

The problem of selecting tree species for non-industrial uses in developing countries has been made more difficult because of the recent world awareness of the importance of forestry to rural development. Coupled with this is the pressure to achieve results quickly. Unfortunately, often lack of experienced for the work involved. Reliable information on the ecology, silviculture, and utilisation characteristics of many of the potentially valuable species is still unavailable and hampers their selection. Typically emphasis is still given to fast-growing trees for fuelwood, shelter, and agroforestry uses but with acquistion of information it may be possible to trade-off species with rapid growth for those with slower but greater resistance to drought, fire or pests, lesser water and nutrient requirements, or providing other products than wood. Compounding this problem is the difficulty in properly evaluating species performance, especially for those species providing more than one product or benefit.

EVOLUTION

As a result of evolution - plants and animals sharing the earth with us - have been classified into discrete and identifiable categories termed taxa (singular taxon). Some taxa include members that are only physiologically distinguishable; others manifest clearly unique visible structural differences. An example of the former may be two Eucalyptus camuldensis provenances that look quite alike but are differentially hardy.

Science concerns itself with methods of classifying life forms. One logical way of arranging the plant kingdom is by evolutionary relationships. Very closely related taxa are grouped as sub-units of the same species; most distantly related and distinctive taxa fall into groups of higher rank. The name attached to an oraganism not only identifies it, but relates it to all others.

The basic taxon used in classifying living ornisms is the species (singular and plural). This was presumed by early botanists to be the unit of creation, the distinctive entity (Janick et al. 1981). Species may be subdivided into subspecies or varieties, for additional identification. These are important because they represent natural variation that we base work on species and provenance selection. Selection for improvement is one element of a domestication process that is often considered for incresed yields.

Trees unlike agricultural crops, have been difficult to improve genetically, because of their long generation times and the prevalence of out-breeding. Although some genetic gains have been achieved, foresters have traditionally improved yield and form by provenance transfer. Recently, however, they have started to use techniques of clonal foresty in exploiting the considerable amounts of genetic variation present within wild populations.

As man began influencing which trees he would produce in forests, and further, began planting and husbanding forests, domestication of forest trees surely commenced. Today, tree breeders can call on centuries of wisdom accumulated during the domestication of our agricultural plants and amimals, and decades of experience with applying the principles of genetics and evolution to create modern breeding theory and practice. This paper addressed problems and strategies of tree species selection in forestry.

There are two levels of selection to be discussed inthis paper. These are:

a) Selection from the original genetic variability within a species.
   - (i) Selection of desired genes or trees
   - (ii) Converting these gene packages into growing trees to be harvested as renewable resource

b) Selection at a species level for those species that have desired characteristics.

ORIGINAL VARIABILITY

Man in ignorance, has made some mistakes during millenia of domesticating our crop plants and animals. Our crop plants and animals. We with he had studied theecology of the native ancenstral populations before he changed them and replaced them with domestic varieties, for this knowledge would be useful as well as satisfying today.

We wish we had saved more of the variability which was present in the ancestral populations, as the modern breeder could effectively draw on such a reserve of variability to better buffer against diseases, insects, and other environmental insults which wreak havoc with our ecologically-fragile, genetically-narrow modern crops.

Selection pressure

The intensity with which the environment tends to alter the frequency of a particular allele in a given population. It is not possible to given an absolute value for selection pressure. However, by comparing the survival of individuals with different alleles, a measure of fitness of one relative to another may be derived.

Natural Selection

The action of the environment, as opposed to the action of man, or individual organisms such that those possesing genotypes better suited to the environment will survive and reproduce more successfully than those with less favourable genotypes, which will eventually die out. By this process the characteristics of a population will change according to the nature of the environmental pressures acting on them. Over a number of generations, the population may diverge into a number of distinct groups each adapted to a particular microenvironment. This process will be hastened if there are barrier to gene flow between the groups. The concept of natural selection is the conerstone in Darwins theory of evolution.

Allele : (Allelomorph) A form in which a gene may occur. Different alleles of a gene give rise to different expressions of a character. Hence alleles for 'green' and 'yellow' are alternative expressions of the gene governing the characteristic for seed colour.

