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FOREST GENETIC RESOURCES
INTERNATIONAL AND AUSTRALIAN PERSPECTIVES

by

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SUMMARY

Trees constitute key components in a healthy environment, and are of pivotal importance to human and societal development. While most other plants are viewed rather dispassionately and food crops are viewed as "commodities", trees are frequently given intrinsic moral and ethical values. Such values are additional to the range of wood and non-wood products and environmental services provided by forests and forest ecosystems. Australian trees have over the past century yielded a number of goods of importance to the national economy. In addition, the distribution and trade in Australian tree seeds has, over the past 200 years, been a resource which has benefited Australia; these benefits have, however, been most pronounced in a large number of countries in the Mediterranean, and in the tropics and sub-tropics, which have introduced Australian tree species and established large areas of forest plantations for productive and protective purposes. The paper traces the history of forest genetic resources work in Australia, with special reference to the collection, handling and distribution of seeds, information and know-how, starting from the founding in 1962 of *The Eucalyptus Clearing House*, established by the Forestry and Timber Bureau in response to calls for action within the FAO Freedom for Hunger Campaign, and as a contribution to activities of the World Seed Year in 1961; through to modern days and the Australian Tree Seed Centre, a highly skilled, specialized unit, attached to the CSIRO Division of Forestry and Forest Products. The paper acknowledges the unique Australian contribution to national and international efforts in the conservation and wise use of forest genetic resources, supported by the work of the ATSC. It places Australian achievements over the past decades within the context of international developments, reviewing the history of seed exchange, advances in tree breeding and in related fields of science, and comments on the relevance and likely effects of new international agreements and regulatory frameworks. Finally, some predictions and suggestions are made related to the future role of the ATSC.

CONTENTS

SOME REFLECTIONS ON THE HISTORY OF FORESTRY

It has rightly been said that trees are at the very basis of life on this planet. They constitute key components in a healthy environment, and they are of pivotal importance to human and societal development. Their presence throughout history has enabled the growth of cultures and productivity; their absence has routinely diminished the likelihood of both. Human responses to threats or loss of trees are often passionate and emotional. While most other plants are viewed rather dispassionately and food crops are viewed as "commodities", trees are frequently given intrinsic moral and ethical values (Bouke 2001). Forests of course also provide wood and non-wood products which constitute one of the largest, but often less publicized and publicly noted economic sectors worldwide, underpinning the economies of many nations. The role of trees and shrubs in the provision of goods for rural communities is fundamental to well-being and food security; their role in watershed management, soil stablization, rehabilitation of degraded lands, and as providers of shade, shelter and other services, is at times maybe even more fundamentally important than are their multiple productive roles. Over the past decade, the role of forests and forest ecosystems as guardians and habitats for biological diversity has been much highlighted and may be today better known to the man-on-the-street than their productive, protective and social functions.

Some 10,000 years ago, agriculture began, with the Neolithic revolution As my FAO colleague, Clive Stannard noted in a recent publication, "we are still coasting on the Neolithic" (Stannard 2002). Over the centuries local farming communities - in repeated bursts of creativity - applied invention to the most promising of the wild plants around them, and substantially added value to them. Crop and animal domestication made settled life possible, and human populations grew exponentially. Population density led generation after generation to move over the next hill, and in so doing they spread their crops and other species useful to Man into new environments. Looking at the more recent past, the human population at the beginning of the 20th century was some 1.6 billion, by the middle of the century this had increased to 2.5 billion, and in the year 2000, world population had exceeded 6 billion. In parallel with population increase, aspirations for higher standards of living have multiplied *per capita* consumption of resources (Lanly and Allen 1991). Between 1960 and 1995, during which the human population almost doubled, the world economy increased 3 ½ fold. In forestry, the area of plantations increased from 18 to 44 million hectares. In 1990, 23% of the plantations in the tropics were eucalypts, 8% acacias (Carle *et al.* 2002).

Looking more at the recent development of human perception of forests and forestry, in the 1950s and early 1960s, the main focus was on <u>industrial species</u>. Development was largely perceived as industrial development. Many Forestry Departments, including the Forestry and Timber Bureau and the Forest Research Institute of Australia, were at the time administratively located in the *Ministries of Primary Industries.*

Accordingly, the World Symposium on Man-Made Forests-1967, organized by FAO and IUFRO in collaboration with the Government of Australia, in Canberra in 1967, stressed that forestry, no less than agriculture, must pursue the technological revolution, where production is obtained from smaller areas through greater inputs. There was a strong emphasis on economic growth and rising material well-being (FAO 1967, 1967a).

