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MULTIPURPOSE TREES AND SHRUBS, OPPORTUNITIES AND LIMITATIONS

- The Establishment of a Multipurpose Tree Data Base -

by

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4 Questionnaire on Multipurpose Tree Germplasm, J. Burley

5 Data Sheet "Caracteristicas de Especies Arboreas", C.A.T.I.E, Turrialba, Costa Rica

6 Data Sheet - Fuelwood (Translated from German into English), von Maydell

7 Print-out of Nitrogen-Fixing-Tree-Association (NFTA) data base II (Example)

8 Print-out of ICRAF data base I7 - Plant Species with Anti-Pest Properties (Example)

PREFACE

Man has always used trees as shelter, for the production of weapons and tools, for building material and as a source of food and energy. As long as the population was in balance with its natural environment, which provided people with all essentials for their livelihood, trees were not subject to any management considerations. Only when the population in a given environment increased and eventually settled and became subject to restriction ins its expansion by the population in another environment, pure tapping of natural resources gradually proved to be insufficient. The onset of management of basic natural resources, including trees and the services they provide, is associated with this point in the history of mankind. To a large degree the attitude of man towards trees therefore reflects the various stages of development.

With dwindling food, fodder, and land resources, and with the increasing need for the full utilization of what nature offers, agroforestry may be looked upon as the most sophisticated form of development of land use, particularly in those environments which, for biophysical reasons, react most sensitively to human interference.

There can be no doubt that in agroforestry multipurpose trees and shrubs are important components which can be considered cornerstones on which most of the agroforestry systems are built. Although agroforestry has been practised for ages in some parts of the world, many trees and shrubs of high potential value have been looked upon as secondary species in a general land-use pattern which was dominated by mono-crop-oriented agriculture and forestry. However, the increasing awareness of ecological aspects of land use and the growing need to fully utilize natural resources on a sustained basis no longer permitted this neglect.

The significant achievements in agricultural and forestry production are based on accumulated knowledge and continued research of their components, carried out over centuries. Agroforestry will only be successful and recognised as a compatible and, above all, sustainable alternative land-use system if the gap -still wide open- of knowledge of its vital components and their interactions is closed.

The establishment of a multipurpose tree data base has to be seen as the foundation on which the development of multipurpose trees and shrubs into an effective tool in the design of new and the improvement of existing agroforestry systems will be built. It is realised, of course, that invaluable work has already been done in this direction. A considerable number of institutions and individuals have compiled vast knowledge and details on certain aspects of multipurpose tree and shrubs. It is, however, the often prevailing restriction to certain uses or regions which lacks a systematic overview and coordination and which calls for a world-wide compilation of data and information, as described in this paper.

Part I briefly outlines in a conceptional way the importance of multipurpose trees and shrubs in agroforestry.

A definition of multipurpose trees is presented which is based on a *systems-approach* rather than on an *individual-tree approach*. *This definition demarcates the borders within which multipurpose trees are discussed in this paper.*

The role of multipurpose trees and shrubs in land use management is revealed and the opportunities are demonstrated which they provide in many ways to validate agroforestry as a range of both ecologically sound and economically promising land use management systems.

But also mentioned are the limitations and problems which require due consideration in the use of multipurpose trees and shrubs. They derive predominantly from the present low level of knowledge, but also from management problems which the users of multipurpose trees are likely to face if trees are incorporated into production systems of any kind as an additional component.

It is not the intention of this paper to discuss in detail the above-mentioned considerations. It is, however, felt necessary briefly to outline them in order to demonstrate the importance of multipurpose trees in agroforestry in general, and, in particular, the pressing need to accumulate, interpret, evaluate and disseminate whatever knowledge is currently available.

Part II then elaborates on ways and means of seeking solutions to the previously mentioned constraints and limitations in the use of multipurpose trees and shrubs. In this attempt the establishment of a multipurpose tree data base features prominently. The means and methods of obtaining information, the computerization of data, and the opportunities and limitations of their evaluation are discussed. Part II also argues the case for linking those data which are collected on a global scale and which are of a basic informative nature with other more specialized data bases.

The establishment of a multipurpose tree data base is certainly not meant to be a solely academic exercise. To develop multipurpose trees into a useful tool in an agroforestry design for identifying, among others, priority research needs for immediate implementation, is one core objective. The ultimate objective, however, is the dissemination of acquired knowledge in a practical way for the benefit of researchers and field workers who are actually engaged in the development of agroforestry.

Finally, it should be emphasized that neither multipurpose tree research, nor the accumulation of knowledge, is an activity that can be accomplished within a specific period of time. It has to be seen as a continuous process of increasing the level of knowledge and of the number of species included, as well as of upgrading and of adjusting the computer programme for storage, retrieval and evaluation procedures.

1. THE DEFINITION OF MULTIPURPOSE TREES AND SHRUBS

Multipurpose trees and shrubs are directly associated with agroforestry. When agroforestry was eventually accepted as an alternative land use management system (25) many attempts were made to define the term "agroforestry" (10). Although there was no full general consensus, all definitions of agroforestry stress the inclusion of trees as an integral part of any agroforestry system. To varying degrees these definitions of agroforestry indicate the distinction between a "tree" in general and a "multipurpose trees". However, whenever multipurpose trees are a subject for discussion in workshops, seminars and, particularly, in publications, the generally prevalent confusion becomes obvious. J. Burley (7) has identified 18 different lists of multipurpose trees and shrubs, some of which are rather all-inclusive and of little help when it comes to distinguishing between "trees" and "multipurpose trees". When certain trees are labelled as multipurpose trees, this is obviously done to indicate that they are different from other trees.

For clarification in the context of this paper and in order to speak a common language when discussing multipurpose trees and shrubs, a definition is necessary and justifiable. In the attempt to offer a definition, the following has to be considered:

- The term "Multipurpose Tree" suggests that a tree, so classified, serves at least two purposes. This, however, turns out to be quite unsuitable as a basis for a definition since, with the exception of a few, all trees have at least two potential uses (wood and shade), if not three - if mulch is added.

- Apart from specific uses, there are two distintly different functions of trees in agroforestry. In some systems (e.g. Taungya) trees play a *passive* role from the agroforestry point of view. Tree species are chosen only for their value as forest industrial products. They may still contribute positively to the sustainability of a temporary mixed tree/crop system, to its economic soundness or to ecological stability. But *such factors are not taken into consideration in choosing these species.* In such systems trees *tolerate* rather than intentionally *support* agricultural crops.

  In most other agroforestry systems trees play an *active* role inasmuch as they are purposely chosen and introduced into the system to support and strengthen its sustainability, its output and its stability.

- Each tree has a certain number of potential uses. It is, however, not very likely that all of them will be of importance to a particular agroforestry system and/or an individual user of the tree. Depending on the predominant objective of an agroforestry system or its specific problem, a tree will be chosen for its capability to address and solve this problem or specifically to support the predominant objective.

The above considerations raise a number of doubts:

- Can the number of potential uses as such be regarded as a suitable tool for distinguishing between trees in general and multipurpose trees?

- Should trees which *tolerate* agricultural crops but are not purposely chosen to support a mixed system and *do not play an active role in this support*, be regarded as multipurpose trees?

- Can the potential uses of trees alone be regarded suitable criteria for sufficiently defining multipurpose trees, regardless of the individual user's perception of their problem-solving capacity?

In the light of the above considerations, but also in order to describe how the term multipurpose tree is used in this paper, the following definition is presented, which is based on a *system-approach* rather than on an *individual-tree approach:*

> *A multipurpose tree is a tree which clearly constitutes an essential component of an agroforestry system or of other multipurpose land-use systems. Regardless of the number of its potential or actual uses, a multipurpose tree has to have the capacity to provide in its specific function(s) in the system a substantial and recognisable contribution to the sustainability of yields, to the increase of outputs and/or the reduction of inputs, and to the ecological stability of this system. Only a tree which is kept and maintained or introduced into an agroforestry system especially for one or more of these purposes qualifies as a multipurpose tree.*

2. OPPORTUNITIES OF MULTIPURPOSE TREES AND SHRUBS

Forest resources, particularly in the developing countries, have shrunk at an alarming rate during the last decade. According to FAO (22) and UNESCO (15) the estimated average annual deforestation rate during 1981-85 in 76 tropical American, African and Asian countries amounts to 11,3 Mill. hectares (= 0,6%). A look at individual countries reveals considerable differences within this average. By 1980 Thailand suffered an average annual loss of 420 000 ha (= 2,6%), Ethiopia of an estimated 200 000 ha (= approx. 4%) and Malaysia of 8 100 ha (= 0,11%) (13). The degree of deforestation varies, but the downward trend seems to be a likely feature of all countries and there is reason to assume that in many cases the conversion of forests to other land uses will continue in an exponential rather than in a linear curve.

Among the causes of deforestation, the need for more agricultural land (cropland and pasture) figures prominently. This is highlighted by estimates according to which shifting cultivation acccounts for 70%, 50% and 35% of the total areas deforested in Africa, Asia and America respectively (15).

Another major contributor to deforestation and to ecological imbalance is the rapibly increasing demand for fuelwood. In 1980 FAO (12) has classified large areas of the tropics as those of fuelwood deficit or acute shortage. The shortage was estimated to rise from a total of 407 Mill. m^3 in 1980 to 925 Mill. m^3 in the year 2000, by which time the deficit situation will have spread to more areas.

Considerable efforts are being made to halt this process. However, the growing population and continuous economic limitations to increase land productivity do not offer bright prospects for the future with regard to maintaining a forest cover which can fully satisfy both the raw material as well as the environmental requirements.

Although forests have a different and more complex ecological impact than multipurpose trees in an agroforestry system, there can be no doubt that multipurpose trees if appropriately arranged, have the capacity to at least partly counterbalance the adverse economic and ecological effects of excessive loss of forests.

Multipurpose trees, introduced into land management systems, *cannot replace forests*. The specific silvicultural management practices aimed at maximizing the quality and quantity of timber production cannot be satisfactorily simulated with trees combined with crops or animals in an agroforestry approach to land use, nor will the watershed effect be as effective as it is with forests. However, a mixed land-use system with trees in various configurations as an integral part of it will no doubt have considerable ecological and economic advantages over mono-cropping systems, particularly where economic restrictions limit external inputs (fertilizers, etc.). Trees, even if in average widely spaced, definitely reduce wind speed and evapotranspiration and halt or reduce loss of topsoil due to wind and water erosion.

Therefore the introduction of trees in land-use systems other than forests has to be seen not only as a big challenge, but also as a unique opportunity to exploit the ability of multipurpose trees to provide both the basic needs of people as well as enviornmental benefits. In fact it may be looked upon as the often only alternative to safefuard the ecological balance in many parts of the world.

2.1 The Functions of Multipurpose Trees/Shrubs in Land Use Management

Multipurpose trees and shrubs are introduced or kept, maintained and managed in agroforestry systems for the multiple benefits they can provide. These benefits can be grouped into two basic roles of MPTs which are characterized by their productivity and by the service they render to the system (see also Fig. 1, page 7).

2.1.1 Productive function

Different direct outputs and products derived from trees are recognized at a different scale in history and in degree of acceptance, as well as in the magnitude of their economic value, e.g. wood as building material, for fuel and for the construction of tools is an age-old economically valued direct output of trees. Other products, like gum, incense and bark for tanning, are either of more recent importance or less relevant to individual owners and operators of farms.

In an agroforestry production system products from trees can be sub-grouped as follows by the way they are used and utilized:

- o Products for cash
- o products for subsistence
- o Primary products as inputs in a chain of their processing to end products

Products like fruits, nuts, spices, fodder, fuel, poles, timber and fibres can be used either for subsistence to meet basic needs and to save cash expenditures or for generating cash required for the purchase of goods unobtainable from farming (e.g. salt, clothing, etc.).

Fodder from leaves or pods may be considered as a primary product which in its crude, original condition has less value as compared to its capacity to be converted into meat and milk by being fed to livestock.

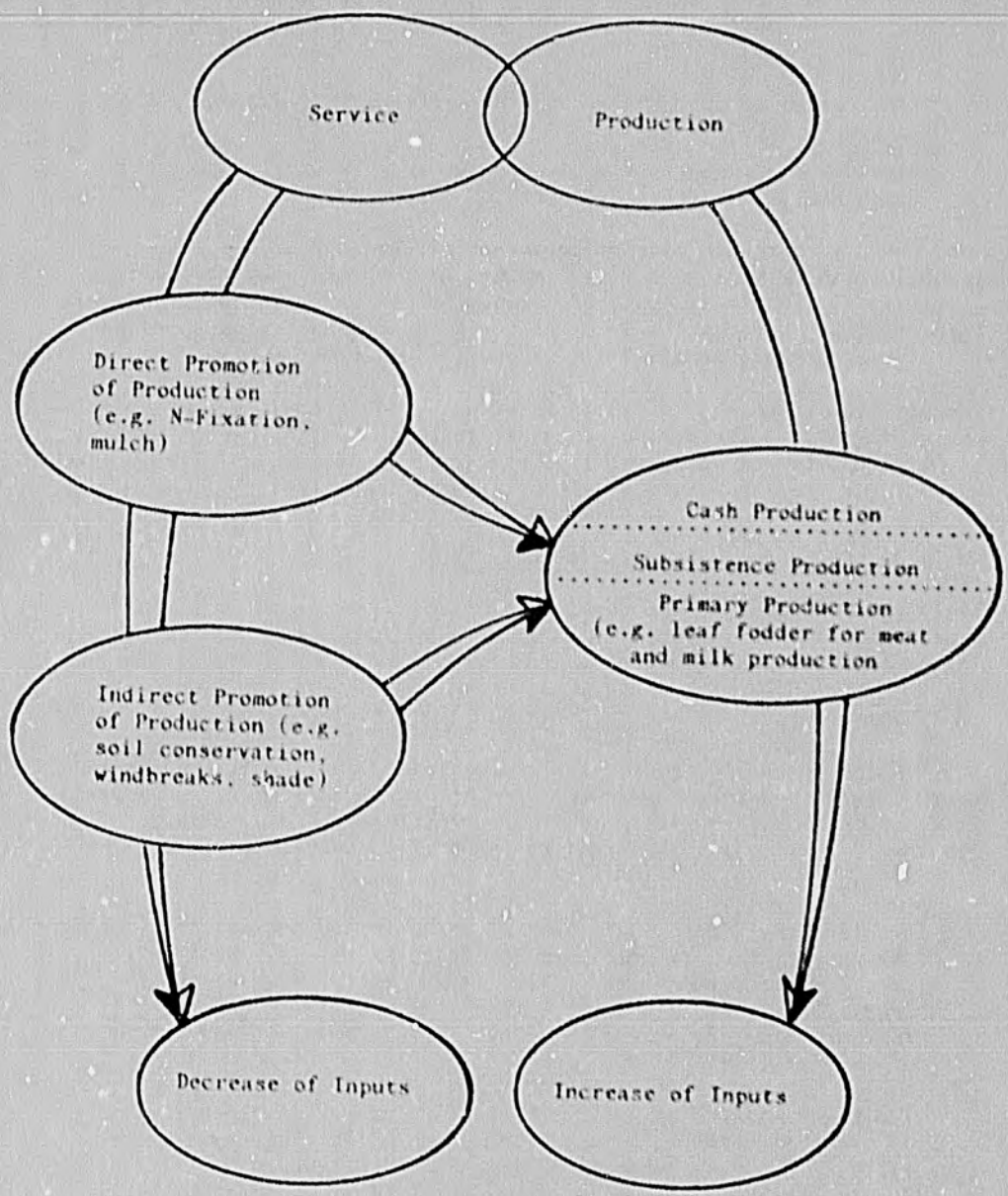
More potential products are listed in the "Multipurpose Tree Data Sheet" (Appendix 1), the "Uses Checklist" (Appendix 2) and in the compilation of "Products and Services" (Appendix 3).

