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Cover Photo: *Juniperus* spp., Taurus, Turkey (Photo: Pierre Sigaud, FAO)

All contributions for the next issue should be sent by 15 June 2001 to:

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NOTE FROM THE EDITOR

The year 2000 is an important baseline for a number of forest-related studies including the FAO coordinated Global Forest Resources Assessment (FRA 2000), to be released at the 15th Session of the Committee on Forestry in March 2001. The FRA 2000 estimates of forest cover and change are based on available national reports, verified in expert meetings and scrutinised through expert advice; information on forest cover change is also supported by remote sensing studies. While deforestation is still very high, the trend towards slowing down, noted already in the interim assessments of 1997 and 1999, has been confirmed (see information in this issue).

In addition to being linked to a number of related forest genetic resources and forest biological diversity related information systems, the FAO World Wide Information System on Forest Genetic Resources, REFORGEN, recently made available on the Forest Genetic Resources Homepage, will in the future be electronically linked to FRA Home Pages. Information provided through REFORGEN, coupled with forest resources data provided by FRA, will help underpin national policies and support decision-making and priority setting in forest genetic resources activities at national, regional and global levels. An up-date on REFORGEN is given in the article by Søren Hald. The article by Namkoong in this issue reviews general principles of priority setting.

The information presently lodged in REFORGEN is far from complete. The regional and sub-regional workshops on forest genetic resources which FAO is supporting in collaboration with international partners, will provide one mechanism to review, up-date and complement such information. Workshops have, to date, covered forests of the boreal zone, temperate North America and Europe (all organized in 1995), the Sahelian and North Sudanian zones of Africa (1998), the South Pacific (1999), and Southern and Eastern Africa (2000). A report on the latest workshop can be found in the present issue, in addition to an up-date on follow-up to the South Pacific workshop (see articles by Sigaud/Luhanga and by Kanawi Pouru).

A topical issue in today's debate is the place and role of new technologies, notably genetic modification, in plant breeding. Earlier this year, FAO organized a series of e-mail conferences on biotechnologies in crop, animal, fish and forest genetic resources. The article by Yanchuk, who has worked with the forest genetic resources team at FAO Headquarters, Rome, over the past 8 months in capacity of Visiting Scientist, summarises the outcome of the forest genetic resources conference.

Other articles review action by FAO partners IPGRI and ICRAF, and by national institutes in some FAO member countries in Africa, Asia and Latin America. Nutshell information on activities of the Convention on Biological Diversity (CBD), with special reference to its working group on forest biological diversity and the close collaboration between the CBD and FAO in this field, is also provided.

In his report to the Millennium Assembly of the United Nations entitled, "*We the Peoples: the Role of the United Nations in the Twenty-First Century",* Secretary-General Kofi Annan noted that the United Nations must increasingly serve to stimulate collective action at the global level, and to catalyse such action both among its Member States and between them and the vibrant constellations of new non-state actors. These principles should underpin our future work in forest genetic resources and will inspire ever greater, joint efforts in the coming Millennium.

Contributions from readers, not exceeding 2000 words, are welcome for future issues. The Secretariat maintains the right to edit material accepted for publication.

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ABDOU SALAM OUÉDRAOGO (1957-2000)[1]
- in memoriam-

Our friend and colleague, Abdou Salam Ouédraogo, Burkina Faso, died in an air crash off the coast of Côte d'Ivoire in January 2000, while on duty travel in Africa. Abdou Salam, who was only 43 years old when he died, was the first full-time IPGRI forest genetic resources scientist, and acted in that position from 1995 to 1999. In 1999, he was promoted IPGRI Regional Director for Africa.

Abdou Salam Ouédraogo received his PhD from Wageningen, Netherlands, where he worked on *Parkia biglobosa*, a dry-zone multi-purpose tree species widely used by local communities in his native Sahel. Abdou Salam's first concern was always the people living in, around and of the forest, and it was very telling that he chose *Parkia* for further study and as the focus for his thesis. The thesis included an important component on socio-economic aspects in the conservation and use of this important species.

Abdou Salam Ouédraogo was the Founding Father of the Tree Seed Centre in Burkina Faso. During his lifetime, he also carried out a great number of international assignments, and worked with IUFRO, IPGRI, FAO and others. Among his many important assignments and tasks, Abdou Salam Ouédraogo acted as Member of the FAO Panel of Experts on Forest Gene Resources, covering forest genetic resources aspects and issues in countries of the Sahel prior to joining IPGRI.

Abdou Salam Ouédraogo helped raise awareness in developing countries, especially those in his own region of origin, the Sahel, of the need to conserve and sustainably utilize forests and woodlands, and of the opportunities and the pressing need to harmonize conservation with sustainable resource utilization. His efforts contributed decisively to strengthened technical interest and policy level support to the field of forest genetic resources in national and international fora.

Abdou Salam Ouédraogo was sincerely convinced of the value of collaboration at national, regional and global levels, and was a strong and tireless alley of FAO's work in the forest genetic resources field. Abdou Salam's strong affinity with FAO was much appreciated: he helped further strengthen working relations and collaboration between IPGRI and FAO, and facilitated common and complementary efforts of these two institutions in support of work carried out in the forest genetic resources field by national institutes in developing countries.

In addition to being an excellent professional, Abdou Salam Ouédraogo was a wonderful and warm person, and an appreciated friend of those he knew personally. His firm belief and faith in a better future for all, especially for the less endowed, was convincing and contagious.

We will continue to work towards common global goals in the forest genetic resources field supported by the foundations of Abdou Salam's past work and inspired by remembering, always, his big and immediate smile.

[1] Adapted from talk given by Christel Palmberg-Lerche, FAO, at the Symposium, "*In situ* Conservation of Tropical Arboreous Species", held in honor of late Abdou Salam Ouédraogo (IPGRI). 46th National Genetics Conference. Simposio 11. Águas de Lindóia, S.P. (Brazil). September 2000.

DECISION MAKING IN GENE CONSERVATION[1]

by

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Is there a rational way to make mistakes?

We obviously don't intend to make mistakes but we also have to admit that we are fallible humans and that we have little time, funds, and personnel with which to execute a conservation program. We also generally lack precise information on which of the genetic resources that reside in populations and species are most likely to suffer irreparable loss and we can't predict with accuracy, how effective our efforts to conserve will be. Therefore, we will not always select the most efficient course of action to save the most valuable of the genetic resources, with the management resources we have available. There can be no question that we will fail to be most efficient, and no question but that we will make mistakes in allocating our efforts. But is there a way to direct our allocation of effort, before we have complete information, so that we can minimize the expected effects of the mistakes we do make?

If we first admit to ourselves as well as to our supervisors that we will make mistakes, we can begin to identify the kinds of mistakes we are likely to make. Among the kinds of errors we will make will be those in which we try to save a certain genetic resource that does not need our efforts, would have survived anyway, and thereby waste our own precious time, effort, and funds. We will also make mistakes wherein we will fail to make efforts where we might be able to avoid loss of a valuable population or species. We will put large efforts into saving one population or species and not put effort on a more valuable resource. Obviously, it is not our intention to do so, but because we are ignorant of what is more at risk than another, and what values are exposed to risk, it is inevitable that errors of omission and of commission will be made. We must therefore admit that some resources will be saved regardless of whether we act or not, and some will be lost, also regardless of our actions. But we might be able to put effort where it counts. The question is how can we use whatever information we do have to best advantage.

The second admission we must make to ourselves is that we are usually not entirely ignorant of the risks and values that are involved and that we may be able to minimize the chances of making costly mistakes. We have choices to make, and we are obligated to using the information we have, as well as we can, to use our time, effort, and funds, to manage our risks. To this extent, we can answer the question posed above in the affirmative. Yes, there are rational ways to approach decision making so that the anticipated costs of making mistakes are as small as we can make them with the information we have at hand or can obtain.

RISK

One approach is to first understand what we feel about the nature of risk to genetic resources. As biologists or geneticists, we often think about how species or populations are at risk of extinction or of substantial change and reduction such that their conservation (*in situ* or *ex situ*) is warranted. We may also think about the safety and availability of genes for future contingencies and what the sizes and location of populations need safeguarding. Since genetic resources are subject to the forces of evolution; namely mutation, migration, drift, and selection, we have to be concerned about how those forces may affect regeneration and the future condition of the resource. For these reasons, it is useful to have studies of the structure of the genetic resource to better target conservation efforts. We can often estimate what the population size is and perhaps can account for uneven reproductive success, by estimating the type and distribution of mating behaviour and seedling success. If we have information on pollen and seed vectors, and on changes in environmental selective forces, we can also

[1] Received Jan. 2000. Original language: English

estimate the effects of selection. Good biological studies reduce the errors of estimating the susceptibility of a resource, but can never totally eliminate error.

Even in the absence of studies, we can still obtain indirect information and can base estimates of susceptibility of the resource to different threats. This kind of information is always imperfect but even without field tests, or marker studies, we usually have some information about how the resource may be endangered by changing forest conditions. This kind of information about the resource tells us what its susceptibility is.

In addition to considering susceptibility, some genes, populations, or species may be more at risk than are others not only because their inherent properties dispose them to problems, but because environmental threats are more likely to expose their vulnerabilities. For example, large fires may be likely to occur or clear cutting may be expected, and would be a threat to species susceptible to such forms of removal. For species that are dependent on vegetative cover for regeneration or that are sensitive to high insolation, that threat may greatly increase the likelihood of population loss in that area. However, for some pioneer species with a seed bank or with a large immigrant pool, the threat may not lead to population loss or reduced regeneration. For some species with many sub-populations, the threat to a small centrally located one that can be easily re-colonized may not be serious to the species, but the same threat may be serious to one located in an isolated and peripheral site.

Threats to forests may be of several types, including grazing, over-harvesting non-timber forest products, selective excessive logging, as well as the more obvious types of large-scale destructive events. For each of these, the probability of occurrence and the probability that each of the threatened genes, populations, or species, would be significantly susceptible to the threats must be included in considerations of risk. In this terminology, the concept of risk combines both susceptibility and threat where susceptibility can be estimated from knowledge of the distribution of genes in populations or species, and their life histories, and threat can be estimated by expected forest practices.

As in all biological problems, these risk estimates are only estimates, and the probability that the risk is exactly as we may guess, is not actually a fixed number. There is finite probability that the actual risk is higher or lower for one resource vs. another, and especially in cases where the genetics of the resource is not well known, we may want to be more conservative in rating risk than if we had more information. The value of further research in this framework is that by further field-testing or with marker data, we can give a closer estimate of the actual risk. Information does not change the actual risk to the resource; it reduces our uncertainty about the risks that we might be able to reduce by management. Information may be useful to indicate how management can be more effective, but in these risk calculations, the value of information lies only in giving better risk estimates.

Our attitudes toward risk is often more complex than we can easily model. We may feel that if risks lie below a certain level, that we can ignore small differences such as between 5% to 25%, and that at very high levels, such as between 75% and 95%, they are equivalent. But we may feel very sensitive to differences between 40% and 60%. We may also feel sensitive to risks above 50%, but not below that and we would want to be able to adjust the importance of actions accordingly.

VALUATION

Another factor to consider in weighing a course of action is whether the loss of the resource carries much of a penalty to any of the forest users. The penalty may be in lost opportunities to improve crops or in losses to income, or in losses to ecosystem health and general forest productivity. This is one of the most difficult questions for a conservation officer to face since we often lack simple measures of value. Many of the values of conservation cannot be measured well, if at all, in economic terms, and rarely would market determinations be useful. In forests, there are multiple features of the ecosystem that are valued including direct income, aesthetics, environmental buffering, and symbolic and religious values. In addition, different parts of society evaluate aspects of the resource in vastly different ways and make it impossible to derive any single measure of value. This is a profound problem that can only be approached in democratic societies by discussion that respects all parties. This is not a topic that can be usefully discussed here, but is necessary for any of the following systems of analysis to be effective. For our purposes, we assume that we can find a relative value for different genes, populations, and species, and can somehow derive an agreed upon score for value.

We might note that at this time, at least one aspect of value is estimable by markets and that national conservation programs often use such values intuitively for estimating the value of conservation. On the other hand, many NGO's and government organizations concerned with the environment estimate value by ecological status. They may target the rare resource, or the resource that supports many other resources, or focus on those that may be most sensitive to threats, or those that indicate the presence of threats, or those that are most widespread. These kinds of resources may be termed keystone, indicator, or flagship resources, that would be targeted for attention. While more complicated and difficult, it is possible to derive estimates of combined, multiple values as long as scores can be derived for single values.

MANAGEMENT

Finally, another factor to consider in decision making for conservation is how effective we think that management can be. For some conservationists, the management options may involve only locking up the resource in some kind of reserve, or leaving it alone. The decision is to make a reserve or not and the problem for the conservationist is to estimate the relative probability of the sufficient survival of the resource with and without a reserve. For other conservation programs, more options may be available but each with their own cost and probability of achieving the various values produced. The benefit of each option may then be estimated for both present and future values.

Presumably, each management option would not only engender a cost and benefit, but it would change the risks to the resource. Obviously, we anticipate that the expected risk is lowered, and perhaps the uncertainty of the outcome is also reduced, but for each option, we assume that we can estimate what management can do for us. We also assume that with multiple resources to consider, that a total combined evaluation can be made for a finite set of management options.

DECISION ANALYSIS

With the kinds of information outlined above, we can try to make decisions that will be logically consistent and transparent. There may be many other factors that impinge on the decisions we make, such as the need to retain political support for conservation. However, we would not want our decisions to be only based on ephemeral or popular whims that pass every few years that have no lasting impact on the resources we wish to conserve.

One principle for conservation management that seems to be useful is to direct effort to those resources that are most valuable, at most risk, and most effectively manageable.

If a resource is easily replaceable then its loss may be of small impact economically, ecologically, or otherwise. If a resource is not at risk, then efforts may be wasted on trying to save something that would be saved without effort. And if management cannot do much to increase security because the techniques that can be applied are ineffective, then expending effort is also a waste of resources that could be more beneficially spent elsewhere. We would like to put our efforts into those cases where we can be most effective in relieving the highest risks to our most valued resources.

On the basis of that principle, we can analyze different management options and estimate what efforts would be feasible to consider. One way to arrange thoughts on decision making is to consider a sequence of actions and events and the likely outcomes that each sequence can take, and then evaluate what actions lead to the best or most acceptable results. This is not the only way, but it openly displays a decision process and can be illustrated by a simple example. Consider first that the reproduction of a potentially valuable population is susceptible to drastic reduction in regeneration capacity due to the threat of wildfire. We may have three action possibilities; increase seedling survival by clearing openings for seedlings, increase fire protection, or do nothing. The first two may have equivalent costs and be equally effective, so we leave that decision to the field manager and consider only the options of managing or not managing. We then consider what we expect would to happen under two action scenarios and the probabilities and costs if a fire occurs or doesn't occur.

Obviously, there are great uncertainties about the probabilities, but if we know anything, we can certainly estimate that the probability of decreasing risks by management is greater than if we did nothing. The issue is to estimate the degree by which we can reduce risk and if its cost would be worth it.

For illustrative purpose, let us assume that the value of a population is 100 units and the management efforts will cost 14 units. Also, let us assume that the probability of a fire occurring is 0.5 and the probability of the population surviving with no intervention is 0.5. However, if management can improve reproduction and increase minimum effective population size, the probability of survival in spite of the fire may be 0.7. If no fire occurs, we assume that the probability of survival is 0.95. Then the expected value consequent to management can be calculated as follows: 0.5 * 0.7* 100) + (0.5*0.3* 0) + (0.5*0.95*100)+(0.5*0.05*0) – 14 = 68.5 units. So the expected value of the management, when there is no information available to begin with, is 68.5 units.

On the other hand, if we don't manage the expected value will be 72.5 units (See Fig 1). This shows that with the assumed level of survival after management, the cost of management, and the value of the population, the better decision is to not go to the expense of management.

The above estimate of management is *a priori* and does not account for what a field conservator knows about the local situation. We can see what the effect of better management is on our decision by changing some parameters. Let us therefore say that based upon field evaluation, the conservator can give us better judgements on how management can be effective, say by supplementing the pollen or source. The probability a fire occurring may still be 0.5, but now by better management, the probability of saving a population is 0.8 in spite of occurrence of fire. Now the rate of fire doesn't change, but we can allocate effort better and now apply management when it is needed. We will still make mistakes and apply management and fail but now only with 0.2 probability. The expected value of management will be 73.5 units compared with 72.5 units for no management option indicating that management is a better option (Fig 2).

Let us assume a third case in which little information is available as in case 1 above, but can be collected at a cost. This third option is to collect additional information before making the decision to manage (Fig 3). In that case, the increase in research or other data analysis system would presumably change the probabilities for making the correct decisions. Suppose for example that research on the actual genetic structure of the population gives us more accuracy in predicting which populations are truly susceptible, and those that are not. In that case, the probability of suffering a loss when management is exercised and a fire occurs is lower because we manage when it is necessary. Now the probability of making the management effective may go to 0.9. Even when we make a decision not to manage, as it is based on more information, probability of survival after a fire incidence will be increased, say to 0.6. However, new information collection bears costs in terms of time and research. If we consider the cost of the additional information is 5 units, the expected value of managing after collecting additional information is 73.5 units. The increased expected value for new information option makes it a better decision to follow. We can now see what the judgement should be if extra information is useful even at a cost to the manager.

CONCLUSIONS

There are many options that can be constructed for estimating the value of multiple management choices. We can include sequential stages of events and decisions by adding more branches to the decision tree and can include more management options by adding to the number of branches at each node. It is possible to include a decision to delay decision until further information can be obtained, such as by research on the genetic structure or mating structure of populations and some are sketched in by Koshy et al, (2000)[2]. There are also ways to evaluate choices when multiple values are involved in making decisions about conservation.