SPECIES RANGE AND TOLERANCE

The tolerance of a species is represented by the range of climatic and soil conditions within which it can exist and reproduce. The expression ecological amplitude is sometimes used to describe this range of conditions.

Some species can exist only in a very narrow range, whereas others can tolerate a broad spectrum of environmental conditions.

In ecological literature, many theories of tolerance have been proposed. One defined in terms applicable to crops that is of great interest to ecologists and geographers is by V.E. Shelford. This is stated as follows:

1. species with a wide range of tolerance are likely to be widely distributed.

2. When one environmental factor is limiting, the range of tolerance to others is likely to be decresed.

[illegible] period of reproduction.

Tolerance has a genetic base. The environment can influence the growth and development of organisms only within genetically imposed limits. Species with a wide range of genetic diversity are more likely to respond favourabley to new and changed environments than those with a narrow genetic base.

The evolutionary forces that determine the range of species involve differentiation and speciation. Long-term forces apply only incidentally to crop plants, because people have imposed evolutionary change through artificial hybridization and other kinds of genetic manipulation. Adaptability becomes one of the main goals of modern plant breeding. The relatively slow migration of natural species, hampered in many cases by natural topograhical barriers, has given way to widespread and rapid introduction to exotic species.
Plants in different stages of growth may have different tolerance. Like animals, they change in structure as they develop. The developmental phases respond differently to environmental factors. The limit of tolerance are often narrow in the seedling stage. For example the stem of a newly regenerated Dobera glabra has no protective bark and may be killed quickly by temperatures of greater than 50°C or lower than 20°C. But the same tree when 10 years old or more will tolerate temperatures approaching the boiling point for a few minutes, because a thick layer of bark will have developed.

Because the geographic ranges of species are tolerance - limited, much effort has gone into world-wide search for areas with similar climates in order to weigh the prospects of successfully introducing plant species from other areas. Areas with similar climates are called homoclines, and if it is with reference to agricultural production they are called agroclimatic analogues. Trevor Booth at CSIRO has developed homoclines of Australia in relation to similar sites in Africa and South East Asia. This he has done by use of mean temperatures and rainfall. This makes it possible to introduce plant species into sites that closely resemble those of the plants natural range. This way, the introduced plant favourably responds to selection pressure of the new site because they closely resemble those of the original site.

HISTORY OF TREE INTRODUCTION

The cultivation of exotic plants has had a long history. The introduction and domestication of small crops such as wheat from the old world and fruit crops like tomatoes from the new world, are reasonably well known; but the equally long history of tree crop introduction is often overlooked.

The history of tree introduction for non-food purposes is much more recent. The Romans introduced the shrubby plant <u>Rhus coriaria</u> into Spain to use its leaves as a tannin source (Gonzalez 19[illegible]). While in West Africa Arab Slave Captains planted <u>Casuarina equisetifolia</u> to clearly mark harbour entrances (Perry and Willan 1975). Though native trees were used <u>in situ</u> for a wide range of non-food uses such as shelter, weapons and handcrafts, it was not until in the 19th century that scientifically managed indigenous and exotic plantations were established. Intensive plantations of exotic pines and Eucalyptus were planted widely during the 20th century for industrial wood and this development overshadowed the need to cultivate trees for other purpose like fuelwood.

The scientific techniques and methodology employed in species selection, introduction and breeding that has been developed for industrial plantations can also be adapted for selecting trees for non-industrial uses. However, the only change to be made is the selection criteria and may be some of the management techniques. There is no doubt that the range of species available for selection has greatly increased because of the increased diversity of products. Also, tree size, stem straighteness and wood quality, are no longer vital factors.

The major research effort in any tree improvement programme involving tree species for the so-called 'non-industrial' uses must be in the initial species screening stage. Unfortunately, this is made difficult by lack of basic information to be included in trials.

<u>QUALITIES REQUIRED OF SPECIES FOR AGROFORESTRY AND FUELWOOD</u>

The goal of agroforestry is to optimise per unit area production while respecting the principle of sustained yield (Combe and Budowski 19[illegible]). Trees and shrubs are the dominant feature of mature agroforestry systems and in choosing species for the system it is necessary to decide on the following:

(.) [illegible]
(.) How [illegible]
(.) [illegible]

To resolve these questions, [illegible] that enhance the value [illegible] particular agroforestry system (Huxley 19[illegible]). In this way, [illegible], [illegible] and [illegible] considerations [illegible].