2.1.2 Service function

In principle all benefits derived from trees which are not listed under products as described in the previous chapter qualify as *service* benefits. These services are manifold. Windbreaks, soil conservation, N-fixation and mulching are some of them and others could be added (see Appendix 1-3). C. Hackett (16, 17) and G. Budowski (5) most probably provide the most comprehensive lists of uses (also of productive benefits), although not exclusive of even more.

It could be argued that some of those benefits and uses which are listed under *productive functions* of trees, may as well rank as *service* benefits. Controversial views may be particularly entertained for those uses which in chapter 2.1.1 are classified as *primary products*. In the case of fodder from tree leaves and pods or - to state another example - of bee forage, the argument that these benefits from trees are *serving* the generation of

FIGURE 1 PRODUCTION AND SERVICE ROLE OF MULTIPURPOSE TREES AND SHRUBS



other products (meat, milk, honey) is certainly worth considering. On the other hand, if compared to such beneficial *service* effects of trees as soil conservation and shelter, the classification as adapted here appears to be justified.

Services as classified in this paper (see also Appendices 1 and 3) are manifold and obviously are of a varying nature. This calls for the following sub-grouping:

- o services to promote the production directly (N-fixation, mulch, compost)
- o services to promote the production indirectly (soil conservation, windbreaks, live fencing, shade for livestock)

Since there is often an overlap between these two sub-groups, the classification of various services has to be determined by the main objective. A windbreak, for example, may be, or is preferably, composed of tree species which not only guarantee a reduction of wind speed but also provide useable products like fodder, fuel or bee forage.

If production is understood in terms of net production value the above-mentioned sub-grouping becomes less meaningful. Many of those benefits listed in the second category, e.g. trees for windbreaks and live fencing, reduce inputs and thereby increase net production value.

2.2 Benefits from Multipurpose Trees/Shrubs

Within their productive and service functions as outlined in the previous chapter the following distinction can be made with regard to the benefits derived from multipurpose trees and shrubs.

2.2.1 Improving, sustaining and increasing outputs

In appendices 1 and 3 direct outputs are listed under food, fodder, and energy/burning and therefore do not need to be repeated here. However, the following basic considerations with regard to these outputs in relation to their value and benefits for land management units deserve mentioning.

- o Provided that appropriate arrangement in space and/or time in observed, the introduction of multipurpose trees/shrubs can result in a considerable improvement of the overall land use which in turn almost inevitably leads to a better balance of outputs in quantitative form, in time sequence of availability of products, and in the kind of products.
- o The higher degree of diversity of products results in a better spread of the production risk; a consideration which has proved to be relevant for many farmers, often subject to economic difficulties due to erratic rains, hail storms or to crop diseases which cannot be controlled effectively.
- o The introduction of trees, shrubs, bamboos and woody vines into crop system is likely to decrease the threat of damaging fungi and insects which often lead to disastrous losses of yields in mono-cropping systems. However, under certain circumstances increased tree cover may also result in increased incidents of crop damage by birds and game (see chpater 3.2.2).

- It is of particular relevance that all the above-mentioned advantages will be achieved with the additional benefit of improved ecological stability of the system. This will further result in improved sustainability of yields by reducing loss of fertility due to erosion and the added benefit of leaf litter suitable for increasing the physical and chemical condition of the soil and the water retention capacity.

2.2.2 Reduction of inputs

In land use management, particularly with regard to small-scale farmers, who are often notoriously threatened by cash and cash flow problems, the reduction of inputs is of equal or even predominent importance as compared to an increase of outputs.

This is particularly true of a cash economy system where reduced cash expenditures for certain required inputs will result in increased net production value. One of the many examples is the replacement capacity of Leucaena leucocephala for non-organic fertilizers in crop land under certain biophysical conditions (7).

Another example is live hedges, which can serve as enclosures for livestock, for protection or as demarcation. Often a carefully planted and maintained hedge of, for example, Parkinsonia aculeata, Acacia meliferra or Gliricidia sepium can take the place of expensive barbed or wire mesh fencing which requires considerable cash resources and/or foreign exhange often not available to small-scale farmers.

The latter may also enable farmers to introduce a rotation grazing system which would otherwise be ruled out by the non-availability of cash for artificial fencing. This additional potential oppertunity is an indirect benefit related to reduced cash inputs.

Also in subsistence economies the introduction of certain multipurpose trees (e.g. Leucaena leucocephala, Cassia siamea, Erythrina poeppigiana) can help to reduce inputs. Mulching, for example, not only helps to maintain or to improve the nutrient status of the soil, but also to reduce labour inputs as a result of suppressed weeds. If the labour saved is invested in more food production in excess of own needs, the system may even change from a subsistence economy to a mixed subsistence - cash economy.

2.3 The Principles of Choice of Multipurpose Tree Species and of their Arrangement in Production Systems

Although easy to apprehend, the simple fact is nevertheless not always observed that planting of multipurpose trees/shrubs in agricultural production systems alone does not necessarily and automatically turn the latter into workable agroforestry systems. Multipurpose trees and shrubs offer opportunities but do not guarantee them. Their introduction into a system requires careful planning to turn opportunities into benefits and improvements of this system.

Ideally any introduction of multipurpose trees into systems should be preceded by a diagnosis and design exercise. ICRAF's Diagnosis and Design Methodology (32, 33) offers the appropriate tool for this essential prepatatory step.

The prediagnostic and diagnostic stage should take into consideration the following aspects and criteria:

- o Biophysical conditions (climate, altitude, topography, soils, etc.)
- o Socio-economic environment (size of the management unit, number of people to be supported by the unit, labour availability, marketing structures, use of external inputs, etc.).
- o Problems of the management unit with particular emphasis on those which can be successfully addressed by the introduction of multipurpose trees and shrubs (e.g. erosion by water and wind, low fertility, demarcation need, fencing, food needs, fodder gap, production risks, labour shortage)

This diagnostic exercise has to be followed by a technology design and planning stage. With a view to achieving the objective of addressing identified problems by the introduction of multipurpose trees/shrubs the following have to be considered:

- o Choice of species best suited to the biophysical condition and to most effectively addressing identified problems and production opportunities
- o Number of trees which best balances the competitive or supplementary benefits of trees and crops
- o Identification of locations within the management unit with a view to
  - (a) priority environmental needs (e.g. windbreaks and contour strips with trees against erosion)
  - (b) crop yield promotion (e.g. hedgerows in crops of leguminous trees to increase nutrient and moisture status of soils and address weed problems by mulching)
  - (c) petty land suitability classification (e.g. small woodlots or clusters of trees on sites unfit for cropping like water-logged sites or shallow soils with rock outcrops)
  - (d) closing fodder gaps for livestock (e.g. pasture enrichment by fodder trees)
  - (e) demarcation and protection against intrusion (e.g. border planting, live fences)
- o Arrangement of the chosen multipurpose trees and shrubs at the identified locations in the system (e.g. single, in hedges, in rows, in clusters). The choice for either of these arrangements is determined by the following criteria:
  - (a) relevance of tree/crop interface (positive or negative)
  - (b) required impact (e.g. only rows of trees can form an effective wind break; maximum shading and fruiting effect achieved by individual tree with large crowns on house compound)
  - (c) need for early protection of multipurpose trees against browsing may call for a block design of trees in the pasture rather than for individual trees more difficult to protect.

Besides arrangements in *horizontal spacing* (trees and crops next to each other), favourable climate and soil conditions may also allow *vertical arrangements* in which trees for timber fuel and fruits together with other woody perennials, like coffee or tea, and annuals, like beans, peanuts or others, occupy the same piece of land in a multi-storey system.

In addition to the aforementioned arrangements in space, conditions may also permit *arrangements in time* where, for example, trees for fodder, fuel and soil fertility restoration may be grown successfully in a tree and bush fallow, provided the rotation cycle is not too short (shifting cultivation) (14).

2.4 The Principles of Tree Management

The overall objective of any management practice of multipurpose trees and shrubs is to optimize ecologically sound and sustained productivity of the system.

Management of multipurpose trees can be practiced basically in two ways

- o Arrangement in the system (see chapter 2.3)
  - horizontal spacing
  - vertical spacing
  - sequential in time
- o Manipulation of individual trees, single or multiple lines and clusters of trees, aiming at (see Fig. 2)
  - increasing the production from these trees
  - increasing the effectiveness of their services to the system
  - minimizing negative tree-crop interface
  - maximising positive tree-crop interface

There are ample examples for management practices which are in use to increase or to fully utilize the production capacity of trees. Cuppressus lusitanica, for example, is intensely *lopped* in some parts of Kenya for small-dimensioned fuelwood. In this operation the photosynthetic area is drastically reduced, which results in the reproduction of shoots/branches from dormant buds. This allows a rotational cutting of fuelwood from the same tree.

Openshaw (30) mentions Calliandra calothyrus as a vigorously coppicing species in the high rainfall areas of Indonesia. Managed on an annual *coppicing regime* it has yielded about 20 tons of air-dry fuelwood per year/ha, thereby not only providing quick returns to farmers, but also contributing to solving the often prevailing fuelwood shortage at an impressive scale.

Pollarding for fuel (e.g. Jacaranda mimosifolia) and for fodder (e.g. Acacia tortilis, A. albida, Balanites aegyptiaca etc.) constitutes another example.

FIGURE 2: Schematic Presentation of Examples of Multipurpose Tree (MPT) Manipulation and its Effects on Land Use Management

Constraints, Additional Inputs	Increased management inputs and skills, additional knowledge and understanding of basic biological processes, add. tools, increased labour inputs				
MPT Manipulation	Coppicing	Pollarding	Individual pruning	Branch	Pruning high and pruning Root - pruning	Trimming
Arrangement and Place in the system	- Fuelwood lots - Hedgerows in cropland	- Pasture - Hedges - Coffee Plantation (see text 2.4)	- House compound - Wide-spaced in crop land - Border Lines	- On border - In cropland - In pasture Root - pruning: On border, windbreaks etc. adjacent to crops	- Around house compound - Around land unit - For livestock enclosure	
Products, Services, Benefits	- Increased fuelwood and fodder yield on short rotation	- reduced shading - seasonal coffee shading (see text 2.4)	- increased flowering & fruiting - add. fuelwood	- reduced shading - stick fuelwood (see text 2.4) - Possibly reduced Tse tse fly incidents (see text 3.1.5) Root - pruning: Reduced tree-crop competition	- Protection by increased density - possibly add. fodder (see text 2.4)	

Increasing the density of protective and/or demarcating hedges by regular *trimming* may serve as an example for enhancing service efficiency of multipurpose trees. A similar example is the semi-annual pollarding of Erythrina poeppigiana over coffee in small-scale farms on sub-optimal sites in Costa Rica to control shading (3, 4).

Tree-crop interface is a key topic in agroforestry and therefore also subject to tree management considerations. *Pruning* of border trees to reduce shading of adjacent, light-demanding crops is an example of how the negative tree-crop interface may be reduced. Another one is *root pruning* along hedges and shelterbelts to remove competition for water and nutrients between trees and crops.

Management of trees may also serve as a tool to enhance a positive tree-crop interface. Hedgerows in cropland, planted to maintain or increase fertility, are kept low to fulfill their function of leaf-mulch production without developing into a serious competitor for space and in nutrient and water take-up.

The latter highlights the often prevailing overlapping of management effects more clearly than the other examples. Minimizing negative effects and maximizing positive effects of the tree-crop interface can be part and parcel of the same management intervention.

Multiple effects are also achieved in many other management practices. Whenever, for example, a live fence of Gliricidia sepium is trimmed for improving its density, a considerable amount of foliage for green manure and fodder is generated at the same time (28). The intended increase of the service efficiency of this management practice also increases the production.

3. LIMITATIONS AND PROBLEMS IN THE USE OF MULTIPURPOSE TREES AND SHRUBS

Besides opportunities and many potential uses and benefits there are also limitations and problems in the use of multipurpose trees and shrubs in land management. They require equal attention in order not to discredit potentially useful species and to negatively balance their efficiency in the system due to oversight of certain restrictions. In one way or the other most of these limitations and restrictions are associated with a low level of knowledge and to management problems.

3.1 Present State of Knowledge

With a long list of major questions to be asked when addressing the role of multipurpose trees and shrubs in agroforestry systems, P. Huxley (15) highlights the complexity of technical, managerial and socio-economic implications of their use. At present there are far more questions than answers.

Past interest and research has focused not only on a limited range of tree species of economic value in terms of timber production but has also restricted relevant efforts to a few biological tree characteristics which are of importance to this production aspect. This rather limited approach to trees has broadened considerably with the growing recognition of the many other production and service potentials - so far neglected - of trees and shrubs relevant to agroforestry.

However, the extended interest in new aspects of trees and shrubs is unfortunately not yet paralleled by the respective knowledge about them. The wide-open information gap will continue to constitute a major limitation in their beneficial use until it is closed or at least considerably narrowed.

3.1.1 Taxonomy

The state of knowledge on taxonomy and problems of nomenclature vary with the species. While in most cases of commercial timber species this does not constitute a problem any more, it is a matter of concern with many others, particularly with the vast number of potential multipurpose trees and shrubs. Even with some of those which have been subject to more intensive research because of their obvious multiple value, taxonomy and nomenclature remains a problem. Burley (7), Little (24) and Arya (2) mention legumes, in general, or Prosopis species, in particular, as examples for hybridization between species (see also R. Leakey and F. Last (23) or phenotypic similarities among species or both as typical causes for difficulties in classification and nomenclature.

The history of taxonomy of Prosopis, as described by Burkhart (6), going as far back as 200 years, may be an exceptional case; it indicates, however, the problems which still lie ahead in properly classifying multipurpose tree and shrub genera to facilitate their appropriate and species-specific use in agroforestry systems. Although the road to a reliable classification of genera may be considerably shortened by modern methods of analysing phenological, morpaological and other variations (e.g. chemo taxonomy), the large number of multipurpose tree species to be assessed and evaluated is still a major problem.