These kinds of decision tools can help to rationalize how we can use information to increase our expected effectiveness. They are not tools for making the problems themselves any simpler or for resolving difficult problems in obtaining the estimates of susceptibilities and threats. It is obvious that the factors of

[2] Mathew P. Koshy, Gene Namkoong, Paulo Kageyama, Andre Stella, and Flavio Gandara 2000. Decision-making strategies for conservation and use of forest genetic resources. In Proceedings of the International Conference on Science and Technology for Managing Plant Genetic Diversity in the 21st Century. 12-16th June 2000, Kuala Lumpur, Malaysia (in press)

biology that make up susceptibility are not independent and that the factors that constitute real threats are also no independent. Nevertheless, means exist for us to rationalize decision-making and to make honest mistakes, but to minimize their costs. Decision trees help to visualize the logical processes that we sometimes use intuitively, but make them more transparent to ourselves and to others.

EFFORTS IN THE CONSERVATION AND SUSTAINABLE USE OF FOREST GENETIC RESOURCES IN THE NEAR EAST[1]

by

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BACKGROUND

The Near East region is characterized by a wide variety of climatic and geographic environments. On one extreme the region is differentiated by high mountain ridges receiving more than 1000 mm precipitation annually, and on the other extreme by the deserts and semi-deserts with an annual precipitation of less than 200 mm. These features, together with the long history of human settlement, have had a profound effect on the biological diversity in this region. A wide range of ecosystems, including forest ecosystems, can be found. These forests and woodlands play a fundamental role in soil, water and environmental conservation, and are also important for the provision of many basic products and services. A considerable amount of the commercialized fruit and nut trees, for example, originate from this region. Many of their wild relatives (e.g. wild pear, wild pistachio and wild olive) can still be found in their natural environment, serving as a valuable genetic base. Coordinated research and protection efforts are already underway in some Central Asian countries towards the conservation of the genetic diversity of wild fruit and forest tree species.

However, due to overexploitation, deforestation, habitat fragmentation, overgrazing and forest fires, these resources are highly degraded throughout the region. Although several countries have put considerable efforts in conservation actions and the awareness of the need to act is growing, the focus is mainly on ecosystem conservation. Much less attention has been paid so far to the issue of conservation and sustainable use of the forest genetic resources (FGR).

INTRODUCTION

In recognition of the importance and the alarming status of the forest genetic resources in the Near East, IPGRI's Global Forest Genetic Resources Program expanded its activities to this region in the beginning of 1998. The objectives of the FGR research program in Central-West Asia and North Africa are (1) to strengthen existing, or promote the establishment of, national Programs on Forest Genetic Resources, and (2) to promote the development of conservation and sustainable use strategies for FGR.

Since the experiences with FGR conservation are limited in the Near East, IPGRI decided to focus its collaboration on two pilot countries. Syria was selected, because of the country's request for technical assistance and need for information on its FGR in order to improve its efforts in afforestation and reforestation. Given Lebanon's concern and active involvement in the conservation of the country's forest resources, this country was chosen as second pilot country.

Forest Genetic Resources Workshops

Priority setting for FGR conservation and use is essential for the efficient allocation of limited resources of time, funds and personnel. Ideally, this priority setting should be done by all stakeholders to ensure optimal support and cooperation. Therefore, IPGRI contributed to the organization of two workshops, respectively in Lebanon and in Syria, on priority setting for FGR research activities, in 1998. The objectives of these workshops were: 1) to identify, and discuss with, relevant national partners, 2) to assist them in the selection of priority species and 3) to help develop a research framework for the conservation and sustainable use of FGR.

[1] Received May 2000. Original language: English
[2] IPGRI Regional Office for Central-West Asia and North Africa, c/o ICARDA, Aleppo, Syria; email: t.bazuin@cgiar.org

In total 28 participants attended the two workshops, representing a broad range of national organizations and institutes involved in forestry or forest related areas. In the first session the participants expressed the need for, and their strong interest in, information collection and management on FGR. This need for better information is linked with the increasing efforts towards the conservation and sustainable and management of forests. Although the current conservation activities focus on ecosystem level rather than species level, there is also an increasing interest in a more targeted, species oriented approach for the benefit of rural communities and farmers, and national forest services.

Selection Criteria Proposed during National Workshops

Associated species
Ecozones in which the species can be found
(Potential) socio-economical value
Ecological value
Distribution pattern of the species and its populations
Distribution pattern of its genetic variation
Threats imposed on the species
Conservation status
Reproductive biology
Presence or absence of baseline information

Figure 1: Set of possible selection criteria proposed during national workshops

Selecting priority species

In the following session the participants discussed on how to select priority species. A set of possible selection criteria was identified and proposed (see Figure 1). Of this set, the participants considered the actual and potential socio-economic value, the ecological value and the conservation status as the most important criteria. The next issue was how to quantify these criteria. After discussing various options, it was decided to give each criteria a code, corresponding to its value or impact on the species. For the socio-economical and ecological criteria a code from 1 (very low value) to 5 (very high value) was given. For coding threats, a similar ranking from 1 (save) to 5 (risk for extinction) was given. Each participant provided information and quantified the criteria for each species on expert's opinion basis, followed by a discussion on the preferences and final agreement. In each countries six priority species were selected, based on their total score (Table 1).

Syria	Total score	Lebanon	Total score
Ceratonia siliqua	15	*Cedrus libani*	14
Juniperus excelsa	4	*Ceratonia siliqua*	12
Laurus nobilis	12	*Juniperus excelsa*	15
Pinus brutia	15	*Pinus pinea*	15
Pistacia atlantica	17	*Salix alba*	12
Quercus aegilops	13	*Quercus calliprinos*	17

Table 1: Selected priority species

Developing a research framework

In order to develop strategies for the conservation and use of FGR, (including *in situ* conservation methods, *ex situ* conservation techniques or an appropriate combination of both), specific information about the target species and its environment is needed. The participants made an assessment of the availability of information important for the conservation of each priority species' genetic resources. For most species relevant information is partly if not completely missing, including scarcity of 1) data on the distribution and characteristics of the species and its populations, 2) information on the uses of and threat to the species, and data on their socio-economic value, and 3) information on the genetic diversity patterns of the species and the processes affecting these patterns. These gaps in information were translated into research activities proposals. There was a general consensus among the participants that priority should be given to those activities that would support the development of strategies supporting FGR conservation and use. At this stage a research framework for priority species was proposed. The research framework concentrated on three different study areas, i.e. (a) eco-geographical surveys, (b) use and threat assessments and (c) genetic diversity studies (Figure 2). Such a research framework should facilitate better linkages between the various research activities, allow a continuously monitoring of these activities and enhance continuing information flow. The participants agreed that to focus their efforts, future activities on the conservation and use of FGR should follow such a framework. They also agreed that the framework could facilitate linkages between the different research disciplines (forest ecology, socio-economics and plant genetics), thus enhancing a multidisciplinary approach.

Based on the outcome of the workshops, workplans were developed for four priority species, i.e. *Pinus brutia* and *Pistacia atlantica* in Syria, and *Ceratonia siliqua* and *Pinus pinea* in Lebanon.

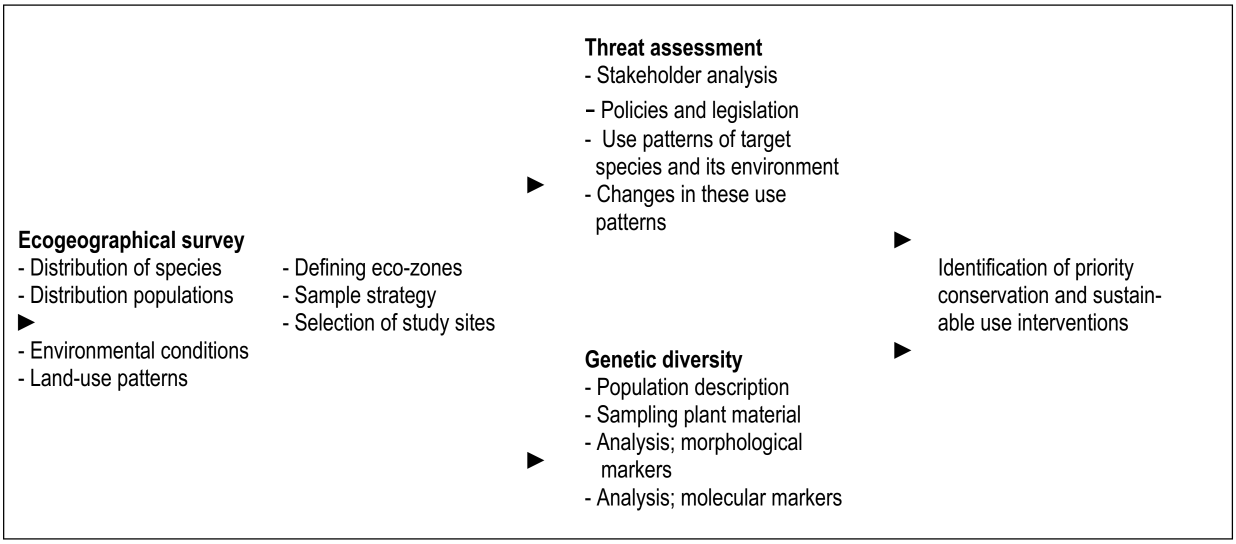

Figure 2: Research framework

ECO-GEOGRAPHICAL SURVEYS

Since 1999 eco-geographical surveys of *Pinus brutia* and on *Pistacia atlantica* have been carried out in Syria, by the Forestry Department of the Ministry of Agriculture and Agrarian Reform (MAAR), the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD) and the Tishreen University. In Lebanon, the American University of Beirut (AUB), the Saint Joseph University and the Directorate of Rural Development and Natural resources of the Ministry of Agriculture (MA-DRDNR) and IPGRI joined forces to organize a joint project on carob (*Ceratonia siliqua*) in 1999. An eco-geographical survey was also carried out, except in the southern part of the country because of the military situation. The aim of these surveys was to map the species/populations distribution, to collate information about the climate, soil and population characteristics, and to define the ecozones. This information was further used to develop sample strategies and collect leaf samples for genetic diversity studies.

To map the distribution of the three species, two different approaches were used. In Syria, GPS (Geographical Positioning System) and GIS applications were used to mark and map the boundaries of the forest stands. Although methods using satellite images, topographic maps or aerial photographs would have given more reliable and detailed results, such material is hardly available in Syria. Moreover, for the mapping of *Pistacia atlantica* stands, which consists of widely dispersed individuals, even more detailed images would have been needed. Altogether, the use of GPS was considered the best alternative for the surveys of *Pistacia atlantica* and *Pinus brutia* in Syria.

In Lebanon another method was used. The carob tree (*Ceratonia siliqua*) occurs mainly in low-rise maquis dominated by *Quercus* spp., as a (sub-) canopy species. while it can also be found in the understudy of pine forests. Mostly, these populations consist of widely scattered or small clusters of individuals. These characteristics make it virtual impossible to use satellite images or aerial photographs, while its frequent occurrence in steep ravines and cliffs makes the use of GPS practically impossible. However, in then field, carob trees are easy to recognize from a distance (using binoculars), since these trees have a very characteristic crown. Moreover, the species occurs mainly in hilly or mountainous landscape with distinctive landmarks. Due to these features, the boundaries of the carob populations could be drawn on detailed topographic maps (1:20000) during the surveys. Afterwards, these maps were digitized for further analysis, using GIS applications. This method proved to be time efficient, while maintaining a reasonable amount of detail. Processing the data of the surveys is continuing and will be made available soon.

THE WAY AHEAD

Besides the ecogeographical surveys, researchers are assessing the genetic diversity of two species (*Pinus brutia* and *Ceratonia siliqua*) and are initiating a genetic diversity study on *Pistacia atlantica*. Furthermore, preparations have been made to start socio-economic studies on the three species, while a specific fire threat assessment on *Pinus brutia* is in its final stage. Outcomes of these studies will be used to identify populations eligible for conservation and to develop appropriate methodologies for priority FGR conservation and use.

Institutional Research Partners in Lebanon and Syria

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EX SITU CONSERVATION OF GENETIC RESOURCES IN THE CONGO: CASE STUDIES OF TWO INTRODUCED SPECIES: *EUCALYPTUS GRANDIS* AND *E. UROPHYLLA*[1]

by

Rafael Gouma[2], Jean Marc Bouvet [3], Philippe Vigneron[3] and Nicodème Kimbouma[2]

INTRODUCTION

Forest genetic resource conservation can be carried out *in situ* (on site, within natural stands) or *ex situ* (off site). *Ex situ* stand conservation, i.e., outside a species' natural distribution range, can be contemplated if the introduced species or population plays a significant economic, social or cultural role in the country of introduction. The example of two eucalyptus species (*Eucalyptus grandis* and *E. urophylla)* introduced into the Congo illustrates this point neatly.

Industrial eucalyptus plantations represent a considerable economic asset in the Congo: close to 42 000 ha are planted and an estimated 450 000 tonnes of eucalyptus logs are exported every year for a turnover of 5 billion CFA francs. Besides, activities linked to wood harvesting provide around 4.000 jobs in a city of 500.000 inhabitants (Pointe-Noire) and thus have considerable social impact. In order to maintain and develop this industrial potential, *Eucalyptus grandis* and E. *urophylla* are utilized as parent species within the framework of an improvement strategy to produce hybrid clones *E. urophylla x grandis.* This article describes efforts made to prolong the survival of trial plots hosting the most promising species and provenances in order to maintain a broad genetic pool among base collections.

STATE OF AVAILABLE GENETIC RESOURCES

During the 1950s, trial plantations were established in the coastal savannah areas of the region with a view to supplying charcoal and fuelwood to the town of Pointe-Noire and energy for the Congo-Ocean railroad.

Despite unfavourable local conditions (annual average rainfall of 1200 mm but with strong annual fluctuations, and four months of marked dry season) and mineral-poor sandy soils, the eucalyptuses generally performed better than other local and introduced species. Therefore, considerable efforts were quickly made to introduce provenances and progenies of this genus (Brezard, 1982): in total, 62 eucalyptus species were introduced into the Congo. Most plant material was established on two different sites, Pointe-Noire and Loudima.

Few species became really acclimatized and the ecological environment of southern Congo is apparently a marginal zone for eucalyptus growth. On the whole, about thirty species still grow in the area on entire plots or relatively dense stands. This mosaic of tests covers a surface area of about 300 ha, more than two thirds in Pointe-Noire, and can be subdivided into two sub-groupings :

- the first sub-group (Figure 1), representing 95% of the total surface area of eucalyptus plots, groups together adapted species of known value.

- the second subset groups together species that are poorly or badly adapted and which survive on fragmented plots. These species currently offer little value but may constitute valuable genetic resources for future work.

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UTILIZATION OF GENETIC RESOURCES

The pure species best adapted to Congo ecological conditions are relatively unproductive (7 to 10 m^3/ha/year of maximum growth in volume). Selection in inter-specific hybrid progenies provided hybrids that were both suitable and vigorous. In this way, cross breeding of *E. grandis* (characterized by vigorous growth, reasonable shape, good adaptation to propagation by cuttings, good technological pulp quality but very badly adapted[4]) with E. urophylla (fairly well adapted, but badly suited to vegetative propagation, average pulp quality and a worse shape than E. grandis) produced *E. urophylla x grandis* hybrids that combined both vigour and adaptation, multiplication ability and good technological aptitude for pulp production, and which yielded 25 to 40 m^3/ha/year in trial plantations. Figures 2 and 3 provide an idea of the growth of some pure species and inter-specific hybrids.

Species	Adaptation	Value	Prov.	Prog.	S. (in ha)
Torelliana	***	*	3(*)		2,7
Citriodora	***	***	14(*)	10	15
Cloeziana	***	***	42(*)		20
Grow	*	***	70	327	42,4
Robusta	***	**	14		17,3
Urophylla	***	***	104(*)	704(*)	119,4
Pellita	***	***	28		5,8
Resinifera	***	***	26		5,7
Alba	***	***	42		12
Tereticornis	**	***	50	72	26,6
Brassiana	***	***	20	81	2,3
Paniculata	**	**	5(*)		0,8
Total			**418**	**1194**	**270**

Figure 1: Preview of species adapted to the ecological conditions in the Congo and utilized as base material for eucalyptus improvement programmes

Key :Prov. : introduced or tested provenance; Prog. : introduced or tested progeny; S. : surface area.
Adaptation and value: * * *: good; * *: means; *: mediocre; (*): provenances or progenies with local races.

SELECTING RESOURCES FOR CONSERVATION

Mainly established about 15 km from Pointe - Noire, the initial stands and tests represent genetic resources of immeasurable value for the continuity of eucalyptus improvement programmes in the Congo. They are particularly valuable since certain provenances can be threatened in their original site or the seed harvests made impossible (as on the island of Timor for *E. urophylla*). Ex situ conservation plots are thus vital for conserving the specie's genetic diversity and maintaining a vast genetic pool among core populations (Bouvet, 1998). In addition to the adaptation problems experienced among most first generation eucalyptuses, the old stands are subject to considerable man-made attack (illegal felling, ...), underlining the importance of these trees for local people

Technical initiatives have been launched to preserve this genetic heritage. Considerable financial resources are required, meaning that currently only certain plots are affected, including selected stands of *E. grandis* (planted between 1980 and 1983) and of *E. urophylla* (planted between 1973 and 1975; see Figure 4). These plots encompass most of the breeding populations participating in the system of recurrent, reciprocal selection (Vigneron, 1991). *E. urophylla* seeds were obtained partially thanks to cooperation between research institutes from Australia (CSIRO), Indonesia (General Forest Authority), and CTFT-Congo, under the aegis of FAO (Gouma, 1998).

[4] Adaptation was established in line with two main criteria: state of health and survival rate (Bouvet, Diallo, Vigneron, Burger, internal notes CTFT-Congo).