At the same time, the need to focus on the needs of increasing populations, especially in tropical countries, was highlighted in international circles, noting the need to pay attention to shelterbelts to protect crops and to the overall role of forestry in increased food production. In addition to the need to select and breed trees to produce high-yielding timber varieties, the role of forestry in establishing forest plantations on difficult sites and in expanding urban areas, was stressed by the First World Consultation on Forest Tree Breeding in Stockholm in 1963 (FAO 1964). Thus, the multiple functions of trees and forests were understood well already at that time.

In the 1970s and the 1980s there was an increased realization in the world of the fundamental need for <u>rural development</u> as a cornerstone for national well-being. Agroforestry species, multipurpose species for food and fodder, and not least fuelwood producing tree species, was increasingly in focus. Correspondingly, many Forestry Departments were administratively moved to become part of *Ministries of Agriculture*.

Genetic conservation became an acknowledged, urgent need in the wake of discussions in fora such as the UN Conference on the Human Environment held in Stockholm in 1972. The need to pay attention to land use planning and the wise management of forests, was strengthened by the subsequent release by FAO of the 1980 Forest Resources Assessment (FAO 1982), which was the first truly global such assessment of state and trends. Following discussion around these issues, the 1990s, in turn, became the decade marked by increased environmental concerns; and Forestry Departments in many countries were administratively moved to become part of the *Ministries of the Environment*. Towards the end of the 1990s, the social dimensions of forests and forestry became more pronounced. The Third International Tree Breeding Consultation held in Canberra in 1977, strongly underlined the importance of widening economic analysis of tree improvement programmes to include estimates not only of financial, but also of net social, benefits (FAO 1977, 1979). In the 21st century, a "*scientific fix*" is frequently looked for, with stronger influence from, and links, between Forest Departments and *Ministries of Science.*

The above developments have been underpinned by perceptions of forests which have gone from "*Nature is a Threat*"; to, " *Man Conquers Nature*", to "*Back to Nature*". As recently as in the Canberra Man-Made Forests Symposium (FAO 1967, 1967a), Jack Westoby of FAO drew attention to the important contribution which man-made forests can make in what he called, "*Man's ceaseless struggle to master his environment*". More recently, the perception of Nature against Man and Man against Nature, at least in many industrialized countries, has been followed by a re-awoken, "Back to nature"- emphasis. Modern man shies away from change, and in the erroneous belief that nature is static, and that the present state is ideal, wishes to stop all human intervention in forests and forest ecosystems. Maybe, here, Man is actually looking for some kind of "Eternal Youth"… which, unfortunately, does not exist! This syndrome has pointedly also been called, "*The nostalgia of wilderness*" (Thirgood 1981).

It is interesting to note that in 1947, the Grand Old Man of tropical forestry, André Marie Aubreville, in an article published in issue number 1, volume 1, of the FAO journal Unasylva, noted wisely: "*Man has set fire to the forest for the same reason that he has hunted, in order to be able to survive in the midst of a hostile nature. By destroying indiscriminately, however, he has only added to the difficulties a tropical climate imposes*" (Aubreville 1947).

Honest, common sense also came through in a book which I recently read on Forestry Research in Finnish Lapland, way north of the Arctic Circle which, in an attempt to balance the extreme positions and varying perceptions opposed to each other in today's world, noted: "*Nature is a friend, but Nature is also at the same time a fierce and merciless competitor and can be a frightening foe*". Subsequent chapters in the book made serious attempts to review forest management as a tool to balance the economic, environmental, social and spiritual values of forests (Varmola and Tapaninen 2001).

The late Gene Namkoong – a pillar in modern forest tree breeding and a great thinker and philosopher- in one of his last articles. stressed that forests were, "*the epitome of diversity*" (Namkoong 2001). He noted that present efforts at forest management and conservation often reflected values of dominant economic powers or a preservationist counter-culture, neither of which brought any higher level of justice to the people affected or concerned. He saw it as our obligation not to abuse this complex system through ignorance, and to avoid management which would simplify forests to manufacturing factories, or attempt to restore or preserve, "*a world that never existed".* He highlighted the evolutionary interdependence between forests and humans, and the need to focus on the issue of *how* to manage forest ecosystems, rather then *whether* to manage them (Namkoong 2002).