3.1.2 Provenance and environmental adaptability

Without going into too many details within the framework of this paper, special problems related to the required multiple outputs of multipurpose trees have to be mentioned. Provenance trials aimed at the selection of the most suitable population/provenance of one species for a given site (soils, climate, altitude) become much more complex if, beyond maximum survival, growth performance and optimizing biomass production, other tree attributes, like palatability of leaves and pods or capabilities to provide live fencing, have to be considered against a varying environmental and socio-economic background. This requires sets of information to be acquired from research different and more complex than conventional provenance research (see also Huxley (19)).

3.1.3 Phenology and morphology

In the use of multipurpose trees phenological behaviour is often of decisive importance. High nutritious value of leaf fodder of trees is of considerably reduced practical value if a deciduous tree shades its leaves in the latter part of the dry season when compensatory leaf fodder is most needed for livestock. To some extent this also applies to seasonal variation in the chemical composition of leaves of fodder trees as substantiated for some fodder species like Grewia optiva, Bauhinia variegata, Robinia pseudoacacia and others in India (29).

As Huxley points out (20), phenophases in relation to environmental (seasonal) changes are easy to recognize for trees and shrubs in their own indigenous area. Based on these records the assessment of the complementary value of such tree species in production systems is comparatively easy. However, in the case of tree species of high potential multiple use, but of different provenance, the question of phenological adaptability to different biophysical conditions immediately arises. The transfer of multipurpose trees/shrubs from one eco-zone to another requires either knowledge on these aspects or small provenance trials. The desired use of a tree or shrub which is related to a certain phenological behaviour will not be achieved if this is not taken into consideration.

What has been mentioned on the sequence of shading of leaves does also refer to other phenological features in relation to uses of trees (e.g. time of flowering versus bee-forage).

The most outstanding difference between trees and shrubs on the one hand and crops and grasses on the other hand is the usually much greater size of the former. The superior height, the more or less spreading crown and the obviously different plant-space occupation relationship of trees as compared to crops and grasses raise questions with regard to the economic use of space by trees. This implies the need for finding answers to the question whether higher space occupancy of trees is balanced by the added value of their products plus their beneficial services. In this respect inherited tree characteristics, such as multistems versus single-stems, ability to self-prune, and size and density of crowns, gain importance. Similar considerations also apply to sub-surface characteristics of plants. Compared to crops and grasses, trees and shrubs usually have a much larger root system to support the bigger overall structure both in statical as well as in nutritional supply terms.

3.1.4 Tree-crop interface

The predominant problem in mixing multipurpose trees and shrubs with crops and grasses is the compatibility of such differently shaped and structured groups of plants. As indicated in the previous sub-chapter, phenological behaviour and morphological characteristics of trees are highly influential in tree-crop interface. A whole range of these characteristics and bio-physical factors, such as time of leaf drop, size and depth of the root system, radiation, erosive rain drop, windspeed and evapo-transpiration, degree of shade tolerance of crops etc., are instrumental in determining the either competitive or supplementary interaction between trees/shrubs and crops/grasses.

Von Maydell (27) reports significantly better crop yields under Acacia albida in the Sahel as obtained from unshaded but otherwise comparable plots. Millet yields 2-2.5 times higher than those obtained on areas not covered by A. albida are reported to be regularly achieved in some Sahelian countries (38). With the added benefit of various products from Acacia albida (leaf- and pod- fodder, fuel), this example of a positive tree-crop interface is mainly attributed to the non-competitive or less competitive species-specific deep rooting pattern of this species. The nutrients taken up from soil layers which are unreachable for crops and most grasses, are partly made available to the topsoil, and thus to flat-rooting crops, in a recycling process through the leaf drop. However, root system obviously do not always follow a species-specific development pattern, which would allow certain predictions to be expected of tree-crop interface reactions. While von Maydell states that roots of Prosopis juliflora in the Sahel reach as deep as 35 m (27), Prajapati et al. (31) have found that a major concentration of roots of the same species in a cultivated field occurred at 0-20 cm depth, stretching as far as 45 m. Sorghum yields were negligible up to 5 m distance from the Prosopis hedge and at 13-18 m distance only 7% of the yield in unaffected areas was obtained.

The above-mentioned exampled are a practical demonstration of the principles of resource sharing in the horizontal and in the vertical dimension as described by Cannel (8). These principles outline how areas of interfaces vary with the number of different types of crops and with their arrangement. The principles of resource sharing and the practical examples together clearly demonstrate that in view of the many variables, such as different plant types, soil conditions, climatic factors, topography, orography etc., considerably more knowledge about the resource-sharing plant components still has to be accumulated and much research still has to be done.

3.1.5 Negative interactions

Besides positive as well as negative tree-crop interface potentials, the introduction and/or maintenance of multipurpose trees/shrubs in agricultural production systems can cause other unwanted side effects. One of the often quoted problems is the too successful adpatation of exotic species to particularly favourable environments. Burley (7) gives as typical examples Robinia pseudoacacia and Ailanthus altissima, which, in the eastern Mediterranean, flower early and profusely and regenerate abundantly, thus spreading quickly and uncontrollably into fields and pasture where they adversely interfere with crop and pasture producton. Sankhla (34) refers to Prosopis juliflora as being noxious in parts of India. There it is said to show an inhibitive effect on the germination and growth of other plants. Opuntia and Lantana are two more well-known examples for intolerant invasiveness.

Although much of this problem can be intercepted by management interventions, it still constitutes a burden to land users, at least in terms of required extra labour input.

The mixture of trees and shrubs with crops and pasture, usually referred to as an important and positive contribution to the restoration or maintenance of ecological balance and stability, may in some cases turn out to be a disadvantage to farmers. Trees and shrubs as individuals or more so in lines or clusters, introduced into agricultural production systems, create biotops often suitable for attracting and supporting an increased population of birds abd small mammals. This may be desirable from a purely ecological point of view, but can quickly develop into a threat to crops and, less significantly, to pasture. As a result increased protective measures are required which may involve additional material and labour inputs by the farmer. In some parts of Africa ranchers and farmers are said to claim that low-branching trees and shrubs encourage the development of the Tse-tsefly.

The above-mentioned adverse side-effects of multipurpose trees and shrubs require management interventions of various kinds. These have to be economically balanced with the beneficial effects of trees and shrubs. Depending on the scale of adverse effects and on the implications derived therefrom, they may advance to important management considerations in land use in general and agroforestry in particular.

3.1.6 Germplasm: Availability, exploration and reproduction

With few exceptions, such as Leucaena leucocephala, Prosopis spp., Calliandra spp., Acacia albida and others, the exploration of multipurpose trees and shrubs is at an early stage. In view of the many species which have received attention for their multiple uses, as indicated by the many lists of multipurpose trees already mentioned, prioritizing the most useful species appears to be necessary to utilize limited resources in the best possible way. In spite of the danger of leaving out lesser known, but potentially valuable species, this need for prioritization is indispensable. However, a universal prioritization seems less meaningful as the frequency of occurrence of certain species, and thus their use, is closely related to major environmental characteristics. Therefore it seems to be more appropriate to develop different priority lists for the major ecological zones. Attempts to set adequate criteria for this prioritisation and to maintain records on the status and progress in exploration, evaluation and conservation of promising multipurpose trees have been made by the FAO Panel of Experts on Forest Gene Resources (11) by Lymann and Brewbaker (26) and von Carlowitz (9).

The problems emanating from this situation of low level of knowledge are manifold. The genetic quality of seeds being used is often unknown and untested. The sudden increase in the demand for multipurpose trees is not matched by an adequate supply. This results in illegal and inadequate trade across countries and continents without regard to proper documentation of provenances and to phytosanitary certification. With reference to known plantation sepcies, such as Eucalyptus camaldulensis, J. Turnbull (37) provides examples of the magnitude of differences in provenance which, if not observed, can result in yields far below the potential of a species. He further points out that poor germplasm quality which fails to perform well can do considerable harm beyond economic

considerations. High mortality rates or low production may discredit species used in agroforestry in spite of their high potential.

At present no world-wide list of seed suppliers for multipurpose tree/shrub species exists. Apart from some reliable seed sources, like the CSIRO Tree Seed Centre, CATIE Latin-American Seed Bank, DANIDA Tree Seed Centre, Commonwelath Forestry Institute and some others, the selection, collection and use of seeds of local multipurpose tree species often appears to be the best bet in order to avoid the shortcomings outline above.

Besides the critical and so far unresolved constraints in seed supplies from reliable sources, there is another conceptional problem. This is related to the multiple uses of trees. Selection and improvement of multipurpose tree germplasm has to be preceded by an assessment of the various uses in such socio-economic terms as reflected, for examplem by regional preferences of certain species and uses, by the adaptability to certain uses and by marketing opportunities for certain tree-based products. These considerations have further to be weighed against the potential performance of multipurpose tree/shrub species and their various provenances for each site (7).

3.2 Multipurpose Tree Management

Tree management in agroforestry is not only to be seen as an opportunity to enhance productivity of individual trees and of the whole system, but also as an intervention which implies a number of problems and constraints. These are to be expected to occur in many ways, some of which are briefly outlined hereunder.

3.2.1 General management problems

It is obvious that a higher degree of diversification of production through an increased number of components in a system inevitably leads to higher management requirements. If trees and shrubs are added to the system, the resulting difference in the production technique, the growing pattern and the length of rotation between trees and crops immediately become important management considerations. The balancing of components in number and kind of arrangement, aimed at specific pre-determined economic and/or ecological effects, requires additional knowledge and understanding of basic biological processes as well as management skills.

The extent to which additional labour inputs are required will depend on the following factors:

- intensity of tree manipulation
- frequency of tree manipulation and "harvesting" (e.g. of pods, of stick-fuelwood in a quick rotation scheme or in a high pruning scheme)
- total number of trees, and zonal versus mixed arrangement

In management units, big enough for mechanization, trees, particularly in the cropland, may slow down agricultural operations conducted by farm machinery.

3.2.2 Protection of trees and tree crops

One of the major reasons for low survival rates of multipurpose trees introduced into pasture and cropland is damaging early browsing by livestock and game. This threat is further aggravated when trees are planted with the objective of enriching the pasture or of producing cut-and-carry fodder elsewhere in agricultural production units. For obvious reasons these fodder trees constitute a particular attraction for all free-grazing livestock and for game. This attraction combined with the improved biotop for game, as already mentioned under 3.1.5, may require considerable efforts, labour and other inputs to protect the trees in their early stage during which browsing often results in total loss.

It appears that little attention has so far been paid to this crucial problem in agroforestry. In forestry plantations exposed to browsing, high-input technologies have been developed for protection. Mass application of chemical repellents or fencing have been used with varying success. However, what may be economically justified in plantations as part of the establishment costs is not necessarily acceptable to a small-scale farmer who plants a comparatively small number of trees and who is often threatened by cash problems. Low-input devices, like piling thorny shrubs on newly planted seedlings may be a solution where thorny shrubs are available and can be used in this way without ecological damage. In other cases the urgent need for simple and cheap protection methods still persists.

A similar problem may occur when fruits and nuts as cash or subsistence crops from trees are exposed to birds, squirrels or monkeys. Game control by shooting or trapping may be the only way to avoid major losses.

3.2.3 Harvesting of multipurpose tree products

The different habits of trees and shrubs as compared to crops, the height and the level of some harvesting and tree management operations (e.g. collection of fruits, nuts, flowers as food additions, young sprouts and leaves as vegetable or fodder, and pollarding, high pruning operations etc.) require techniques and possibly tools, not always known or available to farmers. Although farmers are used to cutting fuelwood, to operating suitable tools and also to collecting wild fruits, leaves, etc., many of the above-mentioned operations need special skills and tools which secure optimum yield-labour input ratios and maximum effect from yield-oriented tree manipulation. For example a clean cut in coppicing and pollarding often provides for faster re-sprouting and for more shoots as compared to crude removal of stems leaving the cambium and the dormant buds damaged. In harvesting fruits and nuts a long-handled plucker may be as useful in terms of reduced labour requirements as a simple tree pruner used to obtain small-dimensional fuelwood from tree pruning or to reduce shade interfering with the growth of adjacent crops.

Other tree manipulation associated with the enhancement of productivity of introduced multipurpose trees, like grafting and budding of fruit-trees or Ceratonia seliqua for pod production, are often not commonly known practices.

The above-mentioned examples may serve to demonstrate the view that the additional management problems linked to the introduction of trees in a productive role can only be overcome if knowledge, skills and practices are introduced along with the trees.

3.2.4 Adaptability and marketing of tree products

While the adaptability of multipurpose tree species to environments other than their indigenous ones is based on biological and inherited genetic capabilities, the acceptance of new species and their products by the people is often governed by psychological, anthropological and socio-economic factors.

Prosopis pods are highly valued as a food resource in many areas of Central and South America and have often acquired the status of staple food, at least in times of low supplies of other food resources (36). However, outside these regions of natural distribution this important potential of Prosopis has hardly been adapted anywhere.

Another example is the use of the bark of Adansonia digitata. Commonly used in West Africa and the Sahel for a wide range of products (27), its potential appears to have been neglected in most parts of East Africa.

Sometimes the reason for this under- or non-utilization of such potentials may be a lack of knowledge. In large parts of East Africa the use of the insecticidal properties of Azadirachta indica for the prevention of weevil infestation of stored grains seems not to be commonly known, while it is extensively researched and used in India (35) and is also mentioned by von Maydell (25) to be applied in the Sahel (27).

Psychologically motivated reluctance to accept something, particularly food products, which people are not familiar with and for which preparation methods are not known, may be another reason.

Often, however, the availability of alternative resources explains the low level of acceptance of new products from trees. The wide-spread availability of Sisal in East Africa and the ease with which fibre for a large variety of traditional uses can be obtained from it obviously accounts for the lack of interest in the bark of Adansonia digitata.

In other cases, for example the above-mentioned food resource value of Prosopis pods, the under-utilization of such potentials often can hardly be afforded in view of increasing food resource deficienies in many developing countries.

Therefore the promotion of the consumption and the development of marketing strategies for products in current and future demand and newly introduced from indigenous as well as from exotic multipurpose trees can be as much a management problem as the management of these trees itself.

PART II

4. THE NEED FOR A MULTIPURPOSE TREE DATA BASE

4.1 General

The vast potentials of multipurpose trees and shrubs can only be exploited to the maximum economic and ecologic benefit in land use if as many aspects of trees/shrubs as possible are explored and understood. Knowledge is also the key to addressing constraints associated with their introduction into land management units.

Information and data are available for a considerable number of multipurpose tree species and certain aspects of using them have been covered at varying levels of practical experience and research. However, much of it has still escaped the attention of those who in one way or the other are concerned with agroforestry and the use of multipurpose trees and shrubs. Valuable information has either not been published or the relevant publications have not yet found the dissemination level which they require to be translated into action. For various reasons invaluable sources of knowledge, often accumulated by farmers and local people over generations as well as by field workers, have hot been sufficiently tapped.