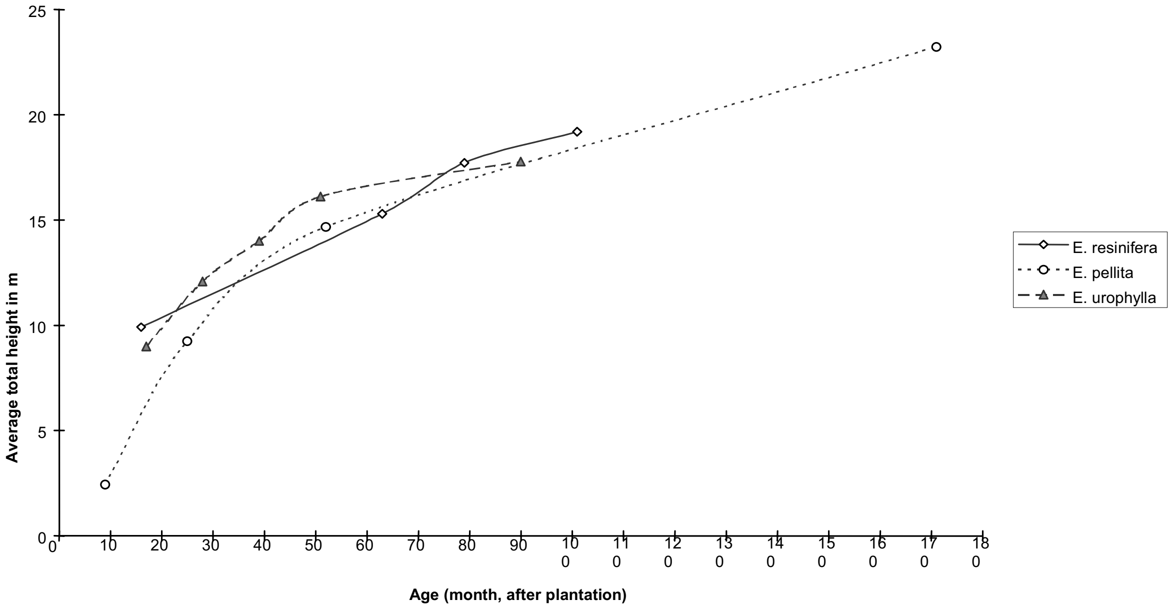

Figure 2: Height growth curves of the three best provenances of pure eucalyptus species adapted to the ecological conditions in the Congo: provenance Monte Lewotobi (E. urophylla), provenance 3763, Grafton (E. resinifera) and provenance 63.11 Loandjili (E. pellita). Curves established from three independent measurement series, corresponding to the evolution of the total average height of one of the best species provenances; as the plots had different ages, comparison between species was not carried out.

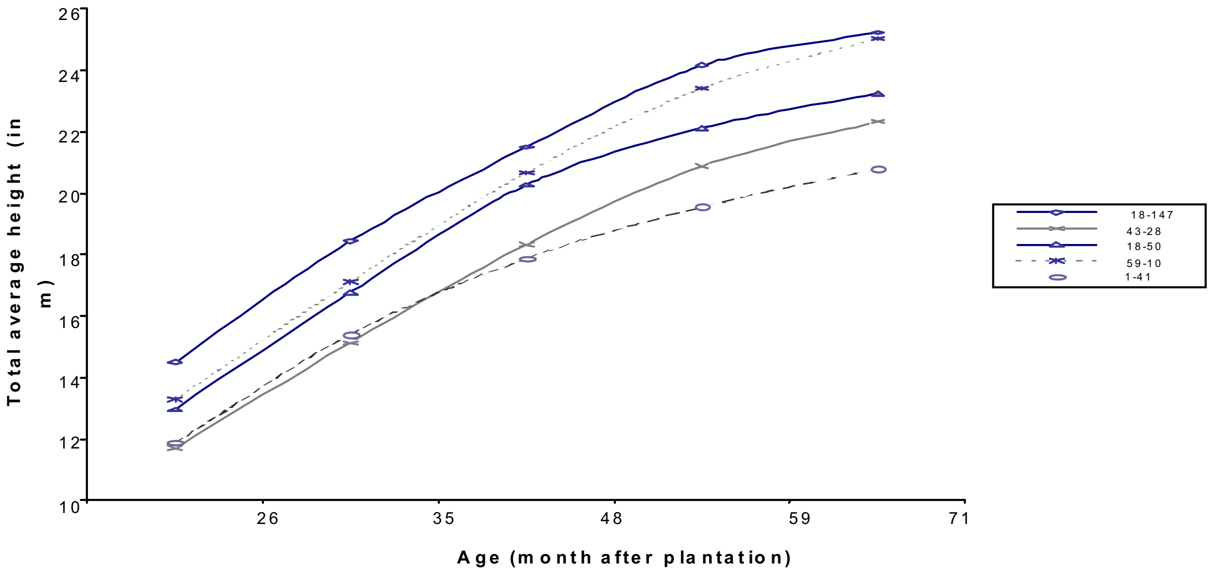

Figure 3: Growth curves of certain hybrids in the Congo : commercial natural hybrid 1-41 (E. alba x unknown), artificial commercial hybrid 18-50 (E. urophylla x grandis), and hybrids under observation: 18-147 (E. urophylla x grandis), 43-28 (E. urophylla x pellita) and 59-10 (E. urophylla x brassiana). Plot R91-3, Kissoko Forest Station, Pointe - Noire (data from A.R Saya).

Species and		Number of	Number of lots	Altitude of

introduction plot	Island or provenance	provenances	or progenies	seed harvest (in m)
Eucalyptus urophylla				
73.3 à 8	Adonara Florès Lomblen Timor	2 10 4 54	4 45 19 252	500 - 700 450 - 1070 520 - 900 500 - 2300
75.3 à 7	Alor Florès Lomblen Pantar Wetar	11 3 1 3 2	53 4 2 9 13	640 595 725 575 330
Eucalyptus grandis				
80.28	West of Pamula, QLD	1	1	900
	South of Ravenshoe, QLD	1	1	940
	SF194 Herberton, QLD	1	1	1000
	Wondecla, QLD	1	1	980
	East of Mareeba, QLD	1	1	740
	N of Tinaroo Falls Dam, QLD	1	1	720
	Mount Putt, QLD	1	1	700
	S.S East of Ravenshoe, QLD	1	1	800
	State Forest 700, QLD	1	1	730
	Tinaroo Falls Dam, QLD	1	1	800
	Machebe Mashnaland, Zimb.	1	1	1600
	Orchard of Pretoria, RSA,	1	1	-
83.02	Mount Fox, NQLD	1	1	680
	Kirrama, NQLD	1	1	580
	Cairns Dam, NQLD	1	1	420
	Total	105	414	

Figure 4: Information on the origins of E. urophylla and E. grandis introduced into plots 73-1 to 8, 75-3 to 7, 80-28 and 83-03 of Loandijili near Pointe-Noire in the Congo. Key : QLD: Queensland; NQLD: North Queensland; Zimb. : Zimbabwe; RSA: Republic of South Africa.

TECHNICAL OPERATIONS

The conservation method outlined aims at improving the condition of standing volume and at prolonging stand survival. In order to do this, silvicultural treatment is conducted both to suppress competition from woody colonizers and to reinvigorate the stand by supplying fertilizer elements. Prominent signs and panels are installed to raise public awareness in these popular areas.

Clearly, prolonging stand survival will not be enough to conserve these genetic resources indefinitely. These operations are carried out in the Congo in order to keep the plant material alive as long as possible with a view to grafting and in vitro cultivation, and are complemented by seed harvesting.

Selected plots have been maintained differently according to initial plantation density and the type of regrowth present: (i) in the first instance, manual work was carried out in *E. urophylla* populations with tight spacing, where it is difficult for agricultural equipment to pass. To do this, smaller trees were thinned with a bush knife before larger trees were felled by chain saw, removing the remains in win rows and using chemical destruction with glyphosphate application; (ii) in a second example, it was possible to carry out mechanical maintenance in widely spaced plots (4,5 x m 4,5 m). These works cost an estimated 16 million CFA francs for a surface area of 15,75 ha (average of 1.000.000 F. CFA/ha). The cost has been entirely supported by the industrial plantation operator (Eucalyptus du Congo SA).

After thinning, N.P.K. fertilizer (13-13-21) was scattered in a circle around each of the trees (400 grams/tree) at the beginning of the rainy season to allow the trees to benefit from the growing season. For the time being, fertilizer has been applied to two *E. grandis* plots and will be extended to the remaining plots identified in line with available financial resources.

RESULTS AND CONCLUSION

Before the rehabilitation work, *E. grandis* trees in the selected plots were starting to rot and suffered from noticeable gummosis. Silvicultural treatment was beneficial and tangible signs of peak recovery can be observed. Similarly, although fertilisation did not take place, *E. urophylla* stands reacted well to the thinning work. The most remarkable feature is the activation of dormant buds that have spread numerous shoots along the trunk.

These voluntary initiatives aimed at conserving *ex situ* valuable genetic resources were undertaken using several straightforward silvicultural operations, which although costly, were motivated by a certain number of considerations. There were two kinds of motivation:

- the desire to sustain a national and effective genetic improvement programme, in turn justified by an industrial reforestation policy to generate foreign currency and jobs and guarantee timber and fuelwood supplies for the second largest town in the country. Plantations also help relieve man-made pressures on natural forest;

- the desire to conserve the products of both national and international research. The genetic pool was only built up after work lasting several decades, with a high cost in effort and resources. The conservation of these resources is also the conservation of a significant part of universal heritage since they may help other improvement programmes. Like other countries with large surface areas planted (Brazil, South Africa), the Congo thus recognises its role in conserving the genetic diversity of its exotic *Eucalyptus* spp.

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PACIFIC SUB-REGIONAL ACTION PLAN FOR CONSERVATION, MANAGEMENT AND SUSTAINABLE USE OF FOREST AND TREE GENETIC RESOURCES[1]

by

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This Action Plan was developed by members of Pacific community at the Pacific Sub-Regional Workshop on Forest and Tree Genetic Resources held in Apia, Samoa from April 12-16, 1999. This workshop was jointly organized and supported by SPRIG/AusAID, FAO Forestry Department and South Regional Office for the Pacific Islands, SPC Forestry Program, SPREP, IPGRI[3] and the Samoan Government's Forestry Division (see Forest Genetic Resources No 27).

The Sub-Regional Action Plan developed during the Apia workshop was recently tabled and discussed at the 9th Pacific Islands Heads of Forestry meeting held from 8-12 May 2000 in Nadi, Fiji. The Heads of Forestry endorsed the Action Plan for donor support and implementation. The objective of the Action Plan is to outline practical actions that can be taken at the international, regional, national and local levels to address the loss of forest and tree genetic resources in the Pacific Islands.

The Action Plan is organised into four themes as follows:

1. Tree Species Priorities for Genetic Resource Operations and Activities

Identification of species/operational priorities was carried out in three working groups, one each focusing on the broad geographic regions of;

- Melanesia - (Fiji, New Caledonia, Papua New Guinea, Solomon Islands, Vanuatu),
- Polynesia - (American Samoa, Cook Islands, French Polynesia, Niue, Samoa, Tonga, Wallis and Futuna), and
- Micronesia - (Guam, Federated States of Micronesia, Marshall Islands, Kiribati, Nauru, Palau, Tuvalu, plus Hawaii).

The Working Groups adopted slightly differing approaches to identifying about 20 common priority indigenous tree species, a limited number of top priority introduced species, and in identifying operational priorities for each selected species.

Three indigenous tree species were identified as being among the top ten priorities in all parts of the Pacific:

- *Calophyllum inophyllum* (beach mahogany, Alexandrian laurel),
- *Cordia subcordata* (island walnut), and
- *Instia bijuga* (island teak).

All three species are widely distributed, produce highly valued timbers, and are among the most highly valued woods for woodcarving and boat-building. In the case of *Intsia bijuga*, it is also found in inland lowland forests as well as along rivers and streams.

In terms of regional priorities for action, the next most important species identified were:

- *Santalum* species (sandalwoods), which are top priorities in south-west Pacific (3 species), eastern Pacific (2 species) and Hawaii (4 species);
- *Calophyllum spp.* (especially neo-ebudicum and close relatives), all excellent timber species;

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- *Pometia pinnata* (Pacific lychee), an excellent timber and firewood species, and medicinal and food plant, commonly found in secondary forests, in shifting agricultural areas and around villages;
- *Terminalia* species (including many fast-growing endemic inland species, and the coastal species, *T. catappa* or beach almond); and
- *Thespesia populnea* (Thespians tree or milo), an important utility timber species and highly valued for woodcarving.

These were followed closely by:

- *Canarium* species (ngarli, nangai or galip nuts)
- *Diospyros* species (Pacific ebonies)
- *Morinda citrifolia* (Indian mulberry, nonu),
- *Serianthes* species (mamufai, vaivai)
- *Syzygium* species (asi toa, yasiyasi, fekika), and
- mangroves (*Xylocarpus, Rhizophora* and *Bruguiera* spp.).

The two highest priority introduced trees for the Pacific Islands were *Swietenia macrophylla* (big-leaf mahogany) and *Pinus caribaea* (Caribbean pine), both originating from tropical Central America.

There are also several genera and species, some of which have important indigenous species in their native Pacific range, and which constitute priority species where they have been introduced elsewhere in the Pacific islands. These include *Acacia* spp. (especially *A. mangium, A. ko*a and *A. spirorbis*), *Casuarina equisetifolia* (beach she oak or ironwood) and *Flueggea flexuosa (*namamau or poumuli).

In terms of conservation, it was recommended that urgent action be taken on the in situ conservation of the genetic resources of *Santalum* species in all three Pacific sub-regions, and also other valuable commercial timber and multipurpose species and those species growing in ecologically sensitive ecosystems. *Ex situ* conservation was noted as a priority for various planted tree species in which desired cultivars have been selected, such as *Barringtonia, Canarium, Pandanus, Pometia* and *Terminalia catappa.* These include some of the species identified for in situ conservation.

2. Conservation, Sustainable Use and Management of Forests and Trees

Throughout the Pacific Islands, and especially in Melanesia, there is a need to improve forest management to ensure a more sustainable use of forest and tree genetic resources. This is inclusive of improved land-use planning and multiple-use management of forested areas. Improved forest management is also a decisive factor for in situ conservation activities.

It was strongly recommended that:

- Reforestation and tree planting programs using both indigenous and introduced tree species need to be further encouraged and developed in the Pacific Islands. Establishment of plantations and agroforestry programs will reduce the pressure on the region's native forests. Priority indigenous species for inclusion in such plantation and agroforestry programs in the Pacific have been identified by the countries.
- It is vital that regional and national programs, including SPRIG, continue to be supported in order to foster the conservation of priority forest and tree genetic resources. Conservation of forest and tree genetic resources will need to include both in situ and ex situ approaches.
- Encourage and support the involvement and commitment of all stakeholders, especially landholders, in forest conservation and management, towards the development of national programs on priority species. This includes the incorporation of traditional practices and leadership with modern science-based approaches in conservation and use plans.
- The uniqueness of Pacific Island environments and the importance of protecting priority species and ecosystems from threats such as pests, diseases, fires and invasive alien species needs to be fully recognized. Any exchange of germplasm of tree species needs to be subject to screening and quarantine. Prior to introduction of new species, varieties, or germplasm from other locations, a science-based risk analysis ought to be performed.

- The limited available resources for forest genetic resources research and development ought to be focussed on priority species.

3. Germplasm Collection, Exchange and Access

At present the region's major forest plantations are based mainly on introduced tree species and germplasm. Relatively little is known about the region's indigenous tree species and basic information may be lacking on important biological characteristics such as seed storage character and susceptibility to pests and diseases.

Planned activities will include:

- Exchange of germplasm – this will entail more extensive use of regional and international databases on forest genetic resources; the need for on-the-job training in seed collection and handling; consideration of seed storage options and development ex situ seed stands; tree germplasm for atoll island environments; and protection from invasive exotic weedy trees through the establishment of import control and eradication programs.
- Quarantine aspects – data gathering on pests and diseases of trees; strengthening linkages between forestry and quarantine officials in country; and preparation of pest risk analyses for safe movement of germplasm within Pacific island countries.
- International and legal considerations on germplasm exchange and access.

4. Institutional Strengthening, Training Needs and Regional Collaboration

Most Pacific countries and territories have small Forestry and Environment Departments, with limited personnel and budget. There is a need to ensure that staff are well trained and informed in the subject areas of conservation, management and utilization of forest and tree genetic resources. The depth of skills and expertise in the region needs to be enhanced through the balanced application of both longer-term University training and through technical hands-on training.

Regional collaboration needs to be maintained and strengthened, especially in the field of research and development and conservation of species occurring in several countries and territories.

More specifically, the following needs and priorities have been identified:

- Training of national staff through formal and informal training on forest genetic resources management and development, including study tours within the region, which address common issues.
- Support and improved use of existing training and education facilities and exploration of opportunities for collaboration with other institutions; and
- Policy issues relating to establishing linkages with other land management and environment agencies and the need to raise awareness at the political level on the importance of forestry and genetic resource conservation and management issues.

The Action Plan sets ambitious but realistic and practicable technical goals. In order to reach them and produce tangible results, the Plan will require voluntary actions from national actors to ensure solid implementation. Current international, regional and bilateral organizations, mechanisms and instruments, will be invited to contribute to its success. In particular, the planned AusAID-funded SPRIG Phase II, a 5-year project which will endeavor to implement key elements of the Action Plan, is expected to commence in early 2001. The lead collaborating agency, during the SPRIG-II Project execution and implementation, will be the relevant Forestry Department or Division of participating countries (which may include Cook Islands, Fiji, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu). For further information, please refer to paper "South Pacific Regional Initiative on Forest Genetic Resources – Phase II" by Lex Thomson in this bulletin.

PROVENANCE TRIALS ON *PINUS PONDEROSA* DOUGLAS *EX* LAWSON IN ARGENTINA'S ANDEAN PATAGONIA[1]

by

J. A. Enricci, N.M. Pasquini and O.A. Picco[2], and V. Mondino[3]

Seeds of 25 provenances of *Pinus ponderosa* Douglas *ex* Lawson were procured in 1980 from the US and Canadian Forest Services for provenance trials to be conducted on this species at five representative sites in western Chubut and Río Negro. Local seeds from the plantations "Isla Victoria" in Neuquén and "Trevelin" in Chubut were used as controls. Traditional local seedling production and final planting techniques were used, and, 18 years later, survival rates were very high with no anomalies detected. The final observations on these trials, which were established in 1982, showed that, in general, provenances from the Cascades area of Washington State performed better on the most favourable sites, and that seeds from the Blue Mountains in eastern central Oregon did better on the less favourable sites. On all sites, the imported seed out-performed the local provenances, though only significantly so on one site. In conclusion, the health and growth species response of these seeds was excellent, and they are recommended for plantations planned in the region.