VALUE OF EXTERNAL REVENUE FROM AUSTRALIAN TREES TO AUSTRALIA

Australia is a mega-diverse continent in terms of biodiversity with more than 80% endemism in its more than 44 000 flowering plants. Two of the most visible tree genera, *Eucalyptus* and *Acacia,* together comprise about 2 500 species (Anon 1998, 2002e,f).

Australian timber was exported long before the country shipped wool, wheat, butter, fruit and metals to Europe. These timbers were known for their exceptional hardness or, conversely, for the ease with which they could be worked. In addition, Australian trees have over the past century yielded a number of other goods of importance to the national economy. Reportedly, about $US 200 000 worth of routine, a eucalypt extract, was exported from Australia to the USA every year in the 1960s (Stivens 1966). In the 1950s, cineole-rich foliar oil from *Eucalyptus polybractea*, was an important commodity, as is presently foliar tea tree oil extracted from *Melaleuca alternifolia* (Anon 1994). Exporting seed from State Forest Services generated trade benefits to Australia of around $A 5 million per year in the 1980s (Anon 1988), and the 25-30 tonnes of seed annually exported from Australia in the 1990s were reportedly valued at some $A 9-12 million (Anon 2002f).

HISTORY OF SEED EXCHANGE

The FAO document, "Handling Forest Tree Seed", published in 1955 (FAO 1955a), noted: "*Some parts of the world have an abundance and others are lacking tree species. International exchange of tree seeds is an opportunity to share the world's forest wealth*."

"There is something very fitting about the exchange of seeds between nations. In distributing seeds of its native trees, a nation loses nothing of its own resources, but [provides] other countries with trees that have been its wealth and pride.". Already at that time, 50 years before the invention of the word, "biosafety", the book noted: "*There are, however, certain dangers, and care must therefore be used to see that only the best stock of suitable geographic source is utilized, and that no diseases, insects or noxious weeds are inadvertently imported."*

The international transfer of germplasm and cultivation of agricultural, forestry and other introduced plant species have long histories. Apart from helping human populations to meet basic needs of food and fibre, exotic plants have at times helped direct or change history. As noted by Midgley, in the late 15th Century, a European craving for pepper and spices influenced the Portuguese, Italian and Spanish exploration of other continents; sugar cane and the need for labour for its cultivation led to trans-Atlantic slave trade and shaped the modern Caribbean; the potato and its narrow genetic base and pest problems in Ireland in the mid 1980s led directly to one of the great human migrations in history (Midgley 1999).

Vigorous action to introduce forest tree species from other countries was also evident already early in the 20th century. As an example of the boom in forest tree seed trade, the Danish author, N.E. Tulstrup, in a fascinating article in Unasylva in 1959, noted that during the winter 1901-02, one single seed firm in Darmstadt, Germany received from France and Belgium more than 200 railway truck-loads of Scots pine cones. The seed was widely distributed in Germany and neighbouring countries from a kiln in the city, simply as seed of "Darmstadt origin" (Tulstrup 1959). No wonder that Central Europe has over the past years experienced problems with extensive areas of mal-adapted forests, reportedly of "native species", which are dying of causes attributed to anything from acid rain to climate change, insects and diseases!

Inter-continental trade in forest seed was first documented in the early days of the eighteenth century, when seed of several eastern American species were shipped to Europe for use as ornamentals. Plantations of species such as *Picea glauca* and *Pinus strobus*, and some North American hardwood species, were also established in Europe at the time. The first introductions of eucalypts into the Mediterranean region took place in the early 1800's, and large-scale plantations were established in the second half of the century. In some of today's main eucalypt-planting countries, such as Brazil, large-scale plantations were started in 1910 or later. China first introduced eucalypts in the 1890s (FAO 1956a). By 1998, China had close to one million hectares of eucalypt plantations (Midgley 1999; FAO 2002).

In the wake of increasing interest, FAO and the Forestry and Timber Bureau organized a two-month *International Study Tour on Eucalypts* in Australia in 1952. Forestry experts from 24 countries participated in this tour, with the purpose of familiarizing themselves with the natural environment of eucalypts of actual or potential value to other countries. Country reports prepared by the participants showed that eucalypts had been planted in more than 50 Mediterranean, sub-tropical and tropical countries, for a range of purposes, (mainly for firewood, but also for posts, poles, mining timber and charcoal, for railway sleepers, sawnwood, pulpwood and as windbreaks, in land reclamation, soil fixation and for the production of oils, other extractives and foodstuffs such as honey). The two countries that at that time had introduced the largest number of eucalypt species were Brazil and South Africa. At the same time, it was noted that, while some 30 species of eucalypts in Australia were used for industry at a relatively large scale, little eucalypt planting had taken place in the country up to that time (FAO 1955).