A number of institutions, organizations and individuals have already done considerable work in collecting and evaluating relevant information on multipurpose trees and shrubs. Their incorporation into any dissemination scheme of information and data is indispensable and of high value. However, the work already done has often been directed to selected species only and/or has been concentrated on specific uses. In addition the collection of information has sometimes been limited to certain regions.

In view of the above-mentioned state of affairs there are a number of good reasons for establishing a world-wide computerized *multipurpose tree data base*, as summerised hereunder:

- The immense but often still under-utilized potentials of trees and shrubs urgently require organized use-oriented data collection, storage, interpretation and evaluation, and the dissemination of these data in a digestable form

- Addressing tree-specific and management-derived problems and constraints, as out-lined under 3 above requires not only the above-mentioned data, but also additional information on existing management practices

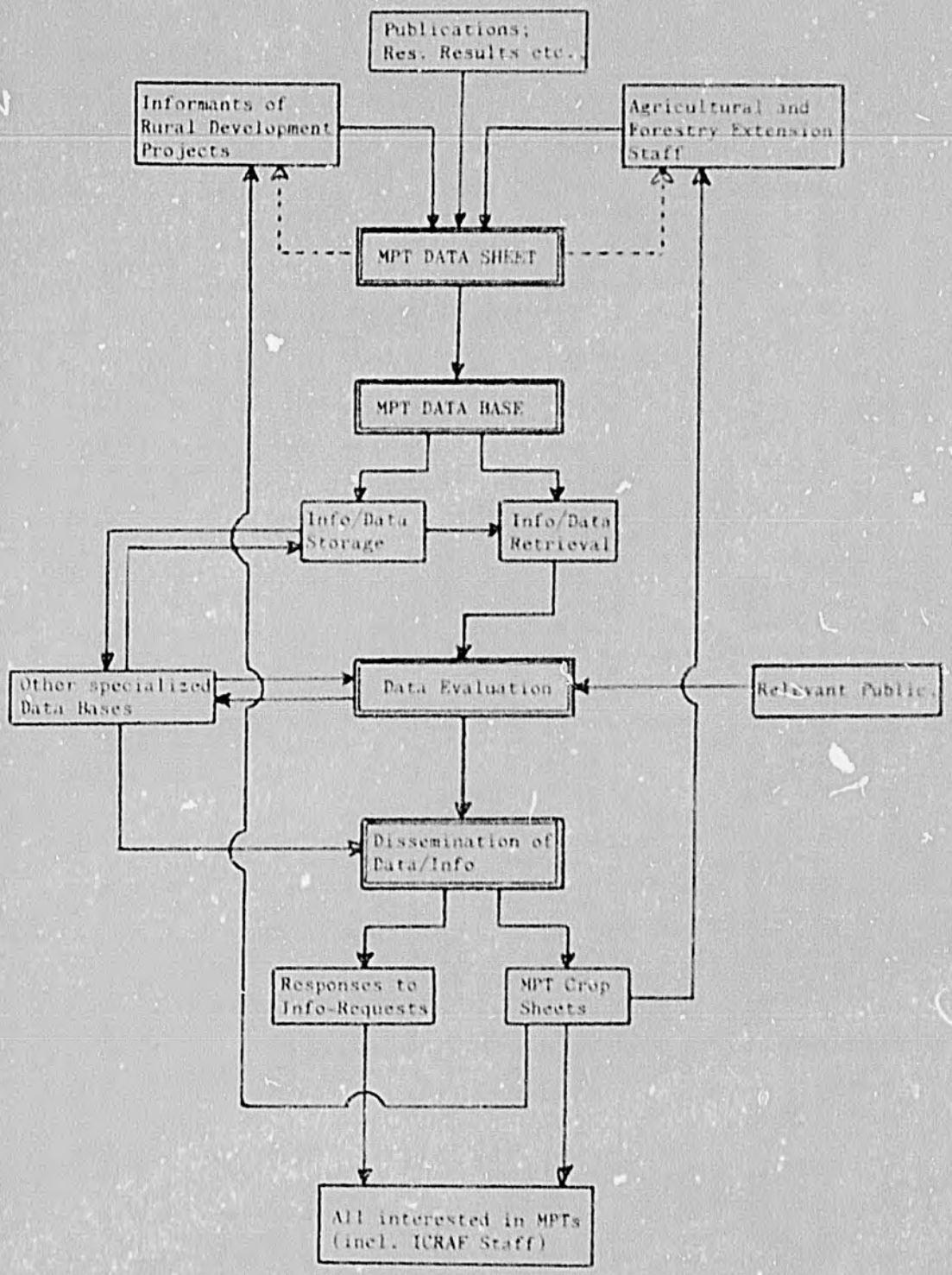
- The aforementioned (intended) limits of many existing tree data bases as well as their strength in regard to detail on certain aspects, call for their organized linking up with the more broadly defined information available from the multipurpose tree data base.

Figure 3 presents an implementation flow chart which summarizes the whole process of collection, computer storage, evaluation, retrieval, and of the dissemination of multipurpose tree data and information, as described later.

4.2 Objectives

The objectives of establishing a computerized multipurpose tree shrub data base are closely associated with the justification of its need. Therefore some of the general objectives, such as data collection and storage per se, have been mentioned already in the previous chapter.

FIGURE 3: THE PROCESS OF COLLECTION, STORAGE, EVALUATION AND DISSEMINATION OF MPT DATA AND INFORMATION



Other procedural and development-oriented objectives are:

- to cover the widest possible range of multipurpose trees and shrubs from all geographic regions and ecological zones;
- to assess their biophysical range (minimum-maximum-optimum);
- to establish possible variations of tree/shrub characteristics within the biophysical range covered by individual tree/shrub species;
- to arrive at a thorough assessment of their uses (beyond known commercial uses);
- to assess the comparative importance of different species as well as of different uses in quantitative terms and by their geographic distribution and scale of appreciation
- to facilitate responses to requests as to which multipurpose tree/shrubs species to choose in order to meet specific biophysical conditions and certain economic and ecological requirements with a maximum likelihood of success.

5. MEANS AND METHODS OF OBTAINING INFORMATION

In order to achieve the above-mentioned objectives it is necessary not only to accumulate, screen, store and evaluate already available information contained in publication, but also to go back to the original sources of information and data. The latter approach requires the cooperation of informants working in the field. They are likely to be familiar both with certain tree/shrub species of economic and ecologic value to people and the specific biophysical conditions in the area they are working in.

Existing data bases on multipurpose trees and shrubs or on certain aspects of trees and shrubs are other important supplementary sources of information.

5.1 The "Multipurpose Tree Data Sheet"

The kind of trees/shrubs in respect of which information is to be collected itself suggests focus on uses. However, as explained in the previous chapters, uses which are not related to the biophysical environment of the trees which provides them and are not seen in the context of applied management practices they are exposed to make their own assessment less meaningful.

The magnitude of information and data required to arrive at a comprehensive evaluation of multipurpose trees/shrubs in their problem-addressing capacity constitutes a basic design constraint. In principle it is safe to say that there is almost no limit to the number of questions to which answers would not be useful in exhaustively assessing multipurpose trees. There is, however, a limit to the degree of preparedness of informants to cooperate and to the time they can be expected to devote to this. Furthermore certain questions require a certain professional background. Praxis-oriented questions, like applied management practices, for example, are likely to be answered best by those who are working in the field. Others should be directed to taxonomists or plant physiologists if optimum results are to be received.

C. Hackett (16, 17) has proposed standardized sets of core modules, e.g. general botany, uses checklist, location and climate, etc., each one dealing with certain aspects at a rather high level of detail. The core modules are divided into those which address factual components and others which elaborate on interpretive components (e.g. environmental relationship: terrain, soils). Supplementary modules are also suggested which provide additional specialized information (e.g. uses as human food).

This intriguing idea allows for independent data collection and interpretation of certain aspects as well as for combining these information blocks in any way useful to describe a plant (tree) with a view to fulfilling certain requirements (e.g. introduction of multipurpose tree into agroforestry systems).

This system, as suggested by Hackett and as implemented in exemplary draft form by Wickens and Hackett (39), also addresses the above-mentioned problem of required number of questions versus time input and level of competence of informants to be expected.

By breaking down the total number of questions into several sets of specific kinds of information (e.g. taxonomy, botany or uses only) not only can the level of detail be increased, but also the appropriate and most competent informants for each set be identified and approached.

This method has been adopted by many institutions and individuals in search of detailed information for various purposes. Examples are J. Burley's "Questionnaire on Multipurpose Tree Germplasm" (Appendix 4), CATIE's "Caracteristicas de Especies Arboreas" (Appendix 5) and von Maydell's datasheet on fuelwood ("Erhebungsbogen Brennholz") (Appendix 6).

C. Hackett's suggestions for standardizing information collection in order to achieve compatability of data bases and his attempts to secure comprehensiveness of results are full recognited and accepted as a necessary long-term objective. However, it has to be realized that in order to meet these objectives a wide network has to be established, substantial time inputs are required, and consensus has to be reached among those who deal with data bases.

Considering the importance of multipurpose trees in agroforestry and in view of the fact that agroforestry has already become part of development project planning and implementation in integrated land use, immediate initiatives are indispensable to accumulate most needed information on multipurpose trees/shrubs as vital components in agroforestry. These considerations are reflected in the design of the "Multipurpose Tree Data Sheet" (see Appendix 1) and in the selection and composition of questions posed to informants. The collection of the most vital field data has to be seen as the first step in gradually building-up an increasing level of knowledge.

In appreciation of the understandable unpopularity of questionnaires among recipients all efforts were made to design the "Multipurpose Tree Data Sheet" in as user-friendly a form as possible. In an attempt to achieve this, the following steps were taken:

- the data sheet is designed in a logical order of information required. Sufficient explanatory notes are provided on how to fill in the data sheets;
- explanations on the objectives and the benefits derived from the exercise are provided in a brief letter accompanying the data sheets;
- the number of questions is limited to the minimum necessary to achieve the objectives;
- the language used is that with which individual informants are likely to be familiar (English, French and Spanish);
- questions are asked only on topics with which the informant can be expected to be familiar (site-specific) and which do not require time-consuming search for data;
- whenever possible a "tick-in-appropriate-box" device is used, rather than demanding detailed answers to lengthy questions in writing;
- as an aid to the informant an example of a filled-in data sheet is provided.

5.1.1 Information included - restrictions

The need for site-specificity in assessing the range of multipurpose trees requires a direct approach of informants in the field. In using data sheets/questionnaires for this purpose the necessity to avoid overstraining the informants' willingness to cooperate is obvious. Returns of completed multipurpose tree data sheets at any reasonable rate can only be expected if this basic rule is observed. This requires considerations on how to limit the number of questions and on what topics to focus.

For obvious reasons *uses* of multipurpose trees/shrubs are the core part of the data sheet.

Appendices 1 - 3 show the vast number of potential uses of trees and shrubs. The incorporation of all of them alone would fill pages of any questionnaire; since however, no individual tree species is likely to provide all possible uses a design-method has been adapted which summarizes the most commonly known ones under the headings "Food", "Fodder", "Wood", "Other Products" and "Service Uses" and which allows for stating "Others" which may be relevant for certain species in any given region or location.

A certain degree of elaboration on the various uses is allowed for by requesting quantitative figures (yields), months of harvesting, and a ranking of importance of the uses listed.

Other sets of information relevant to the time of harvesting tree crops, to the level of yields and to aspects influenced in terms of obtaining benefits are requested under the heading "Phenological Behaviour", Morphological Characteristics", "Applied Reproduction", "Applied Tree Management" and "Other Characteristics". Chapter 7.2 will discuss their relevance to data evaluation in more detail.

Besides such key information as species name, family, and vernacular name as well as location and growing site, seed sources are regarded as an important piece of information.

Much emphasis is given to the "info reliability". The extent to which information received is extrapolable and to which extent it is fit for dissemination will depend on the result of this test applied to each question.

The necessary limitation in the number of questions incorporated in the data sheet results in some information gaps. The almost complete neglect of general botany, save for a few phenological and morphological data requested, may be considered as a major shortcoming in the design of the data sheet. However, given the need to be restrictive for reasons mentioned before, this omission is regarded justifiable considering that for most species sufficient relevant information is available in the large number of standard books on botanical features of trees and shrubs.

Although it is more a matter to be dealt with in chpater 7.2 (Data Evaluation), it is mentioned for the sake of completeness, that direct questions are neither asked on tree-crop interfaces nor on socio-economic aspects (e.g. number of beneficiaries of certain tree products). The main reason again is the complexity of such topics and their reflection in a great number of necessary questions vis-a-vis the acceptable accommodation

rate for questions in data sheets. Furthermore it has to be considered that at the present stage of multipurpose tree development the level of knowledge on these aspects is still low and answers to respective questions are not likely to be received in any appreciable number.

5.1.2 The use of the "multipurpose tree (MPT) data sheet"

The emphasis given to site-specific data collection is documented by the length with which the "MPT Data Sheet", its purpose, its design and its limitations have been discussed in the previous chapters.

The ways in which the "MPT Data Sheet" is being used are the following:

- o mailing in large numbers to potential informants requesting their cooperation;
- o screening, collating and condensing available (published) information and data by using the Data Sheet format;
- o filling regional information gaps by employing junior consultants to collect relevant information based on the Data Sheet format.

As a result of these complementary uses of the MPT Data Sheet, the following will be achieved:

- o coverage of a large number of multipurpose tree/shrub species;
- o coverage of all major ecological zones throughout the tropics and sub-tropics;
- o obtaining information and data from various regions for the same species (gauging their biophysical range and the geographical spread of identified uses, of management practices, etc.,);
- o securing compatibility for computerization.

5.2 The Incorporation of Other Data Bases and Information

An information system on multipurpose trees and shrubs, as aimed at by the establishment of ICRAF's multipurpose tree data base, would be incomplete if full use is not made of already existing data bases and other sources of specialized information. The concept of site-specific data collection, followed by the use of the multipurpose data sheets, needs to be supported and supplemented by that information which provides details, particularly on uses and benefits, but also on other aspects of multipurpose trees and shrubs.