INTRODUCTION

The introduction of forest exotics in Argentina's central Andean-Patagonian region dates back to the early twentieth century with the arrival of Welsh immigrants from the east and from Río Chubut who distributed *Salix fragilis* L. Immigrants from northern and central Argentina introduced broadleaf and conifer species of US and European origin. From 1930 to 1950, forest exotics were intensively planted on nearly one thousand hectares by the National Forestry Administration at its forest stations "Cerro Chapelco" in Neuquén, "General San Martín" in Río Negro, and "Trevelin" in Chubut, and by the National Parks Administration at Nahuel Huapi National Park in Isla Victoria, Lanin National Park in Pucará, and Los Alerces National Park in Villa Futalaufquen. Today, these stands of *Pinus, Pseudotsuga, Tsuga, Picea, Larix, Abies, Sequoiadendron, Cupressus. Libocedrus, Thuja, Juniperus, Chamaecyparis, Salix, Populus, Betula, Quercus, Fraxinus, Acer, Ulmus* and *Robinia* etc. constitute a veritable showcase for the excellent performance of most of these introductions (Enricci, 1994).

Unfortunately, the seeds used were generic seeds, and there are almost no exact data on their origins, even though they were used to produce non-genetically improved seed. Standing plantations of *Pinus ponderosa* in the region should therefore not be considered as base populations suitable for selection and crosses, as the material is highly heterogeneous, and no comparisons have been made with other provenances which might perform better on specific sites, quite apart from the unknown origin of this local seed. Two lots of seed from these plantations were used , however, as controls in the trials reviewed in this paper.

The main objective of this experiment was to establish with some exactitude those provenances which best met the main objectives in each region, (generally concerning health and behaviour).

MATERIALS AND METHODOLOGY

The trial methodology was that recommended by the experts. According to Kemp in J. Burley et al (1979), the purpose of species and provenance trials should be to reduce a great many possible genotype/environmental combinations to a few proven species or provenances suitable for the production of desired forest products on relevant sites.

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Table 1 characterizes the provenances of those *Pinus ponderosa* var *ponderosa* seeds which produced a sufficient number of seedlings in the nursery to qualify for use in trials (excepting lot 8, which concerns var. *scopulorum*). Of the 25 seed lots imported, 18 met this requirement. Lots C 25 and C26 were used as local controls, in accordance with Burley et al, 1979. *Figure 1* illustrates the natural distribution of *P. ponderosa* and the locations of the provenances used in the trial.

Lot Nº	Place of origin	Latitude N.	Longitude W.	Altitude (m)	Seed Zone
21	Pritchard - Brit. Columbia (Can.)	50º 46'	119º 47'	490	
13	Okanogan - Washington (USA)	48º 48'	120º	750	600
11	Okanogan - Washington (USA)	48º 48'	120º	900	600
3	Klichitat - Washington (USA)	46º	121º	1050	653
9	Grant - Oregon (USA)	44º 42'	119º 12'	1350	892
8	Black Hills - S. Dakota (USA)	44º 42'	103º 30'	1650	(*)
5	Deschutes - Oregon (USA)	44º 12'	121º 30'	1500	674
18	Grant - Oregon (USA)	44º 12'	119º	1350	941
19	Grant - Oregon (USA)	44º 12'	119º	1500	941
15	Grant - Oregon (USA)	44º 12'	119º	1800	941
17	Harney - Oregon (USA)	43º 48'	118º 48'	1650	930
14	Harney - Oregon (USA)	43º 30'	119º	1350	952
2	Harney - Oregon (USA)	43º 30'	119º	1650	952
12	Lake - Oregon (USA)	43º 30'	121º 12'	1350	690
10	Douglas - Oregon (USA)	43º 24'	121º 48'	1350	681
1	Klamath - Oregon (USA)	43º 12'	121º 54'	1500	701
16	Jackson - Oregon (USA)	42º 30'	122º 30'	750	502
4	Jackson - Oregon (USA)	42º 30'	122º 30'	900	502
Control	**Harvest site**	**Latitude S.**	**Longitude W**	**Altitude (m)**	**Owner**
C25	Trevelin - Chubut (Arg.)	43º 07'	71º 34'	420	INTA
C26	Isla Victoria - Neuquén (Arg.)	40º 57'	71º 33'	775	Nat'l Parks.

(*) Corresponds to *Pinus ponderosa* var. *scopulorum*

Table 1. Seeds of Pinus ponderosa var. ponderosa used in trials (provenances and controls)

The seedlings were produced at INTA's "Trevelin" Forest Station, using methods traditional in the region. As recommended by Patiño Valera and R. Garzón (1976), the following data were recorded: seeding and emergence dates, total number of seedlings, height, eventual anomalies, health status. The seeds were sown in the spring (13 October 1980) in nursery beds at densities of 70gr/m2. The resulting seedlings (1 + 0) were transplanted on 1 October 1981 into nursery borders at spacings of 0.1 m x 0.1 m.

The final site selection followed the indications of Greaves A. and Hughes J.F. (1979) for representative sites in terms of geomorphology, soil, climate, and existing natural vegetation. Both Table 2 and Figure 1 illustrate the characteristics and location of the four sites chosen for the establishment of the trial plots.

Site	Location	Province	Latitude S	Longitude W	Altitude (masl)	Mean annual Temperature (º C)	Mean annual rainfall (mm.)
I	"Mallín Cumé"	Río Negro	41º 57'	71º 20'	790	9.0	800
II	"Mallín grande"	Chubut	43º 29'	71º 18'	830	8.1	550
III	"Río Pico"	Chubut	44º 10'	71º 28'	800	7.6	650
IV	"Lago Fontana"	Chubut	44º 56'	71º 32'	960	7.0	900

Table 2: Site characteristics of trial locations:

Sites I and III are characterized as "more favourable" and sites II and IV as "less favourable" for the growth of this species in accordance with relief and soil characteristics.

Figure 1: Natural distribution of Pinus ponderosa Douglas ex Lawson and original locations of provenances tested (the broken line separates v. ponderosa (West) from v. scopulorum (East) (US Forest Service, 1965)
Note: Provenances with the same geographical location but at different altitudes:

A. *Includes provenances No. 2 and 14*
B. *Includes provenances No. 15, 18 and 19*
C. *Includes provenances No. 4 and 16.*
D. *Includes provenances No 11 and 13*

In September 1982 the final planting was done in accordance with traditional local methods. Holes were first dug with a sharp-edged spade at spacings of 3 m x 3 m. A randomized block design with four repetitions was used (each block containing plots with 9 plants replicating the provenances). A square plot shape was selected, in accordance with Barret, W. (1973), Wright, J. (1976) and Burley, J. et al, for areas of 81 m2 each.

The following data were recorded: survival (measured every two years after planting), total mean height of the two dominant trees in each plot (every four years), diameter at breast height (each time height was measured once the trees reached 12 years of age), stem and branch characteristics, and health status. The last measurements were made in 1999, given the fact that as of 16 years from the date of planting, at standard plantation spacings, competition was very heavy among individual trees on the plots, with trees one third again as big as in a normal cutting cycle for this species on these sites. The data-processing software used was SPSS/PC + Statistics. The relative significance of the different provenances was arrived at through variance analysis as interpreted by the Rango test, 5% Duncan multiple, as recommended by Burley, J. et al, (1979) and Ditlevsen, B. (1980).

Figure 2: Site location of the trial plots

RESULTS

At the nursery stage (1980-81):

The dates of emergence were 6-20 November 1980. The number of plants obtained at transplant on 1 October 1981 was 12,831, with a mean aboveground height of 5.1 cm., and no observed anomalies. The following year 12,128 plants were left for the final planting, with a very high survival rate of 95% for all provenances. The mean aboveground height of var. ponderosa was 7.8 cm with average values per provenance ranging from 6.2 to 9.4 cm, whereas for the scopulorum variety it was 3.5 cm.

At the plantation stage (1982-99):

Provenance	Height (cm)		DBH (cm)	Survival (&)
Lot N°	at 11 yrs	at 16 yrs	at 16 yrs	At 16 yrs
3	428	676	15.9	97
13	427	663	16.5	100
12	409	634	15.7	92
9	408	636	15.3	100
5	408	631	17.2	92
4	407	621	15.5	89
18	395	619	15.3	92
21	390	622	15.2	92
14	386	601	15.9	97
10	385	605	15.3	94
16	376	609	15.6	92
11	371	612	14.8	92
19	367	601	14.9	83
15	365	585	14.5	92
C25	**358**	**561**	**14.7**	**89**
C26	352	560	14.4	86
2	347	570	14.3	92
1	334	556	13.8	97
17	331	561	13.6	94
8	243	391	9.5	83
Mean	**377**	**596**	**14.9**	**92**

Table 3: "Mallín Cumé"(Site I)

Provenance	Height (cm)		DBH (cm)	Survival (%)
Lot N°	at 11 yrs	at 16 yrs	at 16 yrs	at 16 yrs
18	289	423	12.0	91
2	286	421	12.2	94
4	282	420	12.0	81
14	265	398	11.9	94
C25	**228**	**332**	**9.5**	**67**
16	227	340	10.3	86
21	224	338	10.4	72
17	192	268	8.2	61
15	184	276	8.4	58
19	183	270	8.4	61
12	182	264	8.2	39
9	176	250	7.9	64
C26	174	252	7.8	50
8	168	209	4.8	83
13	154	243	6.9	53
10	153	235	6.4	50
11	150	233	6.7	58
5	148	230	6.3	53
3	147	251	7.5	58
1	135	211	5.7	64
Mean	**197**	**293**	**8,6**	**67**

Table 4: "Mallín grande"(Site II)

CONCLUSIONS

Concerning a possible juvenile/adult size ratio, in comparing the nursery data (two years) to the plantation data (16 years), a very high and significant correlation was observed for the "Black Hills" provenance (No. 8) for the scopulorum variety. The same can not be said of the other provenances.

Survival rates in the nursery as at the various plantation stages were very high, ranging from 95% at the time of final planting to 83% 11 years later, with a final figure of 78% after 16 years in the plantation. The failure rate was also similar for all provenances, though the rate of failure was higher on Sites II and IV due to the less favourable conditions, and to the incidence of attacks by the "European hare" (*Lepus europaeus*) on Site II (Mallín Grande) and by "European red deer" (*Cervus elaphus*) on Site IV (Lago Fontana).

No health problems were observed for any provenance at any of the four test sites.

Generally speaking, the trends for all parameters observed in 1994 when the plantation was 11 years old held true five years later when the plantation was 16 years old. This plus the heavy competition between trees rules out the need for new measurements.

Concerning the height and DBH data, there was a discontinuous variation among the provenances, with a general trend toward better performances by the Washington State provenances from the eastern slopes of the Cascades on the more favourable sites of Mallín Cumé and Río Pico.

Provenances from the central western Blue Mountains area of Oregon State performed better on the less favourable sites of Mallín Grande and Lago Fontana. There were some exceptions for both situations, with more variation between sites than between provenances.

On all sites, the imported provenances were observed to outperform the best response of the local control, though the difference was statistically significant only in Río Pico.

At 16 years from final planting, var. scopulorum development was observed to be significantly poorer at all sites, and it is therefore not recommended that local tree nurseries import seeds of this variety.

Provenance	Height (cm)		DBH (cm)	Survival (%)
Lot Nº	at 11 yrs	at 16 yrs	at 16 yrs	At 16 yrs
13	419	579	15.4	72
2	418	563	15.7	86
11	418	579	15.0	81
3	413	579	15.1	86
18	411	566	14.9	94
C26	**388**	**528**	**15.3**	**86**
12	387	531	14.7	72
15	375	519	13.5	67
17	374	511	14.8	92
10	369	519	13.8	64
9	361	513	13.7	86
16	359	522	14.4	61
1	358	495	13.9	64
19	357	502	13.6	58
5	355	497	13.5	64
21	342	501	14.9	58
C25	342	493	14.8	89
8	206	306	6.7	50
Mean	**371**	**517**	**14.1**	**74**

Table 5: "Río Pico" (Site III)

Provenance	Height (cm)		DBH (cm)	Survival (%)
Lot Nº	at 11 yrs	at 16 yrs	at 16 yrs	at 16 yrs
14	289	471	12.4	78
4	266	423	10.9	86
11	266	430	10.5	81
10	243	397	9.8	83
16	230	402	10.2	86
9	229	396	10.0	78
13	219	352	8.4	69
2	218	356	8.1	78
15	211	363	8.5	89
3	210	385	9.7	67
1	209	379	9.5	83
12	209	349	8.2	83
C25	**206**	**344**	**9.0**	**81**
17	204	348	8.6	58
19	204	344	8.3	69
21	203	362	8.2	72
18	197	365	9.2	83
5	193	344	8.4	81
C26	168	292	6.1	86
8	111	189	3.9	69
Mean	**214**	**365**	**8.9**	**78**

Table 6: "Lago Fontana" (Site IV)

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CONSERVATION OF *PRUNUS AFRICANA*, AN OVER-EXPLOITED AFRICAN MEDICINAL TREE[1]

by

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INTRODUCTION

Prunus africana (Hook. f.) Kalkman (Rosaceae) is a geographically widespread tree growing in the highland forest in mainland Africa (Angola, Cameroon, Democratic Republic of Congo, Ethiopia, Kenya, Malawi, Nigeria, Somalia, South Africa, Sudan, Swaziland, Tanzania, Uganda, Zimbabwe) and outlying islands (Bioko, Grand Comore, Madagascar, Sao Tomé) (Kalkman 1965). The only species of *Prunus* native to Africa, it is a large tree that can grow to more than 40 m in height and a diameter of 1 m. The medicinal property of *P. africana* bark extract for the treatment of benign prostatic hyperplasia has led to an annual international trade worth approximately US$220 million in the final pharmaceutical product (Cunningham *et al.* 1997). To supply this demand, approximately 4,000 tonnes of bark is presently collected annually by the felling of trees from natural stands, leading to concerns on the long term sustainability of harvesting and the conservation of the species. The natural resource base is most exploited and under the greatest threat in Cameroon (Cunningham and Mbenkum 1993) and Madagascar (Walter and Rakotonirina 1995). Exploitation is also high, although currently less intensive, in Kenya (Cunningham *et al.* 1997) and on the island of Bioko (Equatorial Guinea) (Sunderland and Tako 1999). Accurate exploitation figures for other countries are not available, but are considered to be comparatively low (Cunningham *et al.* 1997). Conservation needs are therefore highest in Cameroon and Madagascar, with less urgent needs in Equatorial Guinea and Kenya.

As a result of over-exploitation, trade in *P. africana* products is regulated under Appendix II of the Convention on International Trade in Endangered Species of wild fauna and flora (CITES). *Prunus africana* is listed in the *Tree Conservation Database* of the World Conservation Monitoring Centre (WCMC, 1999). In addition, the FAO Panel of Experts on Forest Gene Resources lists *P. africana* as one of 18 top priority species for action in Africa (FAO 1997).

In its work, ICRAF has considered a number of options for conservation based on determinants that impact most decisively on any conservation strategy. Both determinants and options are discussed here.

IMPORTANT DETERMINANTS FOR A CONSERVATION STRATEGY

Biology and ecology

1. Genetic variation

P. africana has a wide but disjunct distribution in highland forest 'islands' across Africa (Kalkman 1965), and genetic variation can be expected to have diverged accordingly. Analysis by Dawson and Powell (1999) using molecular markers (random amplified polymorphic DNA RAPD) indicated this to indeed be the case at the gene level. Analysing 10 populations sampled from Cameroon, Ethiopia, Kenya, Madagascar and Uganda, data revealed most genetic variation among countries (66%, $P < 0.001$), indicating the importance of regional approaches for conservation. Variation among individuals within populations, and among populations within Cameroon and Madagascar, was also highly significant, indicating the importance of developing genetic management strategies that also take account of genetic variation at a country level. Despite the geographic distance between Uganda and Cameroon, Ugandan material was more similar to west African populations than that from Kenya and Ethiopia (Figure 1). This is consistent with theories by White (1983) relating to historical climate differences and migration corridors during world glacial periods. Data indicated that Malagash populations were most distinct and therefore of particular conservation concern.

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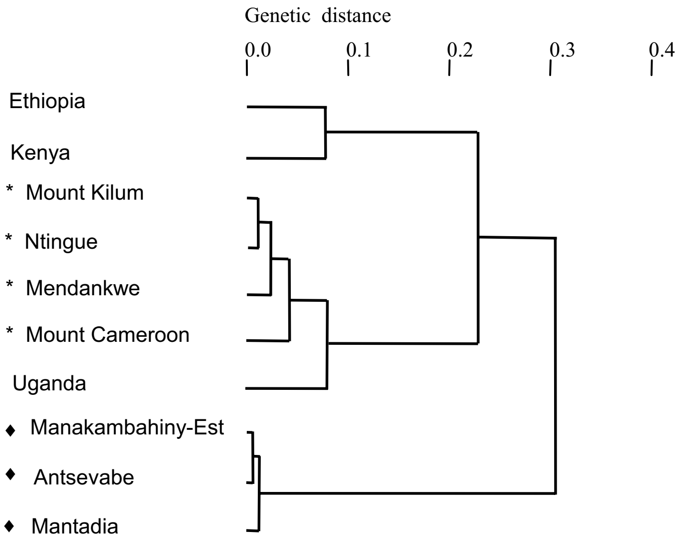

Diagram showing the genetic relationship among 10 populations of *Prunus africana* sampled from five African countries, using RAPD analysis (taken from Dawson and Powell 1999)
* Populations from Cameroon
♦ Populations from Madagascar

Figure 1: Genetic relationships in Prunus africana

2. Reproductive biology

Seed of *P. africana* is intermediate in nature, which limits *ex situ* seed storage (Jaenicke *et al.* 2000; Sunderland and Nkefor 1997). The best conditions for seed storage were obtained when seed from mature (purple) fruit was harvested directly from trees and depulped immediately after collection, followed by storage, without drying, at 5° Celsius. However, even under these conditions, germination was only 35% after 12 months of storage (Jaenicke *et al.* 2000). Long term seed storage of *P. africana* as a means of *ex situ* conservation is therefore not advisable, although short-term storage across planting seasons is possible.