A *First World Eucalyptus Conference,* was organized by FAO in Rome in 1956. The purpose of the conference was to discuss the advantages and the disadvantages of eucalypts, and to review progress in research, silviculture and utilization. The conference noted that, thanks to the adaptability and versatility of species of *Eucalyptus*, they were rapidly being introduced in a number of countries: *"Species of [the genus Eucalyptus] have made it possible to reclaim and afforest waste lands, fix dunes, increase crop yields through shelter afforded by windbreaks, and augment farm returns by plantations in various forms*" (FAO 1956a).

Interestingly, the Conference addressed the fears expressed in certain circles concerning an excessive extension of planting as regards both soil evolution and possible difficulties in utilizing the timber produced.

In the conclusions it was however noted that such fears were generally groundless, or greatly compensated by, "*the immediate anticipated physical, economic and social advantages of planting eucalypts on land unsuited for farming or no longer farmed, or in replenishment of degraded forests*". Possible adverse effects were, moreover, "*limited by the prospects opened up by the conversion of [eucalypt] plantations into relatively stable formations by means of associated [local] species.*" Potential problems could be avoided, "*with all the techniques, care and protection that such [tree] crops require*".

These statements, made in 1956, are very much in line with the findings of the FAO study carried out in the mid 1980s on the ecological effects of species of the genus *Eucalyptus* and published as Forestry Paper 59 (FAO 1985).

In relation to future markets, the 1st *Eucalyptus* Conference (*op.cit.)* noted: "*Supply of abundant, regular, easily accessible and therefore cheap produce, will always find a market in very many regions*". This same principle was echoed in the first edition of the FAO book, "*Eucalypts for Planting",* which had been published just prior to the meeting, in 1955, which noted, maybe in a somewhat overly critical manner, and without giving credit to the principle, "Beauty is in the Eye of the Beholder": "*In many countries, the most pressing forestry problem is quick production, not so much high quality timber. Eucalypts provide remarkable material for planters who, in the regions of the globe poorest in forest resources, believe in the efficient production of wood in quantity, even if the crops grown do not measure up to the exacting standards of silviculturists of the old school or truly represent 'the forest beautiful'* " (FAO 1955). Fast growth of eucalypts, more than beauty, was also stressed by Dal Stivens who, in an article in 1966 published in Unasylva noted: "…eucalypts outside of Australia, [*are reported to grow much*] *faster than they do in their homeland; that is [at least] what some Californians claim, but they have been known to make extravagant claims before''* (Stivens 1966).

By the time of the second *FAO World Eucalyptus Conference*, held in São Paulo, Brazil in 1961, close to one half of a million hectares had been planted with eucalypts in that country, and 144 species of this genus had been field tested, covering many climatic regions (FAO 1961). The area of eucalypts in Brazil is today just under 3 million hectares (FAO 2002).

Since the 1920's, much evidence accumulated which showed the importance of seed source and provenance for adaptation and growth. Despite this realization, and despite vigorous dissemination of information on the importance to ensuring that seed used was of good physiological quality, international trade in forest tree seed continued to rely on the lowest bid. Despite the "common knowledge" that seed quality will decisively influence the success or failure of tree planting projects, seed matters are still today often considered peripheral to mainstream forestry. In the Second Eucalypt Conference, one of the Grand Old Men of Australia, Max Jacobs, noted: "*Tree-planting programmes in many countries are still at the stage of using seed and stock from the most readily available sources, frequently irrespective of species and generally irrespective of quality and origin*" (Jacobs 1961). Steve Midgely and co-authors, almost 40 years later, in the Beijing IUFRO Tree Breeding Conference in 1998, noted that seed procurement was still, in the wake of the 21st century, more often than not the responsibility of administrative and clerical rather than technical staff in plantation programmes– and, thus, seed purchase was still in the late 1990s frequently based on the cheapest bid (Midgley 1999, 1999a).