An [illegible] list of special uses for which tree species may be required include fuelwood, roundwood (poles and posts), fodder, live fences, shade, windbreaks, soil protection (erosion control) and soil improvement.

FUEL WOOD

Fuelwood is required by both industrial and non-industrial [illegible] but consumed much more in countries where domestic fuelwood is often essential for cooking and heating. Rural people who traditionally obtain fuelwood from indigenous species whose burning and smoke properties are well-known, are often extremely reluctant to change to exotic woods for a number of psychological or practical reasons. These preferences must be considered in the selection of species for fuelwood.

The qualities needed for fuelwood can be divided into physical properties of the wood and silvicultural/**environmental** properties of the species. Thornless trees or shrubs with small stem diameters are easier to cut with primitive impliments and to transport. The wood should be easy to split and have a low moisture content or be relatively fast drying (*Grevillea robusta*), as considerable heat is lost in burning moist wood.

For health reasons, smoke should be minimal and non toxic (Poynton 19[illegible]4) as ventilation is traditionally poor in most rural houses. For safely reasons, wood should not spit nor spark while burning. Studies to date indicate that a negative correlation exists between fast growth rate and density, so that fast grown trees have inferior burning qualities compared to those that have grown more slowly.

ROUND WOOD (POLES AND POSTS)

Poles and posts are very important for home and fence building in many parts of Kenya.

[illegible] by-products of [illegible] plantations often have the first thinnings used for [illegible] for telephone or [illegible] poles.

Poles are in great demand for rural house construction, especially [illegible] rafters that can bear heavy grass loads. [illegible] are often used as house poles. In urban areas, poles are [illegible] for scaffolding and it is not uncommon [illegible] to see all building [illegible] by a mass of [illegible], eucalyptus, or [illegible] poles.

Quality of species for suitability as poles can be divided into wood and silvicultural characteristics. Poles should be durable, light, capable of taking high cross-loads (high strength to diameter ratios for a given length is vital), have minimal spirality to avoid opening up when in use, be resistant to termites and other wood borers, or be capable of taking preservatives easily.

The tree should be straight, having strong apical dominance, few or thin branches and preferably self-pruning without leaving knots that causes weakness, little taper from bottom to top, and the bark should strip easily.

FODDER

In dryland areas, trees may be required as an emergency fodder supply, especially during drought periods. Ideally the foliage should be palatable, nutritious and digestible.

Fodder trees have to be carefully protected during their early years from all forms of livestock, especially goats. Trees should produce large crowns above livestock reach.

The crowns must be capable fo severe lopping during periods of high environmental stress.

Alternatively in intensively managed agricultural areas trees may be grown totally protected and the leaves then harvested and fed to livestock, e.g. Leucaena leucocephala.

[illegible]

[illegible] plantings [illegible] by hand [illegible].

Species with prickles or spines, or having stiff branches, [illegible] are preferred. Ideally, species should be [illegible] height, long-lived, be capable of growing under adverse [illegible]. Minimal maintenance is essential although some trimming can be undertaken.

SOIL PROTECTION - EROSION CONTROL

Trees are often required to prevent soil loss through wind or water action and often very hardy trees for poor sites are required. The basic idea is to preven soil movement by root-binding the soil, preventing direct impact of raindrops or by increasing the percolation of water through the soil. Leaf fall also provides a ground cover that further protect the soil.

Casuarina equisetifolia has helped to stabilise coastal sand dunes by binding the sand with numerous fine roots and shedding of branchlets that form a thick and slowly decomposing interlocked mulch on the sand surface (Mendas [illegible]).

Common tree qualities sought for erosion control are fast and healthy growth under adverse conditions.

Spreading crowns; vigorous root system with soil binding properties; either vigorous vegetative reproduction, e.g. root suckers, or heavy natural seed fall and natural seedling development in situ without the tendency to become a weed; trees having roots with high strength values - especially in areas prone to land slip; and fire tolerance.

[illegible]

[illegible]

There is considerable international interest in growing mixtures of [illegible] phosphate [illegible] available phosphorus levels [illegible] deficient soils.