Few studies on the reproductive biology of *P. africana* have been conducted. According to studies by Munjuga *et al.* (2000) the species is predominantly outcrossing. Flowering and fruiting in a given population may be spread over a relatively long period of time, with stigma receptivity of individual flowers short (Munjuga *et al.* 2000). Combined with the frequent low density, patchy and unusual size class distribution of *P. africana* in forest (Ewusi *et al.* 1992; Ewusi *et al.* 1997), these observations raise concerns regarding effective population sizes of exploited natural stands and their long term reproductive viability for *in situ* conservation.

3. Ecosystem function

The Afromontane forest 'islands' or other highland forests which *P. africana* inhabits, have been classified as being important conservation targets (Davis *et al.* 1994). According to Thomas and Cheek (1992), 42 plant species are strictly endemic to Mount Cameroon. Bwindi Impenetrable Forest in Uganda is one of the most diverse forests in East Africa and contains half the world's endangered mountain gorilla (*Gorilla gorilla beringei*) population (Cunningham 1996; Wild and Mutebi 1996). Kakamega Forest in Kenya is considered to be the eastern edge of the Guinea-Congolian Forest block and as such is considered of particularly high conservation value (Kokwaro 1988).

Although the situation varies greatly with location, these forested areas are often under threat from agricultural clearance because they coincide with regions of high population density (Cunningham 1996; Cunningham *et al.* 1997; Watts and Akago 1994; Wild and Mutebi 1996). Other activities may further contribute to the degradation of these highly diverse forests. The possible keystone function of *P. africana* within these forests in maintaining their integrity is therefore a key consideration. However, although the fruit of *P. africana* is eaten by a number of threatened bird and mammal species (Cunningham and Mbenkum 1993), none of these appear to be critically dependent on *P. africana,* but appear to be generalist frugivores that may feed off a number of plants. Moreover, the density of mature *P. africana* trees in forest is generally low (Ewusi *et al.* 1992; Ewusi *et al.* 1997; Nzilani 1999), suggesting that the quantity of fruit produced is limited and unlikely to compose a large part of the diet of bird and mammal species.

The most important impact of *P. africana* harvesting on the ecosystems in which it occurs may be indirect. According to the Bioko Primate Protection Programme (BPPP), in 1997, new access routes opened into the forest of Pico Basile on Bioko to harvest *P. africana*. These gave bush meat hunters easier access to the habitat of a seriously threatened endemic subspecies of the primate Preuss's guenon (*Cercopithecus pruessi insularis*), which has contributed to its endangered status (BPPP 1999). In Cameroon, the Fon of Banso considered that commercial harvesting of *P. africana* bark had aggravated forest clearance by changing local perceptions of forest use, from being a community resource to an asset to be exploited for personal gain (Cunningham and Mbenkum 1993).

Policy and regulation

1. International

Internationally, the main regulation that influences the development of conservation strategies for *P. africana* is CITES. Listing of *P. africana* on Appendix II of the Convention indicates that trade in both wild and cultivated material must be licensed at export and import. However, a difficulty in implementation has been the identification of *P. africana* products in international trade, which has lead to unreported export and, particularly, import of *P. africana* (Cunningham *et al.* 1997). An additional difficulty is based on the fact that some countries have not to date nominated *National CITES Authorities*.

2. National and local

In the countries where exploitation is highest, Cameroon and Madagascar, a number of national regulations address the harvesting of *P. africana* bark (reviewed by Ndibi and Kay 1997 for Cameroon; Walter and Rakotonirina 1995 for Madagascar). Regulations of the two countries differ widely, however, with the Malagash framework in particular being considered inadequate from a sustainable use perspective. Conservation activities in Madagascar could therefore benefit if harvesting regulations were adapted which were more in line with those applied in Cameroon.

However, also in Cameroon, it seems as if the regulations for sustainable harvesting are not always well understood. For example, harvesting licences specify that bark should only be stripped from one quarter of the standing trees, but the level of tree mortality and rate of bark recovery following present practices remain a concern (Sunderland and Tako 1999; Cunningham and Mbenkum 1993; Ewusi *et al.* 1992). Inadequate inventory data on the size of populations is an additional constraint to the possibilities to determine sustainable harvesting levels (Ewusi *et al.* 1997).

Apart from the development of regulations and quotas for harvesting to ensure sustainability, their enforcement is often difficult. In areas where *P. africana* is currently exploited harvesting regulations are not consistently adhered to, due to lack of awareness and resources, and institutional weaknesses (Cunningham *et al.* 1997; Ndibi & Kay 1997; Mbenkum and Fisiy 1992). In Cameroon, for example, at least 900 tonnes of bark is reported to have been harvested illegally around Mount Cameroon between 1994 and 1996, when export licences were awarded to 3 Cameroonian entrepreneurs to fulfil a large order for bark export to Italy (Cunningham *et al.* 1997). In Madagascar, almost all bark is reportedly harvested illegally (Walter and Rakotonirina 1995), and includes harvest in protected areas (Ian Dawson, personal observations).

In Cameroon, where welcome recent moves have been taken to issue a much-reduced quota for bark collection from the Mount Cameroon area, it will be important to ensure that resulting sustainable harvesting will not be counteracted by increased illegal exploitation (James Acworth, Mount Cameroon Project, personal communication).

Thus, even when regulations exist to promote the sustainable management of *P. africana* from wild populations, such formal regulations alone are unlikely to be effective in ensuring conservation of the resources. As a result of verified problems, there have been recent moves, promoted by European countries, to place *P. africana* on Appendix I of CITES, which prohibits all commercial trade (Nouhou Ndam, Mount Cameroon Project, personal communication).

Community management issues

Local human communities are an important determinant in the success of conservation efforts, as they are often involved in harvesting *P. africana* bark and can derive long-term benefits from sustainable utilisation strategies. One of the strongest efforts to encourage community participation in the sustainable management of *P. africana* has been made in Mount Cameroon, where the company handling and exporting bark signed special agreements with two villages in 1997 for the sustainable management and production of *P. africana* (Laird and Lisinge 1998). Elements of the agreement included payment of relatively high prices per unit weight of bark to villagers, and the training of collectors in harvesting techniques. Prescribed harvesting involves no cutting of trees, and is monitored by a committee.

Community management of forests can help overcome difficulties in enforcement of regulations (Ndibi and Kay 1997). However, since approaches to forest resource use differ widely among communities, even within a region (Watts and Akogo 1994), the involvement of communities in conservation efforts has to be location-specific rather than prescriptive. This makes the development of management plans a lengthy process and, often, longer than the window available for effective conservation action.

Markets and economics

As the world population ages, the demand for treatments for benign prostatic hyperplasia (BPH) is likely to increase. Coupled with trends toward the use of herbal products, the future world demand for *P. africana* bark may increase considerably (Simons *et al.* 1998). In this context, unless alternative sources of bark can be developed through cultivation, or alternative remedies for BPH are found, natural stands of *P. africana* are in danger of depletion. In fact, a number of other herbal remedies are used to treat BPH, and these may become more popular if the available stocks of *P. africana* continue to decrease (Cunningham *et al.* 1997).

The collection of bark provides a relatively small return to harvesters compared to profits of the companies marketing the product (Simons *et al.* 1998). However, the poverty of collectors and lack of alternative sources of income mean that they will make considerable efforts to harvest trees. In Madagascar, for example, villagers are willing to walk long distances (for several days) into the forest to harvest bark of *P. africana* (Walter and Rakotonirina 1995). Only extremely remote populations of the species are likely to be not viable economically for harvesting purposes.

OPTIONS FOR CONSERVATION

Forest

In the context of the presently high levels of illegal harvesting without management, *in situ* conservation of *P. africana* in countries where the species is widely exploited will be possible only in very limited cases, in which strict monitoring of harvesting can be assured, strong community involvement in sustainable harvesting can be sustained, or trees are too inaccessible to exploit. Although traditional community beliefs connected with forest conservation are being eroded (Cunningham and Mbenkum 1993), in specific cases they may form a basis for *in situ* conservation efforts. For example, in Embu District of Kenya, over 250 sacred groves of forest have been identified in land otherwise cleared for agriculture. Many of these groves contain *P. africana* (Meru Traditional Healers Group, personal communication). The utility of these groves for conservation purposes depends on their size and isolation from each other, but remnant *P. africana* trees on farmland are expected to provide a degree of gene flow between small natural groves, which may allow population viability to be maintained (Ard Lengkeek, personal observations).

In most areas, *P. africana* does not appear to be a keystone species within the ecosystems in which it occurs. Therefore, *in situ* management strategies should focus on conservation of representative forest blocks rather than on the management of *P. africana.* However, where specific interventions can be undertaken to promote the recovery of *P. africana* populations in harvested areas, these should include opening the canopy around, and clearing the undergrowth beneath, seed bearing trees (Ndam 1998).

Enrichment planting and plantations

To date, successful plantations and enrichment plantings have been primarily limited to Kenya, where *P. africana* has been planted by the Forest Department for timber production. Although these stands provide a useful resource also for bark harvesting, they are of limited utility for conservation as they are often of unknown origin and as they may have a narrow genetic base. However, their success indicates that planting efforts could be successful also in Cameroon and Madagascar. Proper attention should be given to site choice and tree management practices, in addition to the origin and genetic variation of the reproductive materials used. Well managed plantations could serve as *ex situ* conservation stands, and as sources of planting material for future reforestation and on-farm cultivation.

In areas in Madagascar where natural stands are particularly threatened and a forest management culture is not well developed (Walter and Rakotonirina 1995; Dawson 1997), establishing *ex situ* conservation stands should be a priority. In cases where harvesting has removed all mature trees from natural tree populations, vegetative propagation techniques, such as cuttings and grafting, may be used to safeguard genetic resources of *Prunus africana* (Jaenicke *et al.* 2000).

Small-scale farmer cultivation

According to Cunningham (1994; 1996), the conservation of Afromontane forest can be improved through providing opportunities for small-scale farmers to cultivate useful forest products outside of protected areas. Trees planted on-farm can be an important genetic resource if attention is paid to the origin and genetic variation of the cultivated material. As natural forests contract as a result of agricultural expansion, the management of farmland also for the conservation of biodiversity becomes increasingly important. Research indicates that, in some areas, the number of trees planted on small-holder farms has increased together with human population density; natural forest has been cleared, however, more trees have been planted on-farm to compensate this loss (Arnold and Dewees, 1995; 1998). Agroforestry may be a particularly appropriate method for conservation in highland areas of Africa where high population density and the pressure on natural forests are especially high. In areas of exploitation, this system of "conservation through cultivation" is likely to be more effective than attempting to sustainably manage *P. africana* within natural forest.

In Cameroon, where considerable planting of *P. africana* by small-scale farmers has already taken place (Cunningham *et al* 1997), measures are currently underway to assess the current genetic base of material planted by farmers, using RAPD analysis (Ian Dawson, unpublished data).

Despite the merits of on-farm tree planting, there are serious constraints for its expansion. First, the intermediate nature of seed (Jaenicke *et al.* 2000) limits seed availability. Second, although a large tree can yield large quantities of seed, seed yields fluctuate widely between years. Seed shortage is likely to be exacerbated in future years as the size of natural populations of trees diminish. Since the approximate time to the first flowering and fruiting in *P. africana* is 15-20 years, the establishment of seed stands is an urgent priority, as is the further development and adoption of vegetative propagation practices (Jaenicke *et al.* 2000). Other difficulties with cultivation include the relatively long time scale until bark harvesting is possible (approximately 15 years after planting), access to markets for bark from cultivated trees, and policy issues concerning tree tenure (Simons *et al.* 1998).

CONCLUSION

Although *Prunus africana* is heavily over-exploited in parts of its range, it is not in danger of extinction at the species level. However, certain tree populations are being depleted, and valuable genetic resources may be lost.

While there is an urgent need to conserve *P. africana,* the distribution, biology and current and future use of the species are insufficiently known. It will not be possible to determine the optimal approaches for conservation, as there will not be the possibility to determine the impacts of alternative conservation strategies. Thus, approaches for conservation will likely be influenced largely by institutional and individual perspectives, rather than being based on scientific facts (Cunningham 1996).

In this context, approaches for the conservation of *P. africana* must be kept flexible and diverse. Although efforts should focus on a number of approaches, planting by small holder farmers perhaps holds the most potential both for *P. africana* and other Afromontane trees, as natural forest cover continues to contract.

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ATTEMPTS AT CONSERVATION OF RECALCITRANT SEEDS IN MALAYSIA[1]

by

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INTRODUCTION

A large proportion of plant species produce seeds that can be dried to a sufficiently low moisture content that permits them to be stored at low temperatures. These seeds are termed orthodox (Roberts 1973). There is another category of seeds that are termed as recalcitrant. A number of tropical fruit and timber species fall into this category. In Malaysia, which houses 6% of the world's flowering plant species, a majority of these flowering species produce recalcitrant seeds. These recalcitrant seeds cannot tolerate desiccation to low moisture contents and remain viable only for a short time ranging from a few days to a few weeks. Another category of seed as described by Ellis *et al.* (1990) comprises seeds that can be desiccated to fairly low moisture contents but which do not withstand exposure to low temperature. Even though the storage of these seeds can be prolonged from a few months to some years, their long-term conservation as seeds is still not possible.

Traditionally, the field genebank has been the *ex situ* method of choice for those species which produce recalcitrant seeds or that are propagated vegetatively. This method of conservation, however, presents certain drawbacks which limit its efficiency and threaten its security. Genetic resources in field genebanks remain exposed to pests, diseases and natural calamities such as droughts, fire and flood. Furthermore, cost of maintaining these germplasm as field collections are very prohibitive in terms of land and costs.

In Malaysia, the following methods are/have been tested and/or devised as protocols for the mid to long term storage of recalcitrant seeded v. forest tree species:

In vitro propagation for germplasm conservation

Tissue culture techniques provide the opportunity for very high rapid multiplication rates in aseptic environment of those desired germplasm. The *in vitro* propagation of mature forest trees is faced with a number of difficulties at various stages of the propagation process, including notably high levels of contamination in initial explants, high secretion of polyphenols and tannins which inhibit the development of the explants and often cause necrosis, vitrification and low-rooting ability.

Juvenile tissues have been seen to be the most responsive in culture. Marcotts from selected trees have been taken and raised in the nursery and ex-plants from these have been used as starting materials for initiating cultures. Successful examples have been for *Acacia mangium, Acacia auriculiformis, Dyera costulata, Tectona grandis, Azadirachta excelsa, Aqualaria malaccense, Calamus manan* (Aziah et al. 1992, 1994, 1999; Fadillah et al. 1999). Clonal materials propagated in this manner can be safely stored, planted out or used in the germplasm exchange programmes. For storage *in vitro*, the culture medium and the physical environmental growth conditions are modified to reduce the growth rate of the plantlets.

Cryopreservation

Classical cryopreservation procedures comprise a pre-treatment with cryoprotective substances followed by slow controlled freezing. Such procedures have been successful with culture systems consisting of small units of uniform morphology such as in protoplast culture, actively dividing cell suspension culture and fragmented callus cultures (Withers and Engelmann 1995). However, this method gives erratic results for culture systems that consist of large units comprising a mixture of cell sizes and types, such as shoot-tips, zygotic embryos or relatively mature somatic embryos (Krishnapillay and Englemann 1996; Krishnapillay 1999). Currently, reproducible and efficient methods are available such as encapsulation,/dehydration, vitrification, desiccation and pre-growth desiccation (Englemann 1999).

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Encapsulation-dehydration

The encapsulation-dehydration technique is based on the technology developed for the production of synthetic seeds (Redenbaugh 1993). For cryopreservation, apices, somatic or small zygotic embryos are encapsulated in a bead of alginate and pregrown for various duration in liquid medium with high sucrose concentrations. Beads are then partially dehydrated under the air current of a laminar flow cabinet or using silica gel, down to a water content of about 20%. Freezing is usually rapid, by direct immersion of the samples in liquid nitrogen. For recovery, samples are usually placed directly under standard culture conditions. Growth recovery of the cryopreserved material is generally rapid and direct, without callus formation. This technique has been successfully used for the zygotic embryos of *Swietenia macrophylla* (mahogany) (Marzalina et al. 1994). Reports show that successful extension of this protocol for conservation has been performed routinely on 11 varieties of pear, 9 varieties of apple and 14 varieties of sugarcane.

Vitrification

Vitrification consists in placing samples for pretreatment in extremely concentrated cryoprotective solutions and freezing them ultra-rapidly. In these conditions, the intracellular solutes vitrify i.e. form an amorphous glassy structure, thus avoiding the formation of intercellular ice crystals, detrimental for cell survival. Vitrification procedures have been developed for cell suspensions, somatic embryos and apices of various species (Sakai 1993; Takagi et al. 1997; Thinh et al. 1999). Recently this technique has been successfully used for the cryopreservation of zygotic embryos of *Arthocarpus heterophyllus* and *Naphelium lappaceum* (Wong 1999 unpubl.; Tammasiri 1999; Ginibun 1999 unpubl.).

Desiccation

Cryopreservation using a desiccation procedure is the simplest approach. It consists of dehydrating the plant material, then freezing it rapidly by the direct immersion in liquid nitrogen. A number of tropical forest trees such as *Dipterocarpus alatus, D. intricatus* and *Pterocarpus indicus* and palms like *Veitchia merrillii* and *Howea fosteriana* have been successfully cryopreserved using this technique (Chin et al. 1988; Krishnapillay et al. 1992, 1994).