Both Jacobs in 1961, and Midgely in 1999, stressed that seed cost constituted a minute proportion of that of forest plantation establishment: from 0.1 to just over 3%. Jacobs noted, pointedly, in his 1961 presentation: "*There is no purpose in any country purchasing eucalypt seed to a certain value unless funds are available at a rate of at least one hundred times that value [for plantation establishment and management*]". The FAO slogan from the 1950s: "*Good Seed Does Not Cost, It Pays",* was re-launched, first in a 1989 IUFRO meeting in Queensland, and subsequently forcefully stressed by the Australian Tree Seed Centre in its publicity campaigns in the 1990s (Anon 2002e,f). A complementing principle, stressed to national governments and donor agencies alike over the years by both CSIRO and FAO, is that seed-related work deserves strong investment in local technical and administrative skills; the managers of seed are, in fact, managing a very valuable resource.

My own message, over the past 30 years, has been that any seedlot moving within or outside of national borders without documentation on origin, provenance and genetic and physiological quality, must be disqualified from use and -without fail or exception- coldly discarded. I have stressed that the frequently expressed opinion, "*any seed is better than no seed at all*", could not be more misguided, outright wrong and potentially of great and irreversible harm to our genetic patrimony (Palmberg-Lerche 1993a,1999). Needless to say, seed records must follow through from nursery to plantation, and be maintained throughout the life of the plantation- as stressed already in the 1st World Consultation on Forest Tree Breeding in 1963 (FAO 1963,1964). There are still today many sins committed against this rule, in many or most countries in the world.

The need to safeguard local genepools against pollution from hybridising, outside sources of pollen, has gone hand in hand with such messages. Unfortunately, as evidenced in the writings of Tulstrup, mentioned above, the case seems to have been lost for many species in much of Europe. Millar and Libby, in noting an almost total lack of understanding of the risks and potential losses related to the contamination of local genepools by pollen from introduced genetic materials, have called the unqualified calls for use of *"native species"*, a *"Disneyland Fantasy"* (Millar and Libby 1989).

There is an urgent need for major actors, including prestigious establishments such as the European Community and the Convention on Biological Diversity, to heed established scientific and technical principles related to movement of forest germplasm and conservation which take into consideration the need to safeguard local genepools, and to discontinue incentives and correct regulations which may negatively affect such principles.

AUSTRALIAN TREE SEED CENTRE: EARLY DAYS AND DEVELOPMENT OVER THE YEARS

In 1957, the 9th Session of the FAO Conference noted that the extensive use of high-quality seed of improved varieties in agriculture was, *"one of the most generally and most economically applicable measures for increasing productivity*" (FAO 1957). The launching by FAO of the year 1961 as the "*World Seed Year*", within the framework of the *Freedom from Hunger Campaign*, aimed to vigorously raise awareness of this principle throughout the world. In this campaign, and in all documentation and in the many events related to it, it was officially recognized that an important element in any strategy to ease and fight hunger and malnutrition in the world related strongly also to the production and use of better forest tree seed and to increased efforts in forest genetics and tree improvement (FAO 1959, 1959a; Anon 1960).

Within the framework of the World Seed Year, FAO Member Governments were called upon to initiate or intensify, "*programs for the production and distribution of high quality seeds through a suitable national authority*". "*The Eucalyptus Clearing House"*, was established in 1962 by the Forestry and Timber Bureau of Australia in support of these calls for action (FAO 1961, 1963, 1964).

The original mandate of the *Eucalyptus Clearing House* was to, (i) assemble and disseminate technical information on *Eucalyptus* species most suitable for wood production and for sheltering field and food crops; (ii) assist in the procurement of certified seeds of *Eucalyptus* species suitable for use in countries outside of Australia; and (iii) conduct research on the genetics of *Eucalyptus* and in tree breeding for improved varieties. It was stressed that all of these activities would also benefit Australian growers and the Australian forest industry, both directly and indirectly, through information gathered from other countries which would complement and help expand the knowledge base in Australia. The United Nations, and more specifically FAO, was recognized as the proper coordinating agent for the work at international level (FAO 1961; Jacobs 1961).

Dr. Max Jacobs, in a paper prepared for the Second Eucalyptus Conference in Brazil in 1961, noted that the Forestry and Timber Bureau would not be the sole provider of seed and information, but would work in close collaboration with the State Forest Services, Universities and other appropriate Australian institutions. In addition to being a decision in principle, this was in fact a necessity: seed collection in Australia at the time was routinely done in connection with commercial felling and, therefore, there was a need to ensure that seed crops were available in areas being felled, synchronizing timing of felling and seed collection. Jacobs, further, noted that it was hoped to gradually improve arrangements also for the collection of seed of non-commercial eucalypts desired in other countries. However, he warned that orders may take a considerable time to fulfil, seed would be expensive, and it would likely only be possible to supply very small quantities of seed, which should be used by introducing countries for the establishment of seed production areas to satisfy additional needs (Jacobs 1961).