The following institutions - the list is by no means exhaustive - are able to provide such supplementary information:

- o Nitrogen Fixing Tree Association, Waimanalo, Hawaii, U.S.A.
  - NFTA dbII on N-fixing tree species (see Appendix 7)
- o Caesar Kleberg Wildlife Research Institute, College of Agriculture, Texas A&I University, Kingsville, Texas, U.S.A. (P. Felker)
  - db (IBM personal computer) on 1100 tree legume accessions - (expected to be operational in mid - 1984)

- o USDA Germplasm Resources Laboratory, Beltsville, U.S.A. (J. Duke)
  - db on > 1000 plant species of economic value (particularly medicinal properties) -

- o Commonwealth Forestry Institute, Oxford, England (Webb, Wood and Smith)
  - db on 125 plantation tree species including other uses than timber -

- o University of Arizona, School of Renewable Natural Resources (M. Holland)
  - Computerized bibliographic data base "Arid Vegetation Information System - AVIS", description of plants, including trees and shrubs, and of uses of arid semiarid lands -

- o Food and Agriculture Organization of the United Nations, Rome - Italy
  - information on food and fruit trees, on trees and shrubs in arid and semi-arid regions, and on medicinal trees -

- o Royal Botanic Gardens, Kew, U.K. (G.W. Wickens et al.)
  - Survey of Economic Plants for the Arid and Semi-arid Tropics (SEPASAT), db on economic plants, excluding major agricultural crops -

- o International Bee Research Association, Gerrards Cross, Bucks., SL9 0SR, England
  - information on bee-forage tree and shrub species (no details known yet) -

- o Institut fuer Weltforstwirtschaft (Institute for World Forestry), Bundes forschungsanstalt fuer Forst und Holzwirtschaft (Federal Research Centre for Forestry and Wood Technology) (H.J. von Maydell), 2050 Hamburg 80 - Fed. Rep. of Germany
  - db on tree and shrub species of the Sahel -

- o Dates and Palms Research Centre, P.O. 2416, Baghdad, Iraq
  - db on date palms, possibly other palms (no details known yet) -

- o National Academy of Sciences, (N. Vietmeyer), Washington D.C.
  - non-computerized material on fuelwood species -

- o Centre Technique Forestier Tropical (CTFT), 93 100 Nogent-sur-Marne, France
  - various relevant bibliography data bases, among others on experiments undertaken on MPT species -

- o Commonwealth Scientific and Industrial Research Organization
  - CSIRO, Canberra, A.C.T. Australia
  - information on Australian Acacia and other species - (no details known yet) -

For reasons of technical as well as format (kind of descriptors) the above-mentioned data bases will not be compatible in most cases with ICRAF's multipurpose tree data base. However, subject to reaching an agreement with the authors of other relevant data bases, the latter will be used in bundling-up information packages, thus making them more comprehensive and more attractive to any user. The same applies to non-computerized information available at the above-mentioned institutions or elsewhere.

Besides external data bases and other supplementary sources of information, there are also at ICRAF internal data bases of high complementary value.

- o Systems Inventory Bibliography - SIBIB (E. Fernandez)
  - Osborne database II on > 100 references on agroforestry systems including multipurpose trees -
- o Fodder Tree Composition - FT COMP (P. Robinson)
  - Osborne database II covering > 120 fodder trees shrubs species -
- o Plant Species with Anti-Pest Properties (E. Fernandez)
  - Osborne database II covering > 200 records species - (see Appendix 8)

In their capacity to cover certain aspects of multipurpose trees, print-outs on species for which the above-mentioned data bases provide specialized information will be incorporated into information packages on request. They will also be given due consideration in any form of information dissemination based on the multipurpose tree data base which is the subject of this paper.

A direct reading-in of SIBIB and FT COMP into the multipurpose tree data base is not yet possible. This linking-up, however, will be established as soon as ICRAF has the technical facilities for this.

There are two more ICRAF data bases planned on

- o phenology of tropical and subtropical trees (P. Huxley) and
- o root development of plants, including trees (P. Huxley)

Since these data bases are still at the planning stage it will be possible to secure their compatibility with the multipurpose tree data base.

The ICRAF Environmental Data Base for Agroforestry - AFENV (A. Young) will be used as a complementary source of information on biophysical aspects whenever applicable in relation to information services provided by the multipurpose tree data base. AFENV allows for climate and soil data obtained from the multipurpose tree data sheets to be condensed to KOEPPEN climate and FAO soil classes. This may be of interest if crude comparisons in performance of certain species in different environments are of interest.

6. COMPUTERIZATION (by P. von Carlowitz and L. Fidaali)

6.1 General

All data and information collected or acquired from publications by using the data sheet format will be stored on computer. This will facilitate selective retrieval of information on multipurpose trees according to specific requests.

At present storage and retrieval operations are still carried out on an experimental basis both with regard to the number of records entered and to the structure of the data base.

The multipurpose tree and shrub data base is named MUPOTAS.

6.2 Systems Specifications

The hardware used is an "IBM Personal Computer" running on the PC DOS, version 2.0 with dual floppy disc drives (320 K each) and a monochrome display, dot matrix printer and IBM keyboard.

This system has a limited storage capacity which, in due course, will not be able to accommodate the expected number of species and records. This problem will be solved by the purchase of a hard disc drive with a capacity of 10-20 mb.

As software a relational db management system "Knowledgeman" is used which allows for interpretative retrieval of data and information as described under 7.2.

6.3 Data Base Structure and Systems Operation

The data base MUPOTAS is structured in five separate files. These together will hold all information contained in the data sheet format (see Appendix 1 and Figure 4, page 38).

A menu drive system is in the course of being developed to enable users to easily input, retrieve and produce reports in various desired forms, as for example, the print-outs overleaf.

Draft - Not for quotation or publication

"MULTIPURPOSE TREES DATABASE - MUPOTAS

(a computerised database)

P.G.Von Carlowitz

THE INTERNATIONAL COUNCIL FOR RESEARCH IN AGROFORESTRY
(ICRAF),P.O. BOX 30677,NAIROBI , KENYA

Page 1

KEYFI	SPECIES	LOCATION
00003	GREWIA OPTIVA	PALAMPUR, HIMACHAL PRADESH, IN
00003	GREWIA OPTIVA	PALAMPUR, HIMACHAL PRADESH, IN
00003	GREWIA OPTIVA	PALAMPUR, HIMACHAL PRADESH, IN
00004	DEUDROCALAMUS HAMILTONII	PALAMPUR, HIMACHAL PRADESH, IN
00005	ROBINIA PSEUDACACIA	PALAMPUR, HIMACHAL PRADESH, IN
00006	BAUHIMIA VARIEGATA	PALAMPUR, HIMACHAL PRADESH, IN
00007	CANARIUM SALOMONENSE	WIDESPREAD IN SOLOMONS
00008	CANARIUM INDICUM	ALL OVER SOLOMONS
00009	AZADIRACHTA INDICA	IBADAN OYO STATE NIGERIA
00010	GLIRICIDIA SEPIUM	IBADAN OYO STATE, NIGERIA
0011	IRVINGIA GABONENSIS	ETSAKO AUCHI BENDEL, NIGERIA
0012	SPONDIAS MOMBIN	IBADAN OYO STATE NIGERIA
0013	VITEX DONIANA	AYOGWIRI ESTASAKO, BENDEL, NIG
0014	PARKIA CLAPPERTONIANA	AYOGWIRI ETSAKO, BENDEL NIGERI
0015	ALBIZZIA STIPULATA	PALAMPUR, HIMACHAL PRADESH, IN
0016	ZIZYPHUS JORUBA	EL-KOD RESEARCH STATION, ABYAN
0017	AZADIRACHTA INDICA	EL-KOD RESEARCH STATION - ABHA
0018	PROSOPIS CINERARIA	AAF, GHAF
0019	ACACIA MELLIFERA	EL-KOD RESEARCH STATION - ABYA
0020	EUCALUPTUS CAMALDULENSIS	ALICE SPRINGS, NORTHERN TERRIT
0021	ACACIA PEUCE	FINKE, NORTHERN TERRITORY, AUS
0022	PINUS CARIBAEA	SNAKE BAY VIA DARWIN, NORTHERN
0022	ZIZYPHUS JORUBA	WIDESPREAD IN SOLOMONS

Number of Observations: 23

Page 1.

KEYFI	SPECIES	MINTE	MAXTE
00003	GREWIA OPTIVA	12.2	24.7
00003	GREWIA OPTIVA	12.2	24.7
00003	GREWIA OPTIVA	12.2	24.7
00004	DEUDROCALAMUS HAMILTONII	12.2	24.7
00005	ROBINIA PSEUDACACIA	12.2	24.7
00006	BAUHIMIA VARIEGATA	12.2	24.7
00007	CANARIUM SALOMONENSE	.	26.
00008	CANARIUM INDICUM	.	26.
00009	AZADIRACHTA INDICA	21.3	26.3
00010	GLIRICIDIA SEPIUM	21..2	26..3
00011	IRVINGIA GABONENSIS	.	.
00012	SPONDIAS MOMBIN	21.3	26.3
00013	VITEX DONIANA	.	.
00014	PARKIA CLAPPERTONIANA	.	.
00015	ALBIZZIA STIPULATA	12.2	24.7
00016	ZIZYPHUS JORUBA	24.	32.
00017	AZADIRACHTA INDICA	24.	32.
00018	PROSOPIS CINERARIA	24.	32.
00019	ACACIA MELLIFERA	24.	32.
00020	EUCALUPTUS CAMALDULENSIS	13.8	28.7
00021	ACACIA PEUCE	14.9	29.9
00022	PINUS CARIBAEA	18.1	32.0

Page 1

KEYFI	SPECIES	FRUTYILD	FR	F	FR	
00007	CANARIUM SALOMONENSE	50	KG	1	AD	
00008	CANARIUM INDICUM	50	KG	1		
00011	IRVINGIA GABONENSIS			2	CD	
00012	SPONDIAS MOMBIN			3	CD	
00013	VITEX DONIANA			2	C	
00014	PARKIA CLAPPERTONIANA			1	CD	
00016	ZIZYPHUS JORUBA			1	D	
00017	AZADIRACHTA INDICA			3	A	
00007	AZADIRACHTA INDICA			1		Min
00017	ZIZYPHUS JORUBA	50	KG	3	D	Max

Number of Observations: 8

USES		UNIT	YIELD	MONTHS		RANK	IR
FOOD TRUE		SERIAL NO.	00007 = *CANARIUM SALOMONENSE*				
FRUIT	TRUE	KG	50	8	10	1	AD
NUTS	TRUE			8	10		C
VEGETABLE	FALSE						
Oils/Fats	FALSE						
STARCH	FALSE						
SPICES	FALSE						
OTHERS	FALSE						
REMARKS ****							
FODDER TRUE							
LEAVES	FALSE						
PODS/SEEDS	FALSE						
SHOOTS	FALSE						
BEE-FORAGE	TRUE						C
OTHERS	FALSE						
REMARKS ****							
WOOD TRUE							
FUEL WOOD	TRUE					2	D
CHARCOAL	TRUE					4	D
POLES	TRUE					3	D
TIMBER	TRUE					1	D
CARVINGS	FALSE						
OTHERS	TRUE						C VENEER
REMARKS **** VENEER FOR CABINET							
OTHER PRODUCTS TRUE							
WAXES	TRUE						F

ESSEN-OLS	FALSE		
TAN/DYES	FALSE		
GUMS	TRUE	F	
FIBRES	FALSE		
MEDICINAL	TRUE	C	TOOTH BARK
ORNAMENTAL	FALSE		
OTHERS	TRUE		SHADE
REMARKS ****	CANARIUM WAX		
SERVICE USES	TRUE		
WINDBREAKS	TRUE	C	
SOIL CONSV	TRUE	C	
DUNE FIX	FALSE		
LIVE FENCE	FALSE		
N-FIXING	FALSE		
MULCHING	FALSE		
HEDGEROW	FALSE		
OTHERS	FALSE		
REMARKS ****			

7. DATA EVALUATION

7.1 Statistical Analysis

With regard to all information obtained from original sources (site-specific data, not accumulated from literature), a reiterated analysis of the following aspects will be conducted:

- o total number of species covered;
- o number of records received on each individual species;
- o spread of species covered in terms of geographical regions and major eco-zones

These analytic exercises will help to identify regional information gaps and to indicate priority areas for the employment of junior consultants (see under 5.1.2) to close or narrow these gaps. It will further provide orientation to supplementary literature search, to screening, accumulating and to evaluting data contained in publication.

Apart from its operational benefit this analysis will also allow an assessment of regional species preferences and thus may be seen as a first step towards the evaluation of information received.

7.2 Evaluation

The multipurpose tree data sheet (Appendix 1) constituting the basic format by which all information and data are collected, stored and evaluated, comprises of a number of sets of information. They are grouped as follows (see also Figure 4 and Multipurpose Tree Data Sheet Appendix 1):

A. Key Information Sets	- Species and family name; - Provenance/origin*
B. Core Information Sets	- Uses; - Yields
C. Supplementary Information Sets with interpretative value	- Seed sources; - Bio-physics; - Phenology; - Morphology; - Reproduction; - Tree Management; - Other Tree Characteristics; - Relevant Publication
D. Evaluation Sets	- Information Reliability; - Ranking of Importance of Uses Products and Benefits from Trees

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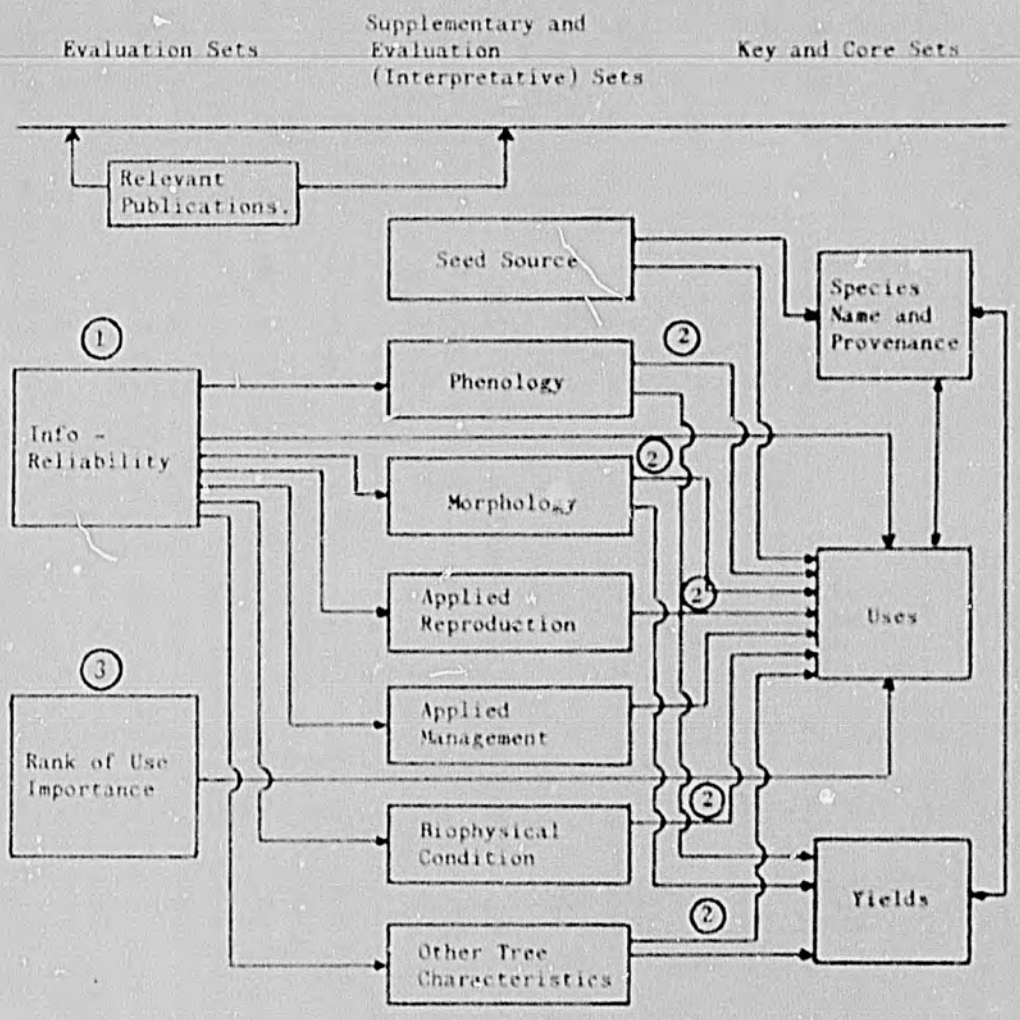
* By definition of OECD: Provenance = The area on which any stand of trees is growing. The stand may be indigenous or non-indigenous; Origin = for an indigenous stand of trees the origin is the place in which the trees are growing; for a non-indigenous stand the origin is the place from which the seed or plants were originally introduced (21).