Seedling storage under low light conditions

On a commercial scale for the continuous supply of planting materials of recalcitrant seeds, it is necessary to develop complementary methods to cryopreservation that are easily executed by nurserymen. It is well established that dipterocarp seedlings usually have low survival and slow growth rates over a period of several months when grown under subdued light. The idea of using this phenomenon was first proposed by Hawkes (1980). Two methods outlined below have been tested.

These are (a) storage of germinated seeds in a controlled chamber and (b) storage of germinating seeds on the forest floor under subdued light conditions.

Seedling Chamber

With this method freshly collected seeds are surface treated with a fungicide (0.1% Benlate/Tiram mixture) and allowed to germinate under ambient conditions in containers kept at high humidity with moistened tissue paper. After radicle emergence, germinated seeds are packed loosely in polythene bags, trays or boxes lined with moist tissue paper and stored in a specially constructed seedling chamber in which the temperature, humidity and light are controlled. The temperature is 16° C, the relative humidity 80% and the photoperiod 4 hours. Light is supplied from a fluorescent source, giving 800-1000 lux.

Development of the germinated seeds into seedlings occurs slowly in the chamber. Seventeen dipterocarp species have been tested to date and the storage period ranges 4-12 months (Krishnapillay and Tompsett 1998).

Seedlings developed slowly in the chamber, barely attaining heights of 20-25 cm over the storage periods tested. Seedlings which were transferred to the nursery and grown in polythene bags needed to be weaned in at least 70% shade for a period of 2-3 weeks before they could be placed under direct sunlight. Survival percentage was between 60-80%, dependent on the species.

Forest Floor

The second approach for storage of seedling is on the forest floor under subdued light. Areas are cleared of undergrowth and freshly collected seeds are sown. Seedlings develop very slowly and so can remain within manageable height for long periods of time.

Seedlings of *Hopea odorata* did not grow to a height greater than 10 cm under these conditions over a period of three years. Seedlings transferred to the nursery and grown in polythene bags began to increase in size rapidly. Weaning in 70% shade for two weeks before transfer to direct sunlight was however necessary. Survival was approximately 80-90% depending on the species. Approximately 8 species have been tested to date.

The constraints with this method are as follows: in the early stages after sowing, unprotected seeds are likely to be predated by squirrels, birds and wild boars. Fencing the area with barbed wire and covering the seed with a plastic sheet is thus necessary. The plastic sheet can be removed when the seedlings have emerged when damage by birds and squirrels is unlikely.

CONCLUSION

Cryopreservation offers interesting technical possibilities for the conservation of valuable germplasm compared to conventional preservation systems. For the tropical recalcitrant forest tree species, there are several prerequisites which have to be fulfilled before long-term *in vitro* conservation/storage is to be considered.

With proper reduction in moisture content and controlled desiccation, seed-derived material can be stored in liquid nitrogen. Over issues relating to continuous supply of planting materials of recalcitrant seeded species, the slow growth strategy of storing germinated seeds either in special chambers or on the forest floor under subdued light although does not offer a long term storage solution but nevertheless, provides an option for mid term storage of such species.

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RECENT DEVELOPMENTS IN EUFORGEN

The second phase of EUFORGEN started on 1 January 2000 for a period of five years. As of October 2000, twenty-five countries had renewed their commitment through Letters of Agreement with the Programme. Five networks are operating during this second phase, some of them with a wider thematic and geographical scope than during the first phase. These networks deal respectively with *Populus nigra*; Conifers; Social Broadleaves; Mediterranean Oaks and Noble Hardwoods, and some of their main activities are summarised below.

- A technical bulletin on *in situ* conservation strategies for black poplar (*Populus nigra*), including a simple decision guide, was developed by Network members. Descriptors for inventories of *P. nigra* stands were endorsed and printed in the Report of the meeting.
- The main objective of the first EUFORGEN Conifers Network meeting was to discuss priorities and future activities of the newly established Network. The outputs of the previous *Picea abies* (Norway spruce) Network were reviewed. The Network started to expand the existing *P. abies* bibliography (available on-line) to include other conifer species. An information platform with links to the further information resources at country level was developed following the recommendation of the meeting.
- Twenty-four countries attended the third meeting of the Social Broadleaves Network. An overview of legislation related to genetic resources of Social Broadleaves was distributed and published on the Web site. The results of a questionnaire on the current status of Social Broadleaves were presented and discussed. As a follow-up, discussion focussed on the technical guidelines for the conservation of genetic resources of European white oaks.
- The Mediterranean Oaks Network members met for the first time in Turkey in October 2000. The outputs of the previous *Quercus suber* (cork oak) Network were reviewed (provenance experiment, bibliography, information sharing) or finalized (technical guidelines) and the new workplan endorsed.
- The Noble Hardwoods Network is currently finalising conservation strategies for a number of species. The next meeting of this Network will take place in May 2001.

The main items on the agenda of the recent informal meeting of Chairs of all EUFORGEN Networks, FAO and IPGRI were the harmonization of network activities and a preliminary discussion on the development of a system of in situ gene conservation areas for several target forest tree species throughout their distribution areas.

RECENT PUBLICATIONS

1999

Populus nigra Network. Report of the fifth meeting, 5-8 May 1999, Kyiv, Ukraine. Compiled by J. Turok, F. Lefèvre, S. de Vries, B. Heinze, R. Volosyanchuk and E. Lipman. International Plant Genetic Resources Institute, Rome, Italy (E).

Social Broadleaves Network. Report of the second meeting, 3-6 June 1999, Birmendsorf, Switzerland. Compiled by J. Turok, A. Kremer, L. Paule, P. Bonfils and E. Lipman. International Plant Genetic Resources Institute, Rome, Italy (E).

2000

Populus nigra Network. 2000. Report of the sixth meeting, 6-8 February 2000, Isle sur La Sorgue, France. Compiled by S. Borelli, S. de Vries, F. Lefèvre and J.Turok. International Plant Genetic Resources Institute, Rome, Italy (E).

Copies of the above publications can be obtained from IPGRI, Via delle Sette Chiese 142, 00145, Rome, Italy, Fax (39) 06 575 0309, Email: j.turok@cgiar.org.

More information on EUFORGEN can be found at: http://www.ipgri.cgiar.org/networks/euforgen/euf_home.htm

SOUTH PACIFIC REGIONAL INITIATIVE ON FOREST GENETIC RESOURCES (SPRIG) – PHASE 2[1]

by

Lex Thomson[2]

The first phase of SPRIG was a three-year AusAID-funded project (1996-2000) focussed on the conservation, enhancement and wise use of priority forest and tree genetic resources in the South Pacific. Project countries included Fiji, Samoa, Solomon Islands, Tonga and Vanuatu. The Australian managing contractor (AMC) consisted of a consortium of CSIRO Forestry and Forest Products (Managing Agent), Queensland Forest Research Institute and FORTECH. Phase 1 of SPRIG acted as a catalyst and focal point in raising awareness throughout the region of the importance of conserving forest and tree genetic resources and the possibilities for their better utilization and development. It also contributed in more tangible and substantial ways through:

- Provision of basic training in key subject areas of forest genetic resources,
- Planning for conservation and sustainable utilization of priority species, and
- Initiation of R&D activities on key indigenous and exotic tree species leading to identification and production of superior tree germplasm.

A comprehensive review of SPRIG Phase 1 recommended a continuation of the project to a second phase with an increased emphasis on development and sustainability.

The proposal for SPRIG Phase 2 follows a strongly supported recommendation from the eighth Pacific Heads of Forestry meeting held in Nadi, Fiji, (Sept., 1998) that the SPRIG project continue beyond the initial pilot phase (Phase 1). A second phase of SPRIG was also strongly endorsed at the Pacific Sub-Regional Workshop on Forest and Tree Genetic Resources held in Apia, Samoa in April 1999 and subsequently recommended in the AusAID mid-term review report of SPRIG Phase 1. Three relevant regional organisations *viz* Secretariat of the Pacific Community (SPC), South Pacific Regional Environmental Program (SPREP) and the University of the South Pacific (USP), have recognized the importance of conservation and management of forest and tree genetic resources. Each organisation is keen to be further involved in SPRIG, welcoming an opportunity for greater collaboration, leading to integration of regional components of the project. Requests for extension of SPRIG activities to smaller PICs in Phase 2 were also received from several Pacific Island Countries (PIC) Governments, including Kiribati and Cook Islands.

SPRIG Phase 2 has been designed as a five-year regional project. The project goal is *to "help PICs conserve, improve and better promote the wise use of the genetic resources of priority regional trees species to enhance environmental protection and to promote economic and rural development*". The project purpose is to "*strengthen the capacity of the participating Departments and regional organisations to conserve, improve and better promote the wise use of priority genetic resources in order to promote sustainable rural development*". The five components of SPRIG Phase 2 are:

- institutional strengthening and regional networking,
- conservation and sustainable management of priority species,
- tree improvement,
- demonstrating linkages between conservation, tree improvement and enhanced rural incomes, and
- project management

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The design of SPRIG Phase 2 differs from Phase 1 in that greater emphasis has been placed on development and sustainability issues at both the national and regional levels. The project aims to develop local institutional capacity and facilitate regional and national arrangements and cooperation such that the project's activities will be technically and administratively sustainable at national/regional level at the end of Phase 2. Institutional strengthening will be mainly through development of local personnel with a balance of hands-on training, technical short courses and tertiary training in key subject areas, and building on skills developed in Phase 1.

Important development elements of SPRIG Phase 2 include:

- development of local germplasm sources (seedling seed orchards and clone bank) and *ex situ* gene conservation stands,
- development and demonstration of model plantings of the region's priority tree species, including sandalwood (village level plantings in Vanuatu and Tonga), mahogany (*Swietenia macrophylla*) and *Terminalia richii* (semi-operational clonal plantings in Samoa),
- enhanced Government extension nurseries, including development of vegetative propagation facilities in Samoa,
- promotion of small demonstration outgrower schemes; whereby a few selected lead farmers are encouraged to plant clones of genetically superior tree material, and
- development of income-generating forest genetic resource activities in support of community-based conservation initiatives in Tonga (Ha'apai group).

The South Pacific Regional Forest Genetic Resources Expert group, an informal group of experts from Government, industry and NGOs, met twice during Phase 1 and provided technical guidance and information on regional priorities. During implementation of Phase 1, a very broad and diverse group of organizations and persons working on and/or with responsibility for forest and tree genetic resources in the South Pacific was identified, contacted and included in a SPRIG-maintained database. It is planned that these organizations and individuals be further involved and updated on SPRIG Phase 2 through the Pacific Islands Forests and Trees newsletter and electronically (through e-mail), and given all opportunity to input ideas and exchange information. The Pacific Sub-Regional Plan for the "Conservation, Management and Sustainable Use of Forest and Tree Genetic Resources" developed in Apia in 1999, will continue to provide an overview of regional priorities for Phase 2 of SPRIG.

It is planned that the project's regional activities will be successively adopted or taken up by regional organizations, especially during the latter years of Phase 2. Representatives from SPC, USP and SPREP will be invited to participate in the SPRIG Regional PCC meetings, and to develop plans progressively for SPRIG regional activities to be incorporated into Regional organization's plans and budgets during Phase 2 and upon its completion. Political events and uncertainties in Fiji and the Solomon Islands have delayed the commencement of phase 2. It is anticipated that the second phase of SPRIG will commence in early 2001.

SADC SUB-REGIONAL WORKSHOP ON FOREST AND TREE GENETIC RESOURCES[1]

by

Pierre Sigaud[2] and Joel Luhanga[3]

The SADC Sub-Regional Workshop on Forest and Tree Genetic Resources was held in Arusha, Tanzania, from 5 to 9 June 2000. National experts from 9 countries and territories attended, as well as representatives from international, regional, bi-lateral and national agencies. The objective of the workshop was to assist countries in Eastern and Southern Africa to assess the status of their forest genetic resources and to discuss the options for a regional plan of action. During the workshop, participants presented reports on the status of forest and tree genetic resources and discussed the main constraints in the sub-region. Based on the discussions, priority tree species, and common issues amenable to regional cooperation, were identified, and recommendations made for follow-up and implementation.

BACKGROUND

The SADC Regional Workshop on Forest and Tree Genetic Resources was held in Arusha, Tanzania, from 5 to 9 June 2000. This meeting is part of a series of workshops facilitated by FAO and other agencies to assist countries in the preparation of regional action plans on forest and tree genetic resources, following recommendations of the 13th Session of the Committee on Forestry (March 1997). The meeting, the first of its kind in the region, was organized by the Forestry Sector Technical Coordination Unit (FSTCU) of SADC. Invitations to the workshop had been sent to SADC member countries, to international, regional and bilateral organizations interested in the field of forest genetic resources, and to resource persons.

The major workshop sponsors and collaborators were the FAO Forestry Department, the International Plant Genetic Resources Institute (IPGRI) and IPGRI's Sub-Saharan Programme on Forest Genetic Resources (SAFORGEN), the DANIDA Forest Seed Centre, and the International Centre for Research in Agroforestry (ICRAF). Strong logistical support was provided by the Forestry and Beekeeping Division (FBD) of the Ministry of Natural Resources and Tourism, Tanzania, and the FAO coordinated UNDP/GEF East African Cross Borders Biodiversity Project.

The meeting was attended by 22 participants from 9 countries (Botswana, Malawi, Mauritius, Mozambique, Namibia, Swaziland, Tanzania, Zambia and Zimbabwe) and international, regional or national organizations (FAO, ICRAF, IPGRI, IUFRO-SPDC, SADC-PGRC and UNEP). Apologies had been received from the Secretariat of the CBD, CIFOR, DFID, DFSC, IUCN and SIDA. Partial attendance was made by officers from local and national authorities and projects.

WORKING SESSIONS AND OUTPUTS

National experts gave summary accounts of country reports prepared beforehand on the status of forest genetic resources. Their reports demonstrated significant differences among countries and underlined the diversity of values and functions traditionally attached to forest trees and shrubs. While some countries still have a high rate of forest cover, several participants stressed that heavy pressures on forests and woodlands were leading to an overall loss of biological diversity and forest genetic resources in the region. In some countries, there was a clear and urgent need for conservation measures targeting particular tree species. In addition to technical considerations, strengthening national capacities and addressing policy issues were reported as crucial factors in planning and implementing forest genetic conservation plans. A wide range of issues common to several countries, and opportunities for exchange of experience and know-how, were identified.

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Five thematic areas were proposed for discussions and incorporation in a regional action plan, viz prioritization of species and operational needs; ways to support sustainable utilization and management of forest and tree resources; issues related to germplasm exchange and access; institutional strengthening and training; and identifications of mechanisms for regional cooperation.

The relevance of a species approach, suggested as an entry point of the action plan, was debated and endorsed. It was recognized that such a strategy, based on utilitarian approach to defining priority species and tree populations, could help focus discussions on operational needs and requirements. In addition, it complemented other conservation strategies targeting ecosystems presently being addressed in other fora and programmes. A presentation was made of the SECOSUD regional programme coordinated by SADC, supporting national herbaria and plant collections.

Based on information provided by participants or gathered from country reports prepared beforehand, ten priority native species were identified for each of the following groups: (i) mainland countries and (ii) island countries (Mauritius). Only one species was found of common high concern to all mainland countries (*Pterocarpus angolensis*), reflecting the wide diversity of ecological conditions and forest types in the SADC area. Nine species were identified as top priority in at least two countries (*Afzelia quanzensis, Baikiaea plurijuga, Colophospermum mopane, Dalbergia melanoxylon, Faidherbia albida, Khaya anthotheca, Milicia excelsa*, *Sclerocarya birrea* and *Warburgia salutaris*). Pines and eucalypts were reported as the most important introduced genera in all countries, with cypress species widely planted at higher altitudes and casuarina plantations established along the sea shores. The lists were validated and complemented, for each species, by a scoring of technical activities most urgently needed (including exploration and collection of germplasm, evaluation, improvement, conservation *in situ* or *ex situ*). Managers of the FAO/UNDP/GEF project then briefed participants on the objectives and ways of functioning of the project and outlined criteria for GEF assistance in biodiversity-related projects.

In a following session, participants considered aspects related to sustainable use and management of forest and trees. A field visit to Mt Meru Forestry District illustrated changes in forest policies and their application at stand level. While management systems are being revised to identify and incorporate non-commercial considerations, efforts are also underway towards a better interaction with neighbouring human communities and a range of stakeholders. Participants debated the need for a multidisciplinary approach and a better integration of forest genetic resources considerations in wider frameworks such as biodiversity action plans and national forest programmes. The involvement of local communities in the decision-making processes regarding the protection and conservation of forest trees, complementing existing regulatory systems, was emphasized. Participants recognized the compatibility of genetic conservation (including *in situ* and *ex situ* techniques) and sustainable use of forests and trees. Considering the variety of forest types and conditions in the region, specific strategies and coordination actions for priority tree species should vary according to each species and its geographical coverage, from regional collaboration projects to national or local undertakings. Presentations by IPGRI and ICRAF illustrated the research aspects underpinning such strategies and programmes. Participants were also informed about *ex situ* conservation of forest tree germplasm undertaken by the SADC Plant Genetic Resources Centre.

A sub-session considered the complexity of the issues relating to access and exchange of germplasm, both within countries and among countries, through several viewpoints and a case study (the International Neem Network). In addition to legal considerations, issues regarding sharing of benefits derived from the use of genetic resources, quarantine and plant protection regulations and provisions to guard against invasive species, were presented and debated. CGIAR centres and CSIRO have developed practical procedures and models for Material Transfer Agreements (MTA). The Organization of African Unity and the SADC Plant Genetic Resources Centre are developing framework approaches to the issue. It was recommended that information available be provided to FSTCU, and that opportunities for developing regional agreements on access to and transfer of forest genetic resources, based on mutually agreed terms, and compatible with national laws, be explored.

The following discussions related to institutional strengthening and training, and regional cooperation. At country level, a number of institutions are involved in forest genetic resources, while coordination of policies and consistency of efforts are not always ensured. A need for increased information exchange and interactions among partners was identified. In addition, national and regional capacities should be strengthened by an appropriate balance of university training and "hands-on" sharing of technical skills and experience. Considering the number of research organizations involved in the issues of forest genetic resources in the region, participants emphasized the importance of sharing experiences, skills and information through formal networking and linkage instruments. On policy matters, participants recognized the need to raise awareness at all levels on the importance of forestry issues in general, and forest genetic resources conservation and management in particular. At operational level, a number of collaborative mechanisms, projects and initiatives on forestry, forest conservation and forest genetic resources already available in the region were presented (IUFRO-SPDC, SADC/FSTCU, SAFORGEN). Participants recognized that such efforts should be continued and encouraged, and proposed to enhance SAFORGEN's action in the region through contractual agreements with FSTCU.

The last part of the workshop was devoted to summarizing issues and recommended actions along thematic technical areas, and to compiling them into a draft action plan based on the conclusions of chairs and rapporteurs. Technical areas where specific actions were identified include (I) exploration and collection of germplasm; (ii) evaluation, tree improvement and seed supply; and (iii) conservation *in situ* and *ex situ*. It was agreed that the detailed elements of the plan of action would be completed later by FSTCU and FAO, in close collaboration with rapporteurs, and circulated to all participants prior to publication.

CONCLUSIONS AND IMMEDIATE FOLLOW-UP ACTION

The workshop provided a forum for discussion of key issues related to forest genetic resources in the SADC region. The participants recognized the need for, and agreed to develop, a regional action plan for the conservation and sustainable use of forest and tree genetic resources in SADC countries. A draft action plan based on the workshop discussions will be circulated to participants, after the proceedings have been finalized by FSTCU. The plan will be complemented by a synthesis of the status of forest genetic resources in Eastern and Southern Africa, based on data available in country reports. It is expected that the regional synthesis will also incorporate information not yet available, from Angola and South Africa. The synthesis and the action plan will be widely disseminated to institutions and organizations inside and outside of the region.

Information on the workshop and its outputs and documentation will be provided to other fora and meetings, including the African Forestry and Wildlife Commission. It is considered to make information available on line through the FSTCU homepage, with cross-references to the FAO world-wide Information System on Forest Genetic Resources (REFORGEN) homepage, and the Clearing House Mechanism of the Convention on Biological Diversity.

LIST OF ACRONYMS

CBD: Convention on Biological Diversity, Montreal, Canada
CGIAR: Consultative Group on International Agricultural Research, Washington, USA
CIFOR: Centre for International Forestry Research, Bogor, Indonesia
CSIRO: Commonwealth Scientific and Industrial Research Organization, Canberra, Australia
DFID: British Department for International Development, London, UK
DFSC: DANIDA Forest Seed Centre, Humlebaek, Denmark
FAO: Food and Agriculture Organization of the United Nations, Rome, Italy
FBD: Forestry and Beekeeping Division, Dar Es Salaam, Tanzania
FSTCU: Forestry Sector Technical Coordination Unit of SADC, Lilongwe, Malawi
GEF: Global Environment Facility, Washington, USA
IPGRI: International Plant Genetic Resources Institute, Rome, Italy
IUCN: World Conservation Union, Gland, Switzerland
IUFRO: International Union of Forestry Research Organizations, Wien, Austria
NGO: Non-Governmental Organization
SADC: Southern African Development Community
SAFORGEN: Sub-Saharan Forest Genetic Resources Programme, Cotonou, Benin
SPDC: Special Programme for Developing Countries (IUFRO), Wien, Austria
SIDA: Swedish International Development Cooperation Agency, Stockholm, Sweden
UNDP: United Nations Development Programme, New York, USA
UNEP: United Nations Environment Programme, Nairobi, Kenya

List of tree species identified as highest priority for action in Eastern and Southern Africa and ranking of required action

Species	Exploration and germplasm collection			Evaluation, improvement, seed supply			Conservation		Remarks
	Biological information	Geneco-logical studies	Germplasm collection and research	Field testing and evaluation	Selection and breeding	Seed supply	Ex situ	In situ	
Pterocarpus angolensis	1 B1, Mal2, Mo2, N1, Sw2, T-, Za1, Zi1	2 B *, Mal-, Mo3, N2, Sw2, T-, Za2, Zi1	2 B1, Mal2, Mo1, N3, Sw2, T3, Za1, Zi1	2 B*, Mal2, Mo2, N2, Sw2, T-, Za1, Zi-	2 B1, Mal2, Mo2, N1, Sw3, T2, Za2, Zi-	2 B1, Mal2, Mo3, N3, Sw1, T*, Za2, Zi-	2 B2, Mal2, Mo-, N1, Sw3, T-, Za2, Zi2	1 B1, Mal1, Mo-, N1, Sw2, T1, Za1, Zi2	Timber species Overexploited Slow growing, fire prone
Sclerocarya birrea	2 B2, Mal1, N2, Sw3	2 B1, Mal-, N2, Sw2	2 B*, Mal*, N3, Sw2	2 B*, Mal*, N2, Sw1	1 B*, Mal2, N1, Sw1	2 B*, Mal2, N3, Sw2*	2 B-, Mal1, N3, Sw2	3 B3, Mal1, N3, Sw3	Fruit tree, fodder, oil Priority for domestication by ICRAF. Sust. livelihoods of rural families
Milicia excelsa	2 Mal2, Mo2, T-, Zi1	2 Mal-, Mo3, T-, Zi1	1 Mal1, Mo1, T-, Zi1	2 Mal2, Mo3, T-, Zi1	2 Mal2, Mo3, T2, Zi1	2 Mal2, Mo3, T*, Zi1	2 Mal2, Mo-, T2, Zi1	1 Mal1, Mo-, T-, Zi1	Timber species Overexploited.
Baikiaea plurijuga	2 B2, N1, Za3, Zi3	1 B1, N1, Za1, Zi3	2 B1, N3, Za1, Zi3	2 B2, N1, Za2, Zi3	2 B2, N1, Za3, Zi-	3 B2, N3, Za3, Zi-	2 B2, N1, Za2, Zi-	1 B-, N1, Za1*, Zi-	High value timber species. Overexploited, Regeneration difficult.
Afzelia quanzensis	2 Mal2, Mo2, T-, Za2, Zi2	2 Mal-, Mo2, T-, Za3, Zi2	1 Mal1, Mo1, T-, Za3, Zi2	2 Mal2, Mo2, T-, Za1, Zi-	2 Mal2, Mo3, T2, Za3, Zi-	3 Mal2, Mo3, T*, Za3, Zi-	2 Mal2, Mo1*, T2, Za2, Zi-	2 Mal1, Mo1*, T-, Za-, Zi3	Timber species, shade, shelter. Overexploited.
Dalbergia melanoxylon	2 Mal2, Mo2, T-, Za2	3 Mal-, Mo3, T-, Za2	1 Mal1, Mo1*, T-, Za1	2 Mal-, Mo3, T-, Za1	3 Mal2, Mo3, T3, Za2	2 Mal2, Mo3, T*, Za2	2 Mal1, Mo-, T2, Za1	2 Mal1, Mo-, T1, Za2	
Khaya anthoteca	2 Mal2, Mo1*, T-, Za2	2 Mal-, Mo2, T-, Za2	1 Mal1, Mo1*, T-, Za1	2 Mal1, Mo1*, T-, Za2	2 Mal*, Mo1*, T2, Za2	2 Mal2, Mo2, T*, Za2	1 Mal1, Mo*, T-, Za1	1 Mal1, Mo1, T1, Za2	Timber species Overexloited.
Faidherbia albida	2 B2, Mal2, Za2	2 B1, Mal-, Za3	1 B1, Mal*, Za1	2 B*, Mal*, Za2	3 B3, Mal*, Za3	3 B3, Mal1, Za3	2 B-, Mal1, Za2	2 B2, Mal1, Za2	Fodder, charcoal, agroforestry, soil improvement
Colophospermum mopane	2 Bo*, Mal2, N2	2 Bo2, Mal-, N1	2 Bo3, Mal2, N2,	1 Bo*, Mal2, N1,	2 Bo3, Mal2, N1,	3 Bo3, Mal2, N2,	2 Bo2, Mal2, N2,	1 Bo2, Mal1, N1	Fuelwood, timber, termite Drought resistant.
Warburgia salutaris	1 Mo2, Zi1	2 Mo3, Zi1	1 Mo1, Zi1	1 Mo2, Zi1	1 Mo2, Zi1	1 Mo2, Zi1	1 Mo-, Zi1	1 Mo1, Zi1	Food species Endangered

Countries: B: Botswana, Mal: Malawi, Mau: Mauritius, Mo: Mozambique, N: Namibia, S: Swaziland, T: Tanzania, Za: Zambia, Zi: Zimbabwe

Legend: 1 = Top priority, action urgently needed; 2 = Action within the next 5 years; 3 = Action within the next 10 years; - = Action not required; * = Action in progress ; 2 = Average priority index; Mo3, Zi1 = Priority index by in individual countries

RECENT PUBLICATIONS FROM THE DANIDA FOREST SEED CENTRE

Guide to Handling of Tropical and Subtropical Forest Seed, by Lars Schmidt. July 2000. A textbook on handling of tree seed, from seed biology, through seed collection and processing to trade and transfer of seed. 15 chapters; 490 pp. (see below for more information)

Technical Note No. 55. Application of the Pilodyn in Forest Tree Improvement, by Christian Pilegaard Hansen. July 2000.

Technical Note No. 56. Handling of desiccation and temperature sensitive tree seed, by Kirsten Thomsen. September 2000

Technical Note No. 57. Laboratory manual for basic tree seed studies, by Kirsten Thomsen and Sigrit Diklev. September 2000.

Information on previous publications and on the activities of the DANIDA Forest Seed Centre in general is available at the DFSC homepage at http://www.dfsc.dk

Copies of the publications are available free of charge from:
DANIDA Forest Seed Centre
Krogerupvej 21
DK-3050 Humlebaek, Denmark
Fax: +45 49 16 02 58, E-mail: dfsc@dfsc.dk

A New Book for Your Library
'Guide to Handling of Tropical and Subtropical Forest Seed'

During his employment at Danida Forest Seed Centre, the Danish seed biologist Lars Schmidt was engaged in writing a new guide to handling of forest seed. Lars Schmidt, who has a university degree in biology, has many years' experience in practical seed biology and seed handling in the tropics. Based on a vast range of litterature, and on his own experience and that of his many forestry friends and colleagues world-wide, he has gathered valuable knowledge on seed handling of interest for the tropics and subtropics. Originally the idea was to update 'A Guide to Forest Seed Handling' by R.L.Willan, published as FAO Forestry Paper 20/2 in 1985, but the result became a new book written by an expert who is both a scientist and a practitioner. The list of chapter titles shows the wide range of subjects. Great efforts have been made to make it an inviting and useful book, and DFSC believes that it will be of interest to most readers of this newsletter.

Seed biology, development and ecology
Planning and preparation of seed collections
Seed collection
Fruit and seed handling, collection and processing
Seed processing
Phytosanitary problems and seed treatment
Seed storage
Dormancy and pretreatment
Germination and seedling establishment
Seed testing
Genetic implications of seed handling
Microsymbiont management
Seed documentation
Trade and transfer of forest seed

LATEST DEVELOPMENTS IN THE IMPLEMENTATION OF THE WORK PROGRAMME ON FORESTS OF THE CONVENTION ON BIOLOGICAL DIVERSITY[1]

by

Jean-Pierre Le Danff[2] and Pierre Sigaud[3]

The Convention on Biological Diversity (CBD) entered into force in December 1993 as part of the outcome of the decisions of the United Nations Conference on Environment and Development (Rio de Janeiro, 1992) decisions. In May 1998, the Conference of the Parties (COP) of the CBD adopted a work programme on forest biological diversity (Decision IV-7) which was reviewed during the fifth meeting of the Conference of the Parties, May 2000 (Decision V-4). Forest ecosystems will be an item for in-depth consideration at the next COP meeting in 2002 which will deliberate on, *inter alia*, expanding the work programme from research to practical action. Several other items in the work programme of the CBD are of direct relevance to forest biological diversity such as its work on indicators, traditional knowledge, public education and awareness, cooperation and the ecosystem approach. More generally, the CBD is the only global framework addressing forest biological diversity and genetic resources, their conservation and sustainable use.

BACKGROUND

The Convention on Biological Diversity which was formally adopted in May 1992 in Nairobi, Kenya, was opened for adherence at the United Nations Conference on Environment and Development (UNCED) at Rio de Janeiro, Brazil, in June 1992, where other instruments addressing directly or indirectly the forestry sector were adopted, namely: (i) the *Agenda 21*, Chapter 11 of which aims to "Combat Deforestation" and Chapter 15 deals with the "Conservation of Biological Diversity"; (ii) the "*Forest Principles*"; and (iii) the *United Nations Framework Convention on Climate Change* (UNFCCC).

The stated objectives of the CBD are, "*the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources*". To achieve its objectives, the Convention promotes partnership within and among countries. Its provisions on scientific and technical cooperation, access to genetic resources, and the transfer of environmentally sound technologies form the foundations of this partnership. The Global Environment Facility (GEF), the financial mechanism of the Convention, helps to fund the added costs of making planned projects environmentally friendly and finances regional approaches to multinational problems.

The Secretariat of the CBD is based in Montreal, Canada. The Convention, which entered into force on 29 December 1993, has to date been ratified by 180 countries. Decisions are taken by the Conference of the Parties (COP), which meets every two years to discuss thematic agendas. COP meetings are preceded by preparatory meetings of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) which provide relevant background information and make recommendations to the Parties.

FOREST BIOLOGICAL DIVERSITY

Within the CBD, while the issue of forest biological diversity was discussed at the first and at the second meetings of COP, the momentum was given at COP4, in 1998, where Parties adopted Decision IV/7 and the work programme for forest biological diversity. The work programme elaborates, as follows, the elements for inclusion:

(i) a holistic and inter-sectoral ecosystem approach that integrates the conservation and sustainable use of biological diversity, taking account of social and cultural and economic considerations;

(ii) a comprehensive analysis of the ways in which human activities, in particular forest-management practices, influence biological diversity and assessment of ways to minimize or mitigate negative influences;

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[2] Secretariat of the CBD, Montreal, Canada. The author wrote this paper in his personal capacity
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(iii) methodologies necessary to advance the elaboration and implementation of criteria and indicators for forest biological diversity, and
(iv) specific research and technological priorities.

COP-5 (May 2000) highlighted the need to expand the focus of the CBD programme of work for forest biological diversity from research to practical action. Decision V/4 calls upon parties, governments and organizations to take practical action within the scope of the existing work programme. It encourages the application of the ecosystem approach, a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It also decided to establish an *ad hoc* technical expert group on forest biological diversity to assist SBSTTA in its work programme. The group, whose mandate includes a review of available information on the status and trends of, and major threats to, forest biological biodiversity, and identification of options and suggestions for action for conservation and sustainable use of biological diversity and its genetic components, will report to SBSTTA at its Seventh Meeting in November 2001, in view of the discussion of COP6 (April 2002).

OTHER WORK PROGRAMMES

In addition to its work programme on forest biological diversity, the CBD addresses a number of issues directly affecting forest biological diversity and forest genetic resources. These issues include:
(i) Property rights on, and access to, genetic resources, and equitable sharing of benefits arising from their use. The on-going discussions in the framework of the Convention have contributed to raising awareness of the actual or potential value of genetic diversity. Exchange of materials, including the forestry sector where the issue has long been overlooked, is increasingly taking place under the terms of agreed contracts (Mutual Terms Agreements) recognizing the origin or provenance of the materials exchanged, even when exchange is made on a non-commercial basis.
(ii) Biosafety (safe transfer, handling and use of living modified organisms resulting from modern biotechnology) specifically focusing on transboundary movements. The Cartagena Protocol on Biosafety, adopted in January 2000, seeks to protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology. It establishes a procedure for ensuring that countries are provided with the information necessary to make informed decisions before agreeing to the import of such organisms into their territory.

The CBD has also initiated, or given impetus to, work on a global taxonomic initiative; agrobiodiversity, including forest trees growing in agricultural ecosystems; marine and coastal ecosystems, including the protection and conservation of mangroves; introduced alien invasive species, a major threat to forest genetic resources in some Pacific islands and in some countries of Southern Africa; and biological diversity of dry and sub-humid lands.

The CBD is the only international legally binding instrument to which actions and activities relating to conservation, sustainable use, management and enhancement of forest genetic resources can be referred at global level. In the forestry sector, although the need for specific focus on the management of the genetic resources of trees and shrubs has received increasing attention over the past 30 years, there is to date no forestry equivalent to the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture, which focuses on agricultural crop species. The plan, adopted by the Fourth International Technical Conference on Plant Genetic Resources in Leipzig, Germany in June 1996, makes reference to wild relatives of cultivated plants, often found in forest ecosystems, and to domesticated tree crops (fruit trees, rubber, etc.), but explicitly excludes forest genetic resources. The CBD work programme on forest biological diversity, and other related work programmes and activities, provides a global framework for action in which the issues regarding forest genetic resources can be addressed in a global and comprehensive, although not very specific, way.

Future meetings in the framework of the CBD with relevance to forests include: SBSTTA-6 (Alien Invasive Species, February 2001); SBSTTA-7 (Forest Biodiversity, November 2001); COP6 (Forest Ecosystems and Alien Species, April 2002); SBSTTA-8 (Protected Areas); SBSTTA-9 (Mountain Ecosystems), and COP 7 (Protected Areas and Mountain Ecosystems). More detailed information is available from the Clearing House of the CBD, at the Internet address: http://www.biodiv.org/chm/index.html.

REFORGEN NOW AVAILABLE ON THE INTERNET

by

Søren Hald[4]

In *Forest Genetic Resources* No 26 (1996), we informed our readers of the development by FAO of a world-wide information system on forest genetic resources (REFORGEN). The system is now available on the internet at the following address:

http://www.fao.org/forestry/FOR/FORM/FOGENRES/reforgen/

Fig 1. The REFORGEN homepage

The REFORGEN database is a tool for searching for information on forest tree species and the management of their genetic resources, as well as information on institutions active in this field. Information in the system is divided in two major groups:

(i) data **by species,** with related activities in a given country; and

(ii) data **on institutions** dealing with forest genetic resources in a given country.