FIGURE 4. EVALUATION OPPORTUNITIES OF INFORMATION SETS DERIVED FROM THE MULTIPURPOSE TREE DATA SHEET FORMAT (see Annex 1)



Major interpretative Outputs

1 Degree of extrapolability; possibly, identification of research needs

2 Influence of biophysical conditions, phenology, morphology, reproduction and management on uses and yields of trees

3 Regional preferences for certain products and benefits of trees as an aid to the identification of priority species for further development

Figure 4 demonstrates the way in which the different information sets are related to each other, and indicates evaluation opportunities. It also shows that *uses* and *yields* are the focal points in outlining possible ways of evaluating data and of drawing preliminary conclusions from relationships which may be established between information sets listed under group C and *uses*, but also between other groups and sets. A few examples of evaluation opportunities are presented hereunder.

7.2.1 The relationship between uses/yields and tree characteristics, biophysical conditions, reproduction and management

Provided that information and data on a sufficient total number of species and on several records of individual species have been stored on the MUPOTAS data base, it is obviously easy to relate and compare, for example, total rainfall and rainfall pattern with the average height of certain species and their leaf fodder yield. Quantitative differences in leaf-fodder production between unmanipulated trees and those which have been pollarded or coppiced are easy to assess if at comparable biophysical conditions records of a certain species with different management treatments are separately retrieved from the data base. In this case an exemplified retrieval procedure to facilitate the comparison would involve the following steps:

- o retrieve all records on Acacia tortilis which are unmanaged, growing at 200-500 mm rainfall, at 200-800 m altitude and on sandy soils
- o retrieve all records on this species which, under the same bio-physical conditions, have been pollarded.

As has already been briefly mentioned the comparison between climatic data (seasonality of rains), deciduousness (dry or wet season) and the month(s) of harvesting will allow useful conclusions on the capability of certain fodder trees to close fodder gaps.

The true value of a species recorded as used for bee-forage can be better assessed if its flowering periods and the extend and age of first flowering is also retrieved from the stored data.

When planting trees to obtain pods for fodder or human consumption, such efforts are in vain if, for example, the fact is overlooked that a species capable of providing this product, e.g. Ceratonia siliqua, is dioecious and therefore requires planting trees of both sexes in a certain ratio to facilitate fruiting.

In considering the proportion of evaluation opportunities offered by the MUPOTAS data base, it should be remembered that information stored is not restricted to that which is collected through the use of the multipurpose tree data sheets from site-specific, original sources. As explained earlier, the data sheet format will also be used to store data available from publications and research results. In each set of information, the data sheet format allows for additional details to be recorded and stored ("Comments" and "Remarks" - See Annex 1). This, together with retrievals from specialized data bases, as listed in Chapter 5.2, will considerably widen the range of evaluation opportunities.

7.2.2 The ranking of importance of uses

A ranking of the importance of products and services of trees can only be expected from site-specific data collection. Usually information accumulated from publications does not facilitate such a ranking. Although this may limit the interpretative value to some extent, ranking of the importance of tree uses will remain a useful tool for drawing some preliminary conclusions.

The preference of certain products or services from tree species reflects not only their economic or ecological value in certain localities, but will also indicate site-specific problems of land users and or of land use. The evidential value of these indications will be enhanced if preferential statements on certain uses of certain trees are repeatedly mentioned in several localities and regions.

In the latter case repeated high ranking of certain uses linked to certain species in a wider geographic range can be regarded as an aid in identifying priority species for further development and lend support to J. Lyman's and J. Brewbaker's attempt to prioritize species, in this case N-fixing trees, along the line of major uses and major eco-zones (26).

7.2.3 Reproduction and germplasm availability

Site-specific data collection with the help of the multipurpose tree data sheet is not likely to produce conclusive information on the important topic of multipurpose tree seed availability. Nor can the screening of existing publications be expected to yield exact species and region-specific information on problems related to germplasm availability beyond the general concern about this topic.

Only one question posed in the data sheet on "source of seed" and a set of information requested on "applied reproduction" are related to the germplasm subject. However, it will be useful to conduct the retrieval of records directed towards assessing by geographic region and/or eco-zones the following:

- number of cases in which locally collected seeds have been used. If these cases are related to applied reproduction showing, for example, the repeated use of direct sowing, the suggestion may be near at hand that seeds of certain species are more readily available as compared to others;

- provided that this information coincides with a narrow regional range of species used a preliminary conclusion, although of an admittedly low degree or reliability, may be drawn to the effect that this limitation is at least partially caused by the non-availability of seeds of other useful species. To some extent this may also explain the preference of certain species.

The retrieval and comparison of all records showing the use of externally obtained seeds may also indicate to what extent care has been taken in using seeds of adequate provenances.

7.2.4 Information reliability

The information reliability requested to be stated in connexion with almost all information provided, will be of assistance in evaluating

- o the general level of factual information and data available
- o the priority research needs if certain aspects of tree/shrubs are repeatedly met by a low ranking of reliability
- o the degree of extrapolability of certain information
- o the dissemination value of information and data obtained

The latter in particular, needs to be stressed. The quality of the information service, to provide which is the main objective of the MUPOTAS data base, will be judged by the validity of data and information it offers.

7.3 Limitations of Evaluation

Apart from the generally limited level of detail which can be achieved in the data collection, there are the following two aspects which are insufficiently represented in the multipurpose tree data sheet format used both in data collection and information storage:

- o multipurpose trees/shrubs and their interface with crops
- o socio-economic aspects of multipurpose trees/shrubs

It would require by far more questions than can be accommodated by any data sheet of the chosen format to obtain meaningful and conclusive answers on aspects of such complexity.

What little of interpretative value is contained in the used data sheet format in terms of tree-crop interface is associated with information relating to such aspects as for example, root development, deciduousness and canopy. Deep-rooting species, like Acacia albida, may appear more suitable candidates for positive tree-crop interface than those which are repeatedly reported as shallow-rooting, thus competing with crops for soil moisture and nutrients. Light canopy/foliage, as for example typical of Albizzia falcataria, will have a reduced shading effect on crops grown beneath it and may therefore be seen as one positive aspect in considering various possible tree-crop interface effects.

With regard to socio-economic effects of multipurpose trees, interpretation opportunities are limited to drawing, for example, rather vague conclusions on expected increase of labour input imposed by recorded tree management practices. The MUPOTAS data base does not provide sets of information which would allow more conclusive interpretations of socio-economic aspects. This has to be tackled in future specialized studies.

8. USE AND USERS OF THE MULTIPURPOSE TREE DATA BASE

8.1 General

The data base MUPOTAS, combining information obtained both from original sources (site-specific field level) and from screened publications, will form a useful pool of knowledge on multipurpose trees and shrubs. The complementary support it will receive from other ICRAF-internal and external data bases and a continuously conducted updating process will increase its capacity as a research and development-oriented tool for researchers as well as for field workers.

8.2 A Tool for Agroforestry Research

In general an increased level of knowledge on individual species, on their phenological behaviour, their morphological characteristics and on the management practices they have been exposed to will offer opportunities to help to short-cut field experimental evaluation in the various stages as mentioned by Huxley (19).

In the selection of multipurpose trees for elimination trials to explore their suitability and problem-solving capacity in agroforestry, interpreted information and data from the MUPOTAS data base, particularly those which have been obtained on the basis of site-specificity, will be useful to researchers. This information, once evaluated, is likely to be of assistance in narrowing down the range of species for these trials.

Much can be learned from the output of MUPOTAS with regard to site-specific preference of species, their uses and adopted management practices. This will help to provide orientation on which aspects to focus in conducting on-farm trials.

Particularly with regard to the experimental research objective to tree response to management, MUPOTAS in its capacity of data evaluation may in some cases offer such valuable information as possible effects of tree management and manipulation on yields of tree crops.

The above-mentioned examples of how MUPOTAS can serve agroforestry and multipurpose tree research are not exhaustive.

8.3 Identification of Research Needs

In Part I, under chapter 3 of this paper a whole range of limitations and problems in the use of multipurpose trees were outlined. All of these imply the need for considerable research efforts, particularly in fields and aspects where the level of the required knowledge is low.

The systematic accumulation of information from various sources, as outlined previously, will reveal gaps both with regard to whole genera and species and to certain aspects of species relevant to their use in agroforestry. The genus Grewia may serve as one example. Due to the absence of any tannins in the leaves and to other favourable chemical attributes, Grewia optiva is highly regarded as a fodder tree in parts of India and Pakistan (29). In East Africa there are more than three dozens of different Grewia species (Dale and Greenway, 1961), but obviously nothing much is reported on their appreciation as fodder trees and to my knowledge no chemical analyses have been carried out to substantiate

whether among them similarly favourable chemical compositions can be found as in Grewia optiva. Once a sufficient level of development is reached, MUPOTAS will also provide a fairly clear indication of the economic and ecological value of species and their preference by land-users. This may be seen as an opportunity to base the necessary prioritization of species for further development on facts, rather than on individual opinion and preference.

8.4 Multipurpose Trees and MUPOTAS: A Tool for Development

On the one hand the level of exploration of the many potential multipurpose trees is admittedly low. On the other hand with the growing recognition of agroforstry as an alternative land-use system, multipurpose trees are already in extensive use in many rural development programmes in spite of the restricted knowledge, particularly on their interactive effects on crops. The combination of the often prevalent lack of relevant experience among experts and of the low level of knowledge on multipurpose trees constitutes a certain degree of danger emanating from use of trees. This is likely to lead to disappointing results and could discredit high potential species or even agroforestry as a potentially viable solution to land-use problems. However, the fact remains that multipurpose trees *are* used, as indicated by the many requests for advice.

In this situation, which requires all efforts to intercept an inappropriate use of multipurpose trees, there can be no doubt that field workers in rural development are important clients for the information services MUPOTAS can provide.

8.5 Internal Use of MUPOTAS at ICRAF

In ICRAF's approach to agroforestry, which is basically system-oriented, the increase of general knowledge on one of its important components (trees) will be useful to most programmes. Also certain aspects of multipurpose trees, which can be retrieved either directly from the data base or be provided in MUPOTAS's evaluation capacity may serve as a supplementary input to ongoing activities.

The support which can be provided by MUPOTAS is likely to be of particular relevance to the Technology, the Agroforestry Systems, the Field Station and the Collaborative Programmes. To some extent the training programme may also benefit from MUPOTAS, particularly in the Programme's efforts to develop training material.

8.6 Dissemination

In the attempt to make the best use of the data base, due consideration has to be given on how to effectively disseminate the information collected, stored and evaluated and on how best to meet the requirements of those who are interested in it.

8.6.1 Information packages

Until a higher degree of compatibility of the different data bases is achieved at a later stage, information on multipurpose trees will be offered in packages which will consist of

- core information retrieved and outprinted from MOPUTAS
- relevant supplementary information from other in-house ICRAF or external data bases (see Chapter 5.2).

These information packages will be presented either in a comprehensive form by bundling-up whatever information outprints can be produced on certain species or on groups of species, or can be composed in a way which responds best to individual and specific requests.

8.6.2 Individual information requests and "multipurpose tree crops sheets"

Apart from the permanent access all ICRAF Programmes or individual staff members have to the data base there are two ways of dissemination:

- o response to individual information requests in the form described above, and
- o the publication of "multipurpose tree crop sheets"

The latter will be designed in a standard format and are intended to find the widest possible distribution. They will contain in a condensed form information which, in its orientation to practical aspects and needs, will make it easier for field workers to use multipurpose trees in an appropriate and more site-adopted way in land management. Some of the elements contained in the "Multipurpose Tree Crop Sheets" are

- o visual "description" of the species (colour photos of tree habitus, of leaves, flowers and pods/seeds, and of bark/wood incisions);
- o distribution within and outside the natural range (map and verbal description);
- o seed information (reliable sources, number-weight ratio, pretreatment, germination etc.);
- o reproduction techniques;
- o uses (if possible related to regions);
- o management practices;

and others.

As more information and data are received and collected revisions of the "Multipurpose Tree Crop Sheets" are envisaged at intervals determined by the relevance of the new information.

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34. SANKHLA, N. et al. (1965). Phytoxic Effects of Acqueous Extract of Mesquite, Prosopis juliflora D.C. ("Current Science" Journal 1965)

35. SCHMUTTERER, H. et al. eds. (1980). Natural Pesticides from the Neem Tree (Azadirachta indica A. Juss), Proceedings of the First International Neem Conference, Rottach-Egern, F.R.G., 1980).

36. SIMPSOM, B.B. (1977). Mesquite, Its Biology in Two Desert Ecosystems

37. TURNBULL, J.W. (1983). Tree Seed Supply - A Critical Factor for the Success of Agroforestry Projects (Supporting Document for the MPT Germplasm Workshop in Washington D.C., June 1983)

38. WENTLING, M.G. (1983). Acacia albida: Arboreal Keystone of Successful Agro-Pastoral Systems in Sudano-Sahelian Africa (Cornell University)

39. WICKENS, G.E. and HACKETT, C. (1984). Three Draft Components for a Five-Component Paper (to be published in 1984)

MULTIPURPOSE TREE DATA SHEET

ICRAF
INTERNATIONAL COUNCIL FOR RESEARCH IN AGROFORESTRY
CONSEIL INTERNATIONAL POUR LA RECHERCHE EN AGROFORESTERIE
CONSEJO INTERNACIONAL PARA INVESTIGACION EN AGROSILVICULTURA
P.O. Box 30677, Nairobi, Kenya. Tel. 29867/332304. Telex 22048 Cable: ICRAF

EXPLANATORY NOTES FOR ANSWERING THE MULTIPURPOSE TREE DATA SHEET

1. In answering the Data Sheet **please be site-specific!**

2. **Please fill in Data Sheets only for those species with which you are familiar and which are of importance in the area you are concerned with.** This will hopefully make it easier and less time-consuming for you and provide us with the necessary site-specific information.