The main topics include:

Species information	Information on institutions
- species origin (native or introduced) - species management (natural or planted) - main uses of the species - main threats, if endangered or threatened - *in situ* conservation activities - *ex situ* conservation activities - tree improvement activities - availability of reproductive material	- name of institution - address, telephone, fax no., e-mail address - name of contact persons in the Organization - type of Organization - main activities of the Organization

As of October 2000, the system includes data on more than 1600 species in 146 different countries and territories. Efforts now aim at harmonizing and updating information in the present format, towards the provision of key data describing the status of important tree and shrub species in the countries.

BACKGROUND

The development of REFORGEN was initiated in 1993 at the request of FAO's member nations and national institutions, especially in developing countries, to fill an identified gap in information. REFORGEN has been developed for use by national institutions who, at the same time, are the main providers of the information

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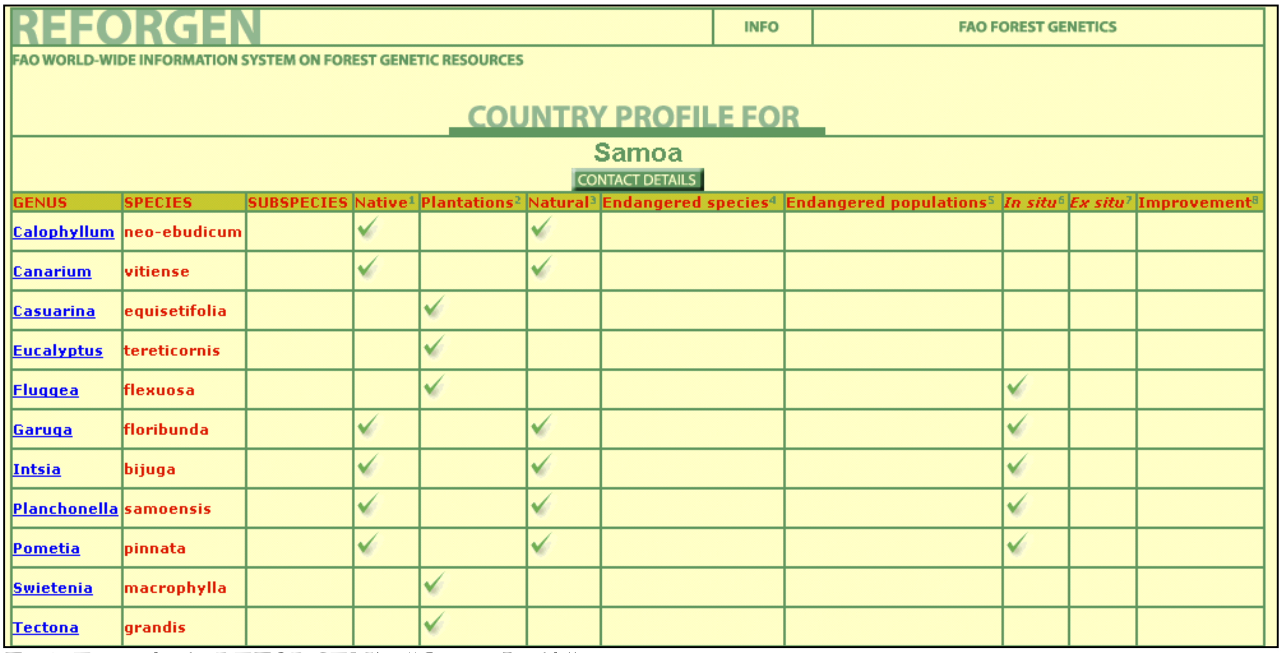
stored in the system. The technical development of the database programme has been carried out in collaboration with, and with the support of, the USDA Forest Service, International Programs.

The overall objective of REFORGEN is to provide reliable and up-to-date information on forest genetic resources activities for use in planning and decision-making at national, sub-regional, regional and international levels.

Its specific objectives are:

- to summarize, at national level, the status of the genetic resources of important tree and shrub species;
- to briefly describe, at national level, the main activities related to forest genetic resources;
- to help identify gaps in current activities at sub-regional, regional and international levels; and thus
- to highlight areas of potential collaboration, to strengthen action and impact;
- to facilitate decision-making on forest genetic resources priorities at sub-regional, regional and international levels.

The present system covers a number of key topics related to conservation and use of forest genetic resources. The basic question underpinning its development was: "*Who is doing what on which species*?". The system has therefore aimed at providing a short review of the activities carried out in a given country or for a given species, and relevant links to those institutions where the main activities are being carried out. Considering the large number of existing forest tree species and their unequal importance to human beings, REFORGEN has initially focused on those tree species of high utilitarian value, whatever the nature of the value[5]. Once basic information has been gathered, compiled and updated for all important tree species, the system may be extended, time and resources permitting, to a wider range of topics, in close collaboration and consultation with participating countries and institutions, based on the results and experiences gained.


REFORGEN | INFO | FAO FOREST GENETICS

FAO WORLD-WIDE INFORMATION SYSTEM ON FOREST GENETIC RESOURCES

COUNTRY PROFILE FOR

Samoa

CONTACT DETAILS

GENUS	SPECIES	SUBSPECIES	Native[1]	Plantations[2]	Natural[3]	Endangered species[4]	Endangered populations[5]	*In situ*[6]	*Ex situ*[7]	Improvement[8]
Calophyllum	neo-ebudicum		✓		✓					
Canarium	vitiense		✓		✓					
Casuarina	equisetifolia			✓						
Eucalyptus	tereticornis			✓						
Fluggea	flexuosa			✓				✓		
Garuga	floribunda		✓		✓			✓		
Intsia	bijuga		✓		✓			✓		
Planchonella	samoensis		✓		✓			✓		
Pometia	pinnata		✓		✓			✓		
Swietenia	macrophylla			✓						
Tectona	grandis			✓						

Fig 2. Example of a REFORGEN's "Country Profile"

SOURCES OF INFORMATION

The core data in REFORGEN was provided by FAO member countries through replies to a specific questionnaire despatched in March 1993 to all Heads of National Forest Services. The questionnaire invited Heads of Forestry to contact and consult the national institutions and agencies concerned, as well as other governmental bodies, research institutes, universities, the private sector and other relevant NGO's. The

[5] Species which were reported by national focal point institutions may reflect preferences in terms of social, economic, ethical, environmental or any other values

information provided through replies to the questionnaires has been complemented by data found in country reports prepared for the Fourth International Technical Conference on Plant Genetic Resources (ICPGR) held in Leipzig, Germany, June 1996. Additional relevant information is currently extracted from various country reports, publications, FAO field programme activities, travel reports, etc.

As mentioned above, the system presently includes information on forest genetic resources activities in 146 countries. The information relates to more than 1600 tree species. The amount of available information is fairly well distributed between regions and between developed/developing countries. It is however far from complete and there are large differences between countries in the amount of information presently available in the system, ranging from limited information on a few national priority forest tree species for some countries, to detailed information on a wide range of species and activities for other countries.

FUTURE DEVELOPMENT AND UPDATING OF REFORGEN

Having reliable and updated information is of crucial importance to the system, and efforts to secure a high degree of data reliability will receive top priority.

The task of maintaining and regularly updating reliable information is complicated by the many and different types of organizations active in the field of forest genetic resources in individual countries and the often low level of national coordination between them. It is further complicated by the different jurisdictions involved, at local, provincial, state and national levels. FAO has for some countries received uncoordinated information from more than one organization, and for others the information at present in the system is unlikely to be a fair representation of priority forest genetic resources in the country due to lack of comprehensive information from national actors. These shortcomings underline the importance of regular revision of information available in REFORGEN.

The process of revision and updating of the information by countries is on-going. Since the data is now available in the internet, it is hoped that countries, institutions, individual experts and users concerned will be in a position to help improve and complement the data. Other sources of updated and valuable information include country reports prepared for regional and sub-regional workshops on forest genetic resources[6]. In countries not yet covered by a regional process, individual focal points will be approached and their assistance requested for reviewing and complementing the data. Possibilities for delegating responsibility for updating to interested focal points, and options to allow users to update information directly through the internet, are also being explored. Voluntary contributions of information from individual institutions, experts and persons with an interest in the matter are also very much appreciated. REFORGEN is a tool whose value very much depends on the collaboration of its users to regularly revise, up-date and improve information contained in it.

Several databases containing either data on tree and shrub species data, or information on countries, exist on the internet today. The unique features of REFORGEN in addition provide crossed country/species information at species and population levels. Efforts are being made to link REFORGEN with other databases containing complementary information. The FAO Forestry Department homepage (http://www.fao.org/forestry/Forestry.htm) already allows navigation by countries for a number of topics (including forest cover, forest products, trade), and links to REFORGEN are planned in the future. Outside FAO, several databases complement REFORGEN's scope and format. They include: (i) the *Tree Seed Supplier Directory* and the *Agroforestree Database* maintained by ICRAF (http://www.icraf.cgiar.org/treessd/databases.htm); (ii) the *2000 IUCN Red List of Threatened Species* (http://www.redlist.org/); the *World Conservation Monitoring Centre's Tree Conservation Database*, available on Internet at: http://www.wcmc.org.uk/trees/index.html; and the CAB *Forestry Compendium* (http://tree.cabweb.org/Compendium/compenfrm.asp). Several taxonomic initiatives have also recently been launched or revived and their databases contain increasing amounts of data. Opportunities to create links with such databases and other systems will be explored in the future.

[6] See for example "*SADC Sub-Regional Workshop on Forest and Tree Genetic Resources*" in the present bulletin

THE FAO ELECTRONIC FORUM ON BIOTECHNOLOGY IN FOOD AND AGRICULTURE: A BRIEF SUMMARY OF THE FORESTRY CONFERENCE[1]

by

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The area of biotechnology in agriculture has created many questions about man's role in modifying the basic structure of organisms in relation to food supplies and their impacts on agricultural and wild-land ecosystems. Developments in biotechnology in forestry are somewhat behind agriculture but major advances are nevertheless being made. However, many questions about the appropriateness of biotechnology in agriculture are now being posed to the forestry community.

Within the framework of a series of two-month e-mail conferences on biotechnologies in food and agriculture, including the crop, fisheries, forestry and animal sectors, FAO recently organized an Electronic Forum on Biotechnology in Forestry, with special reference to developing countries. These forums were designed to enable a wide range of parties, including governmental and non-governmental organisations, policy makers and the general public, to discuss and exchange views and experiences about specific issues concerning biotechnologies in food and agriculture. The forestry conference, "*How appropriate are currently available biotechnologies for the forestry sector in developing countries*," was held from 25 April to 29 June 2000.

Nearly 170 individuals registered for this second conference, which ran shortly after the conference on crop biotechnology. Thirty-two messages were posted and a majority (88%) of the participants were from developed countries. The 32 submissions were written by 15 individuals (9% of all registered) from 10 countries. Genetic modification (GM) of trees was by far the biotechnology of greatest interest in the discussions, but molecular genetics and tissue culture were also discussed many times. Developments in tissue culture and molecular genetics were largely considered to be extensions of currently acceptable and well-known practices.

Below are some of the main points that were made during the conference.

a) The point was made several times that modern biotechnology should only be realistically developed for species which already have a substantial infrastructure in basic plantation technology (e.g. in seed collection, nursery techniques, silviculture and in tree breeding and related research) and thus that it should be an enhancement to classical breeding rather than its substitute.

b) The long generation time of most forest trees will likely be an important difference in the wide-scale development and application of GM technology to trees compared with crop species. For example, patents may only provide protection for a finite time period (e.g. 20 years), but biotechnology patents applied to trees may expire prior to the trees being harvested. On the contrary, if payments for the use of biotechnology are made at the development stage, then substantial economic benefits must be present in order to carry the costs of the investments. The long economic rotations of most trees also raised concern about the risk of pathogens developing resistance to GM trees. However, it was also pointed out that because of the long time period required to develop and use GM trees, the forestry sector should have more time to monitor and correct trends/policies regarding GM trees than the crop sector with GM crops.

[1] Received August 2000. Original language: English
[2] This work has been carried out in the framework of the Cooperation Programme between FAO and Scientific and Research Institutions

Participants argued that the use of GM trees in developing countries would largely be limited to trees that are harvested in a relatively short period of time (e.g., 10 years of age), such as those grown in intensive plantation forestry (e.g. *Eucalyptus* in South America or Africa, short rotation *Populus*). Only for species with relatively short rotation-ages, it was predicted that investments in biotechnology might be profitable. As well, testing should be more reliable with short-rotation species, as expression of the GM trait can be tested and monitored for the expected rotation time.

c) There was a clear consensus that many factors need to be considered in deciding whether or not any biotechnology is appropriate in forestry (i.e., biological, economical, and political restraints and opportunities). Therefore it was not easy to say that modern biotechnology is either appropriate or not appropriate for developing countries.

d) Many of the messages touched on the fact that there was much substantial public awareness and concern regarding the risks and benefits of biotechnology. It was discussed several times that there is a greater need for the public to be informed about these technologies, and how they could be applied to specific situations in forestry, before they should or will be used.

e) Several of the issues that might have been expected to have been debated (e.g. ownership/control of biotechnologies; the ability of developing countries to regulate and monitor the use of biotechnology products or the potential impact of *Bacillus thuriengensis* toxins on other organisms), were either not discussed or were discussed to a far lesser degree than in the crop conference. This was probably due to the higher level of application of GM technology in the crop sector today compared to forestry, where no GM trees have yet been commercially released.

A range of other topics was also discussed in the conference and these can be followed by consulting the actual messages posted on the FAO homepage (at http://www.fao.org/biotech/logs/c2logs.htm), or reading the Long Version of the Summary Document which should be posted soon at the above Internet site. Hard copies of these documents are available to readers of *Forest Genetic Resources* who do not have easy Internet connections, upon request to FAO.

THE GLOBAL FOREST RESOURCES ASSESSMENT 2000

Since 1951, FAO has regularly reported on the world's forest resources, in capacity of UN agency responsible for forestry and forest related issues, and in line with requests by its member nations. The global forest resources assessment programme (FRA) is carried out in cooperation with a number of national and international partners. The FRA coordination unit, based in the Forest Resources Division of FAO Headquarters in Rome, Italy, is responsible for the overall management and coordination of the periodic assessments. Other units of the Forestry Department and in the FAO Regional and sub-Regional Offices contribute to FRA 2000 by supporting these efforts and by coordinating special studies related to thematic issues such as non-wood forest products, trees outside forests, fellings and removals, and forest biological diversity. The UN Economic Commission for Europe (FAO-ECE) contributes by coordinating information collection and analysis for developed temperate and boreal zone countries[1].

Up-to-date information, with a baseline of the year 2000 (FRA 2000), will be released at the 15th Session of the Committee on Forestry (Rome, Italy March 2001). The information is based on available national reports, discussed over the past many years in a series of in expert meetings, scrutinised through expert advice and verified by countries concerned. Information on forest cover change is, additionally, supported by statistical sampling of the world's tropical forests through satellite remote sensing, which complements basic studies of the state and change of tropical forests at regional, ecological and pan-tropical levels.

FRA 2000 includes a set of country profiles, prepared for each country, which contain *i.a.* a general description of geography and the ecological setting; forest status in terms of coverage, volume and biomass; protection status in terms of legally protected areas; assessment of trends in forest cover change; and finally, a listing of major contacts and the sources and baseline data used in generating the information. In addition, geo-referenced maps of forests, protected areas and ecological zones, are made available within the framework of FRA 2000.

According to FRA 2000, forests in the year 2000 covered 27 per cent of the world's total land area. The distribution of forests between countries and regions was highly variable. Almost one half of the area of countries in Europe and South America was forested, whereas the corresponding area in Africa, Asia and Oceania was less than one-fifth.

The total area of forests was approximately 3 500 million hectares, including natural forests and forest plantations, these latter accounting for about 3 percent of the total. About one half of the world's forests were located in tropical and sub-tropical regions, predominantly in developing countries. The other half was found in temperate and boreal regions, predominantly in industrialized countries.

Between 1980 and 1990, deforestation amounted to 15.5 million hectares per year. While deforestation was still high in the 1990s, the trend towards slowing down of deforestation rates, noted already in the interim assessments published by FAO in 1997 and 1999, was ultimately confirmed. Accordingly, data released at the XXI IUFRO World Congress in Kuala Lumpur, Malaysia in August 2000, indicated that the rate of deforestation in tropical countries, where most deforestation was taking place, was at least 10 percent less in the past ten years than that documented for the 1980s.

The major causes of deforestation were the expansion of subsistence agriculture in Africa and Asia and large economic development programmes involving resettlement, agriculture and infrastructure in Latin America and Asia. In addition to deforestation, which refers to permanent loss of forest cover, un-managed harvesting of industrial wood and fuelwood, overgrazing, fire, insect pests and diseases, storms and air pollution continued to cause at times severe degradation of all kinds of existing forests.

[1] Europe, USA and Canada, the Commonwealth of Independent States (CIS), Australia, Japan and New Zealand

On the international level, a number of international agreements and conventions, notably those dealing with biological diversity and climate change, require country-based quality inputs to underpin models and analyses, as well as to support regional and global monitoring. On the national level, reliable information is needed for policy development and implementation and for regular monitoring and reporting, with a view to improving prevailing practices. To meet such needs, FRA 2000 has helped develop comparable, comprehensive, reliable and authoritative baseline data on forest resources and related parameters for all countries and regions of the world.

Lessons learned during the execution of FRA 2000 will provide a sound basis for the development of new and better ways of generating reliable information on the world's forests. Experience to date points to the urgent need for both industrialized and developing countries to improve their national assessments through the implementation of comprehensive, continuous forest inventory practices, and to broaden surveys beyond traditional timber inventories to provide information needed to underpin sustainable forest management, taking into consideration productive, protective, social and environmental functions of forests and forest ecosystems.

Note. The results of FRA 2000 are released on the FAO Forestry Department website as they became available (http://www.fao.org/forestry/fo/fra/index.jsp), including country data on forest cover and change, by country. Results of the Special Studies will also be made available on the website, as they become available. All key information will also be published in printed form in the course of 2001.

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