3. If the described species has been grown from seeds collected locally then the question "Source of Seeds, if known" (first box on front page) should be answered as, for example, "local, from vicinity of growing site". If the described species is from natural regrowth please state this. In other cases the country and location of seed origin should be stated according to documents received with the seeds.

4. The "Info-Reliability" is regarded as important by us. For each answer to the questions you are requested to use one or more capital letters (A-F) according to the code given on top of page 2.

5. Except for questions 1-9 and 21-27 for which specific data or information are required, only tick in the boxes ☐ wherever appropriate.

6. Questions 23-25: In case there are two "Growth Phases"/"Flowering-"/"Fruit Ripening"-periods per annum please enter these separately in the two boxes indicating the months (e.g. for "Growth Phases": 4(Apr.) - 6(June) in the first box and 11(Nov.) - 12(Dec.) in the second box; for "Flowering"/"Fruit Ripening": e.g. 9(Sept.) in the first box and 2(Feb.) in the second box. If there are more than two phases/periods per annum please enter details under "Comments" (26).

7. In questions 62-73 and 80-85 (Food, Fodder, Other Products) "Months of Harvest" are marked with "(1-12)", meaning January to December. Please note in the appropriate box the number of the correct month(s).

8. For questions 62-95 (Uses) a ranking of importance is requested only for the uses in the area you are concerned with, and/or for the site(s) where the described species grow. Only the first three most important uses may be ranked, 1 being the most important of all indicated uses.

9. **If, for whatever reasons, data and information requested under questions 1-61 are not available to you, please enter "n.d." in the appropriate box or space behind the respective question(s), unless questions are competitive (e.g. "evergreen" (34) versus "deciduous" (35/36) or "monoecious" (41) versus "dioecious" (42)) in which case a tick for the one question makes entry of "n.d." for the alternative question irrelevant.**

10. The box on page 4 ("Relevant Publications") should be filled in when you have access to lesser known but relevant publications or unpublished research results.

Species: Family:

Synonyms:

Vernacular Name (state language):

Location (nearest Town, Prov., Country):

Growing Site: Long: Lat.: Alt./m.:

Source of Seeds, if known (state location, country):

von Carlowitz
ICRAF, Oct. 1983

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Code for Info-Reliability:

A = Scientific Research/Measured
B = Case Study
C = Observation
D = Common Knowledge
E = Best Guess
F = Unknown/Unconfirmed

Bio-physical Data

		✓	Info-Reliability (see code)
1	Mean annual Rainf. (mm)		
2	nearest Met. Stat. at		
3	at altitude of ..... m.		
4	..... km from site		
5	Mean max. Temp. °C		
6	Mean min. Temp. °C		
7	Absol. min. Temp. °C		
8	Approx.av. depth of dry season ground water table in m		
9	Monthly Rainfall (mm)		

Jan.	Feb.	Mar.	Apr.	May	Jun.

Jul.	Aug.	Sept.	Oct.	Nov.	Dec.

Soil Texture

10	Heavy (clay)		
11	Medium (loam)		
12	Light (sandy)		

Soil Reaction

13	Acid (p.H. < 6.5)		
14	Neutral (p.H. 6.5-7.5)		
15	Alkaline (p.H. > 7.5)		

Drainage

16	Well drained		
17	Seasonal water logging		
18	Permanent water logging		

Other Soil Characteristics

19	Shallowness (< 50cm)		
20	Salinity		
21	Soil Type		
22	On which Soil Classification:		

Phenological Behaviour

		State month(s) (1-12) of		
23	Growth Phases			
24	Flowering			
25	Fruit Ripening			
26	Comments			

Morphological Characteristics

		✓	Info-Reliability (see code)
27	Average height of Tree/Shrubs at maturity, being ..... meters		
28	Generally single-stemmed		
29	Generally multi-stemmed (as at ground level)		
30	Special Characteristics (describe):		

Canopy

31	Dense		
32	Medium		
33	Open		
34	Evergreen		
35	Deciduous, dry season		
36	Deciduous, wet season		

Root System (cm)

37	Shallow Rooting 10-50		
38	Medium Rooting 50-100		
39	Deep Rooting > 100		
40	Others (state)		
41	Monoecious		
42	Dioecious		

Applied Reproduction

43	Direct Sowing		
44	Seedlings		
45	Coppicing		
46	Cuttings		
47	Others (state)		
48	Seed Pre-Treatment		
49	Inoculation		

Applied Tree Management

50	Coppicing		
51	Pollarding		
52	Lopping		
53	Grafting		
54	Budding		
55	Others (state)		

Other Characteristics

56	Shade tolerant		
57	Termite resistant		
58	Fire resistant		
59	Succulent		
60	Others (state)		
61	Problems (e.g. developing into weed) state		

	USES		Unit, (kg, gr, etc.)	Ann. Yield per tree	Month(s) of harvest (1-13)	Rank importance of use (1-3 1 = most imp.)	Info-Reliability (see code)	Remarks
	Food	✓						
62	Fruits							
63	Nuts							
64	Vegetable							
65	Oils/Fats							
66	Starch							
67	Spices							
68	Others (state)							
	Fodder							
69	Leaves							
70	Pods/Seeds							
71	Shoots							
72	Bee-forage							
73	Others (state)							
	Wood							
74	Fuel wood							
75	Charcoal							
76	Poles							
77	Timber							
78	Carvings							
79	Others (state)							
	Other Products							
80	Waxes							
81	Essential Oils							
82	Tannin/Dyes							
83	Gums							
84	Fibres							
85	Medicinal (state)							
86	Ornamental							
87	Others (state)							
	Service Uses							
88	Windbreaks							
89	Soil conservation							
90	Dune Fixation							
91	Live Fencing							
92	N-Fixing							
93	Mulching							
94	Hedgerow							
95	Others (state)							

Relevant Publications:

(Use separate sheet if necessary)

Informant

Name

Position

Address

Date

Please return filled-in Data Sheet to

Peter G. von Carlowitz
International Council for
Research in Agroforestry (ICRAF)
P.O. Box 30677
NAIROBI, Kenya

Thank you for your valuable co-operation

Module C.3, p.1

USES - CHECKLIST (by C. Hackett)

Species name and auth.: .....
..... Ref. no.: .....
Geographic region(s) covered by entries: .....
.....

DOMESTICATION (tick)

Grows wild and untended ..... Planted intentionally .....
Not planted, but tended ..... Commonly planted unintentionally (e.g. weed seed among crop seed) .....

USE/NON-USE

Past, present or potential uses (Y/N)? .....
If 'no', proceed to 'NUISANCE PROPERTIES' below.

PAST, PRESENT OR POTENTIAL USES (tick)

Chemical (not human consumption):

Alcohol, methane .....
Cosmetic .....
Dye, ink .....
Latex .....
Oil - illuminant .....
- lubricant .....
- perfume .....
Resin .....
Saponin .....
Starch .....
Tannin .....
Wax .....
Other (specify) .....
.....

Farming, gardening, landscaping:

Agroforestry (perennials only) ....
Animal feed or forage .....
Bactericide .....
Bee forage .....
Bird attractant .....
Compost .....
Cover crop .....
Fencing .....
Fire-quenching .....
Fungicide .....
Hedgerow .....
Herbicide .....
Insect attractant .....
Intercrop (separate rows) .....
Mixed cropping (not separate rows) ....
Mulch .....
Nitrogen fixation .....
Organic matter addition .....
Ornamental (intact plant) .....
Pest repellent .....
Pesticide .....
Shading - animals .....
- people .....
- plants .....
- structures .....
Soil binding or protection .....
Soil texture improvement .....
Windbreak .....
Other (specify) .....

Module C.3, p.2

USES - CHECKLIST cont.

Human consumption:

Colouring .....
Drinks, juice .....
Flavour, spice, condiment .....
Flour, meal, starch.....
Fruit (fresh and/or cooked) .....
Jams .....
Jellies .....
Masticatory .....
Medicine, pharmaceutical .....
Narcotic, stimulant .....
Nut .....
Oil-cooking, edible .....
Source of salt .....
Sweetener .....
Tenderiser .....
Vegetable, soup .....
Other (specify) .....
.....

Other uses:

Bee forage .....
Containers, wrapping, baskets .....
Fibre - clothing, textiles .....
- cordage .....
- paper, card .....
- sacking .....
Filling .....
Fuel (direct burning), charcoal ....
Ornamental (cut plant) .....
Poison, not pesticide .....
Rituals, ceremonies .....
Thatching .....
Timber - building .....
- carving .....
- furniture .....
- musical instruments .....
- tools .....
- toys .....
- weapons .....
Other (specify) .....
.....

NUISANCE PROPERTIES

Parasitic plant .....
Toxic to animals .....
Toxic to humans .....
Weed, potential weed .....

EXPLANATORY NOTES .....
.....
.....
Author(s) of entries (name, location, year): .....
.....
Author(s) of descriptors (name, location, year): C. Rackett, Canberra, Australia, 1983, with additions due to C.E. Wickens, Kew, U.K., 1983.
.....

The two large groups include Products and Influences. (by C. Budowski)

PRODUCTS

Wood	Industrial uses	lumber, chips, sawn timber, veneer, posts, etc. (also other industrial products such as destilates, extracts, derivates)
	local uses	posts, canes, rattans, handicraft, etc.
Burning	fuelwood	from stems branches, husks, etc.
	charcoal	from stems branches, husks, etc.
Food (includes beverages; consumed directly or processed)	buds	
	foliage	
	young stems (heart of palm)	
	fruits	
	flowers	
	starch	
	sap	
	rhizomes	
	other	
Fodder (feed)	foliage	
	fruits	
	flowers	
	branches	
	bark	
	trunk	
	other	
Exudation etc.	latex	
	resins	
	gums	
	tannius	
	ambar	
	other	
Thatching	leaves	
	wood	
	other	
Fibers	fruits (kapok, balsa, etc.)	
	bark (clothing, cordage)	
	branches (weaving, etc.)	
	other	

Medicinal products (pharmaceuticals)	Products harvested for drugs and similars including:	anticonceptives afrodisias horlocinogenous
Ornamental products (collars, bracelets, etc.)	seeds spines, etc.	

SERVICES (and INDIRECT GOODS)

Windbreaks or shelterbelts

Other favorable environmental climatic influences (includes microclimate, fog catchment, shade, etc)

Soil improvement (includes physical and chemical, e.g., water percolation, nutrient basis, etc.)

Erosion control

Dune fixation

Addition of organic matter to associated crops

Nitrogen fixation

Nutrient recycling mechanisms

Mulching

Compost

Weed control

Litter for cattle

Mushroom substratum

Live fence posts (wire attachment)

Live hedges

Property delineation

Firebreaks

Habitat for wild animals (includes harvesting of mammals and their products, hunting, etc.)

Basis for food chains (e.g., mangroves, palm swamps)

Other animal products

lac
honey
wax
silk
edible (starch of palms as feeding source)
larvae

Scientific values

Education values

Recreation values, etc.

QUESTIONNAIRE ON MULTIPURPOSE TREE GERMPLASM

(Including trees, bushes, palms, bamboos and vines)

CFI, Oxford, UK. APPENDIX 4

1 December 1982

Please type your answers to the following questions for each species used for multiple purposes in your country. You do not need to repeat the entire question, just show the number or fit your reply on to copies of this page if only one species.

1. Your name and official address

2. Species Latin name and authority

3. Local common names

4. To your knowledge are there any taxonomic difficulties in this species?

5. In your country what are the approximate limits of the natural distribution of the species (latitude, longitude and altitude)?

6. Have any systematic attempts been made to explore and sample the natural range (for seed, herbarium materials or other samples)? If so, by which organisation?

USES (Answer YES or NO)

7.	Unprocessed roundwood, poles, including rattan.	Yes/No	14.	Extractives	Yes/No
8.	Sawn timber	Yes/No	15.	Herbal, medicinal	Yes/No
9.	Firewood	Yes/No	16.	Honey	Yes/No
10.	Charcoal	Yes/No	17.	Silk	Yes/No
11.	Fodder	Yes/No	18.	Shelter (shelterbelts, windbreaks, shade trees)	Yes/No
12.	Fruit	Yes/No	19.	Soil stabilisation, watershed protection.	Yes/No
13.	Pulp and paper	Yes/No	20.A	Soil improvement.	Yes/No
			20.B	Others	Specify

PLANTATIONS (Estimate annual plantings in whole country)

21. Pure blocks (hectares)

22. Intercropped lines (number of trees)

23. Isolated trees (number of trees)

24. Has any silvicultural research been conducted on this species?

25. Is tree breeding practised with this species?

26. Are plantings established from seed or vegetative propagules?

SEED SUPPLY

27. Approximate number of seeds per kilogram

28. Approximate annual total weight collected by (a) farmers and other individuals (b) Government agencies (c) Commercial collection.

29. Names and addresses of commercial collectors

30. Does the current seed supply meet the demand?

31. Are there any problems that need special treatment? (a) seed storage (b) seed germination

PUBLICATIONS

32. Please list all your publications and reports dealing with any of the above aspects for this species.

PLEASE RETURN YOUR REPLY TO -

Dr J Burley
Commonwealth Forestry Institute
South Parks Road
OXFORD
OX1 3RB
ENGLAND

CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA, CATIE
Departamento de Recursos Naturales Renovables
Turrialba, Costa Rica, mayo 1983

CARACTERISTICAS DE ESPECIES ARBOREAS*

TAXONOMIA

1 Nombre científico: _____

2 Familia: _____

3 Sinónimos: _____

4 Nombres vulgares: _____

5 Países y/o región de origen: _____

6 Distribución en Centroamérica: _____

7 Exótica Exótica naturalizada Nativa

REQUISITOS ECOLOGICOS

8 Rango altitudinal: _____ m.

9 T.M.A. _____ a _____ °c 11 Bt. M.A. _____ a _____ c°

P.M.A. _____ a _____ mm 12 Tolera escarcha: si no

13 Meses secos: _____ (Base: _____)

14 Zonas de Vida (Holdridge)

bs-T bh-T bmh-T bh-P bmh-p bh-MB bmhMB bp-MB bmh-M

Otros: _____

15 Asociación: Climática Edáfica Atmosférica Hídrica

16 Sucesión: Primaria Aberturas Secundaria Fuego

17 Suelos:

	Profundidad	Textura	Drenaje int.	Fertil.	pH	Sal
Preferido	P R S	Ac F An	B R M	A M B		
No tolerados	P R S	Ac F An	B R M	A M B		

DESCRIPCION

Arbol

18 Raíces: Contrafuertes Zancos Neumatóforos Envuelvandas

19 Base: Cilíndrica Ensanchada Acanalada

20 Fuste: Monopodial Simpodial Múltiple Recto

21 Copa: Cónica Tabular Redonda Densa Abierta

22 Corteza: Lisa Lenticular Escamosa Fisurada Espinosa

23 Savia: Claro Blanco Amarillo Fragante Resinífera

24 Hojas: Alternas Opuestas Verticiladas Simple Paripinada ___ Imparipinada ___

Digitada ___ Aristada ___

25 Peciolo: Sesil Redondo Acanalado Alado Basifijo Peltado

26 Limbo: Acícula Escama Lámina _____

27 Apice: _____ Base: _____

28 Margen: Entero Sinuoso Crenlado Dentado Bidentado Pinatilobula Palmatilobula

29 Nervación: Pinata Palmata Curvata Paralela

30 Flor: Perfecto Monoecio Dioecio Solitario Inflorescencia _____

31 Fruto: Vaina Cápsula Baya Drupa _____

---

* Véase las intrucciones antes de comenzar.

MADERA:

32 Gravedad espec. _____ 33 Grano: Recto Sinuoso Enredo

34 Figura: Conspicuo Inconspicuo 35 Color duramen _____

36 Durabilidad natural: Bueno Regular Poco

37 Preservación: Fácil Regular Errática Difícil

USOS

38 Fija nitrógeno Forraje Rompeviento Cerco vivo Ornamental Conservación Comestible Sombra _____

39 Ebanistería Carpintería Contrachapada Artesanía Rústica Tablas sintetizadas Cajas Fósforos Pisos Leña Carbón Postes Resina Tanina Aceite Goma Durmientes

SILVICULTURAL

40 Pleno sol Tolerante joven Tolerante

41 Rebrote Siembra directa Raíz desnuda Envase Tocón Vegetativo

42 Fuentes de semilla _____

43 Semillas/kg. _____ 44 Almacenaje _____

45 Pretratamiento: Escarificación Agua caliente/agua fría Agua fría Estratificación _____ días a _____ °C

46 Germinan en _____ días 47 Planta en _____ meses

48 Poda: Necesaria Deseable Natural 49 Entresque: Necesario Deseable Natural

50 Rendimiento:

Edad	dap	h	m^3/ha/año	Espaciamiento y Raleos

51 Plagas y enfermedades: Común Ocasional Raro _____

52 Recomendaciones y Notas: _____

53 Referencias: _____

CBB/kaz

(From: "Baum - und Straucharten der Sahelzone unter bes. Berücksichtigung Ihrer Nutzungsmoeglichkeiten," by von Maydell, translated into English)

Data Sheet: FUELWOOD

Location: Date:

1. Interviewed:

Individuals

Households (No. of persons)

Enterprise (No. of employees, production)

.....

Comments:

---

2. Consumption:

Fuelwood only

Predominantly

Less

None

Quantity per week	Unit	conversion	Kg
Fuelwood			
Charcoal			
.....			
.....			
.....			

Comments:

---

3. Seasonal Distribution

At what time fuelwood is needed?

why.....

At what time shortages occur?

why.....

Comments:

---

4. Utilization for Fuelwood/Charcoal: Ranking of Species

Positive (favoured)		Negative (rejected)	
Tree Species	Why	Tree Species	Why
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....

5. Fuelwood-Quality/Dimensions

Dead wood — Green wood

Stem — Branches, stickwood

Re-used wood

Used air dried? Yes — No — Varies

Cut to pieces Yes — No — Varies

Dimensions, respectively weight:

Comments:

6. Procurement of Fuelwood/Charcoal

Free of charge — against payment — against other substitutes

Costs..... — which kind.....

how much.....

Procurement from where?.....

Legal/other Restrictions.....

Who procures?.....

How is fuelwood transported?.....

Time required daily / weekly / periodically.....

Storage? Yes No

Comments:

7. Use (of fuelwood)

Where/how often

1. Cooking	-	household community commercial		open fire cooker permanent fire place
2. Heating	-	Yes	No	When.....
3. Commerical Purpose	-	What for 1. 2. 3.		
4. Sales		Quantity/time unit (e.g. per week)..... Location (e.g. market place)..... Annual season..... Species/Charcoal..... Price per Unit.....		

Comments:

---

8. Effects of Availability/Use as seen by the Interviewed:

1. Supply situation
2. Employment situation
3. Social effects
4. Environment
5. Forest vegetation
6. Other forms of vegetation
7. Soils
8. Economy

Comments:

---

9. Estimates of Trends with Regard to Supply/Demand as seen by the Interviewed:

---

10. Recommendations of the Interviewed for practical Activities:

11. Recommendations of the Interviewed for practical Activities:

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APPENDIX 7

ENVIRONMENTAL REQUIREMENTS OF SELECTED NFT SPECIES

SPECIES	CLIMATIC ZONE(S)	MINIMUM RAINFALL	DRY SEASON TOLERANCE	ELEVATION RANGE	TEMP. RANGE	SOIL REACTION	OTHER LIMITATIONS
Acacia auriculiformis A. Cunn. ex Benth.	HT, SH,	1300mm	4-6 months	0-600m	20-30C	strongly acid - highly alkaline	low wind tolerance
Leucaena diversifolia (Schlecht.) Benth.	HT, SH	500mm	4-8 months	0-1500m	18-30C	moderately acid to alkaline	unknown
Sesbania grandiflora (L.) Poir.	HT	1000mm	2-3 months	800m	24-30C	limits not reported	susceptible to wind damage
Pithecellobium dulce (Roxb.) Benth.	A, SA	450mm	6-8 months	0-1800m	20-30C	no limitations reported	windthrow danger,
Leucaena leucocephala (Lam.) De Wit	HT, SH	600mm	4-8 months	0-1000m	20-30C	moderately acid - mod. alkaline	strongly acid soils, waterlogging
Acacia albida Del.	A	300mm	extended	na	na	na	na
Acacia confusa Merr.	HT, SH	750mm	na	na	na	acid soils	na
Acacia farnesiana (L.) Willd.	A	na	na	na	na	wide adaptability	na
Acacia mangium Willd.	HT, SH	1000mm	na	na	na	moderately acid	na
Acacia mearnsii Willd.	TH	500mm	2-3 months	1500-2500m	12-18C	neutral to acid	moderately frost susceptible
Acacia nilotica (L.) Willd. ex Del.	A	na	extended	na	na	na	na
Acacia saligna (Labill.) H.Wendl.	HT, SH, A	300mm	na	0-300m	13-30C	acid to alkaline	na
Acacia senegal (L.) Willd.	A	200mm	extended	100-1700m	14-43C	na	na
Acacia tortilis (Forsk.) Hayne	A	100mm	extended	lowland	na	na	na
Albizia falcataria (L.) Fosberg	HT, SH	1000mm	0-2 months	0-1200m	20-34C	neutral to acid	na
Albizia lebbek (L.) Benth.	A, SH	600mm	2-6 months	0-1600m	20-36C	neutral to acid	na
Alnus acuminata O. Kuntze	TH	1000mm	na	1200-3200m	4-27C	na	na
Alnus glutinosa (L.) Gaertn.	T	500mm	na	na	na	na	na
Alnus nepalensis D. Don	TH, T	800mm	na	1000-3000m	na	na	na

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ENVIRONMENTAL REQUIREMENTS OF SELECTED NFT SPECIES

SPECIES	CLIMATIC ZONE(S)	MINIMUM RAINFALL	DRY SEASON TOLERANCE	ELEVATION RANGE	TEMP. RANGE	SOIL REACTION	OTHER LIMITATIONS
Cajanus cajan (L.) Millsp.	A, SH	400mm	na	na	na	na	na
Calliandra calothyrsus Meissn.	HT, SH	1000mm	na	0-1500m	na	na	na
Casuarina cunninghamiana Miq.	TH, T	500mm	na	na	na	na	na
Casuarina equisetifolia L.	HT, SH	750mm	3-4 months	0-1400m	10-35C	alkaline to neutral	na
Casuarina glauca Sieb. ex Spreng.	A, SA, HT	na	na	na	na	na	na
Casuarina junghuhniana Miq.	HT	na	na	na	na	na	na
Dalbergia sissoo Roxb.	A, SH	500mm	3-4 months	0-1000m	na	na	na
Erythrina berteroana Urban	HT	na	na	to 2000m	na	na	na
Erythrina fusca Lour.	HT	na	na	to 1500m	na	na	na
Erythrina poeppigiana (Walpers) O.F. Cook	A	na	na	na	na	na	na
Gliricidia sepium (Jacq.) Steud.	HT, SH	1000mm	4-6 months	0-1600m	22-30C	na	na
Inga vera (L.) Britton	HT, TH	1000mm	na	lowlands	na	na	na
Intsia bijuga (Colebr.) O. Kun	HT	2000mm	na	na	na	na	na
Mimosa scabrella Benth.	TH	na	na	to 2400m	na	na	na
Parkia javanica (Lam.) Merrill	HT	na	na	0-700m	na	na	na
Parkia speciosa Hassk.	HT	na	na	to 1500m	na	na	na
Parkinsonia aculeata L.	A	200mm	6-9 months	0-1300m	na	na	intolerant of waterlogged soils
Pongamia pinnata (L.) Pierre	A	500mm	na	0-1200m	na	na	na
Prosopis alba/chilensis 'complex'	A	200mm	8-11 months	to 2900m	na	na	intolerant of moderate (-5C) frost
Prosopis cineraria (L.) Druce	A	100mm	8-11 months	lowlands	na	neutral to highly alkaline	na

Draft - Not for quotation or publication

"PLANT SPECIES WITH ANTI-PEST PROPERTIES"

[a computerised database]

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COMPUTER DATABASE FOR PLANT SPECIES

WITH ANTI-PEST PROPERTIES

FAMILY	SPECIES	AREA	PLANT PART	PEST	FUNCTION
MALVACEAE	HIBISCUS ABELMOSCHUS L.	AFRICA	FRUIT	INSECTS	INSECTICIDE
MALVACEAE	HIBISCUS ESCULENTUS L.	INDIA	TRAP CROP AROUND COTTON	INSECTS	ATTRACTANT
BALANITACEAE	BALANITES ROXBURGHII PLANCH.	INDIA	POWDERED BARK	INSECTS	INSECTICIDE
ZYGOPHYLLACEAE	PEGANUM HARMALA L.	INDIA	ROOTS	LICE, MOSQUITTOES	INSECTICIDE, REPELLENT
EUPHORBIACEAE	ACALYPHA INDICA L.	INDIA	CRUSHED LEAVES	WOUND MAGGOTS	REPELLENT, INSECTICIDE
EUPHORBIACEAE	ANGRACHNE OVALIS MUELL.	AFRICA, INDIA	MILK INFUSION	FLIES, LICE	INSECTICIDE, REPELLENT
EUPHORBIACEAE	DISCOGLYPREMNA CALONEURA PRAIN	AFRICA		LICE	REPELLENT, INSECTICIDE
EUPHORBIACEAE	EUPHORBIA ANTIQUORUM L.	INDIA	SAP	WOUND MAGGOTS	REPELLENT, INSECTICIDE
EUPHORBIACEAE	EUPHORBIA BALSAMIFERA AIT.	AFRICA	LATEX	TSETSE FLIES	REPELLENT
EUPHORBIACEAE	EUPHORBIA LATERIFLORA SCHUM &THONN.	AFRICA	SAP	LICE, CHIGGERS	REPELLENT, INSECTICIDE
EUPHORBIACEAE	EUPHORBIA NERIIFOLIA L.	ASIA, INDIA	SAP	WOUND MAGGOTS	REPELLENT, INSECTICIDE
EUPHORBIACEAE	EUPHORBIA THYMIFOLIA L.	INDIA	OIL	HOUSE INSECTS	REPELLENT
EUPHORBIACEAE	EUPHORBIA TIRUCALLI L.	INDIA	WOOD	INSECTS	INSECT REPELLENT
EUPHORBIACEAE	JATROPA CURCAS L.	AFRICA, ASIA	LEAVES	INSECTS	INSECTICIDE
EUPHORBIACEAE	MACARANGA HYPOLEUCA MUELL.	ASIA	STEMS	INSECTS	INSECTICIDE
EUPHORBIACEAE	MANNIHOT UTILISSIMA POHL.	AFRICA	PULP	INSECTS, WOUND MAGGOTS	REPELLENT
EUPHORBIACEAE	OLDFIELDIA AFRICANA BENTH. & HOOK.	AFRICA	BARK, LEAVES IN OIL	LICE	REPELLENT, INSECTICIDE
EUPHORBIACEAE	RICINUS COMMUNIS L.	AFRICA, INDIA, S.AMERICA	SEEDS OIL	INSECTS, FLIES, C YBYTES, MYAEMAS, PREDATORS	INSECTICIDE, POISON
EUPHORBIACEAE	SAPIUM ELLIPTICUM PAX.	AFRICA	DRIED LEAVES	WOUND MAGGOTS	REPELLENT, INSECTICIDE
EUPHORBIACEAE	SPONDIANTHUS PREUSSI ENGL.	AFRICA	BARK, SEEDS	RATS	POISON
EUPHORBIACEAE	TOXICODENDRON CAPENSE THUNB.	AFRICA	SEEDS IN CARCASSES	FLOCK PREDATORS	POISON
THEACEAE	CAMELLIA SINENSIS (L.) O.KUNTZE	ASIA	SEED CAKE	INSECTS	INSECTICIDE
ERICACEAE	AGAURIA SALICIFOLIA (OLIVER) HOOK.F.	AFRICA	INFUSION	BEETLES, INSECTS	INSECTICIDE
HYPERICACEAE	PSOROSPERMUM BAUMII ENGL.	AFRICA	ROOTS IN WASH	LICE	REPELLENT, INSECTICIDE
HYPERICACEAE	PSOROSPERMUM GUINEENSE HOCHR.	AFRICA	BARK, ROOTS IN SEED STEEP	BIRDS	POISON
HYPERICACEAE	SYMPHONIA GLOBULIFERA L.	AFRICA	RESIN	SKIN PARASITES	REPELLENT
CLUSIACEAE	GARCINIA KOLA HECKEL	AFRICA	SAP	SKIN PARASITES	REPELLENT
CLUSIACEAE	MAMMEA AFRICANA G.DON	AFRICA	SAP	SKIN PARASITES	REPELLENT
MYRTACEAE	ECALYPTUS GLOBULUS LABILL.	AFRICA, INDIA	LEAVES	INSECTS	REPELLENT
MYRTACEAE	MELALEUCA LEUCADENDRON L.	AFRICA, INDIA	SEEDS OIL	MOSQUITTOES	REPELLENT
BARRINGTONIACEAE	BARRINGTONIA RACEMOSA ROXB.	AFRICA, ASIA	BARK	INSECTS	INSECTICIDE
MELASTOMATACEAE	DINOPHORA SPENNEROIDES BENTH.	AFRICA	INFUSION FOR WASH	LICE	REPELLENT, INSECTICIDE