It is interesting to note that, from the outset, it was stressed that Australian seedlots should be sold at cost or commercial price, in acknowledgement of the considerable costs involved in arranging and ensuring the supply of seed of good quality. It was noted that only if those receiving seed were obliged to pay for it, would they fully understand the value of this important commodity and treat it with the care it deserved. It was repeatedly stressed, echoing the recommendations of many sessions of the FAO Panel of Experts on Forest Gene Resources, that countries seriously interested in eucalypts should develop their own seed sources of all major exotic species and provenances in use, soonest possible (FAO 1968-2002).

Commencing in 1962, the Forestry and Timber Bureau routinely provided a leaflet on seed handling with each seed order, hoping thus to help prevent wasteful use of seed and enable limited supplies to assist more countries. These leaflets, subsequently, grew into useful, massive reference books, used throughout the world. The publication of two *magum opuses, "Growing trees on Australian farms*" (Brown 1968); and "*The use of trees and shrubs in the dry country of Australia" (*Hall *et al.* 1972), provided the knowledge basis for more intensive use of eucalypts also in Australia; yet, it would take many years before action in the country caught up with the scale of eucalypt planting in other countries.

In response to the *World Seed Year*, the second edition of the FAO Tree Seed Directory was issued in 1961 (FAO 1961a; see also FAO 1958a, 1975b; and ICRAF 1986,1997, for other editions of Forest Seed Directories). Things were moving, and seed and genetic improvement started being a well-known field of discussion in national and international fora, culminating in the FAO/IUFRO World Consultations on Forest Tree Breeding held in Stockholm in 1963, Washington D.C. 1969, and Canberra 1977 (FAO 1963, 1964; FAO 1969, 1970; FAO 1977, 1979). A fourth tree breeding Conference was organized by IUFRO in Beijing in 1998 (Matyas 1999).

Activities related to seed certification were also energetically discussed, however, progress was slow and continues to be less than adequate even today in many countries. A forest seed certificate form was adopted as early as 1951 by the FAO Conference. Some further elaborated forms and related guidance, were later published as an annex to the FAO Handbook, "*Handling Forest Tree Seed*" (FAO 1955), and in Unasylva (Morandini 1961). Matthews, who reviewed progress in forest tree seed certification in 30 countries in a paper presented at the First World Consultation on Forest Tree Breeding in 1963, noted that, in spite of the obvious advantages to both suppliers and purchasers, only a handful of countries, and only Mexico in the developing world, had adopted forest tree seed certification. He noted that the effectiveness of implementation of such schemes depended on efficient but flexible and functional supervision and inspection of seed imports and exports, which at the time was largely lacking (FAO 1963; Matthews 1963). This brings, to me, visions of today's situation, in spite of efforts such as *e.g.* the organization of a IUFRO coordinated meeting in the subject in 1992 (KEFRI/GTZ/IUFRO 1992).

In the late 1960s, the potential of other Australian tree genera, in addition to eucalypts, was increasingly recognised. With the encouragement of the FAO Panel of Experts on Forest Gene Resources, the charter of what had become known as the Australian Tree Seed Centre (ATSC), was expanded to include other native genera of woody plants, both trees and shrubs (Drielsma *et al.* 1997; Anon 2002e,f). At the same time the demand for eucalypt seed continued to increase sharply. The 4th Session of the FAO Forest Gene Panel, in 1977, "*noted the large demand for seed of eucalypts in certain of countries, notably Brazil, which was importing many tons of seed each year, not only from Australia, but also from countries in Africa in which eucalypts were grown as exotics*" (FAO 1968-2002). Political pressure behind the large Brazilian tree planting programme, which was supported by vigorous fiscal incentives, was massive, and this, at times, led to some policy level friction related to (physical) availability and cost of seed.

The ATSC's collection of tree seed has grown over the years to include a wide range of multipurpose trees of Australian origin (Vercoe and Midgley 1993). In 1998 the Centre was reported to hold about 30 000 accessions comprising 1 200 species, from several thousand collection sites (Midgley 1999). Eucalypts made up about one half of the species in the collections, while other genera represented included *Acacia*, *Casuarina*, *Grevillea*, *Melaleuca*, *Sesbania* and *Terminalia*. Most accessions came from natural populations but the Centre was also establishing and managing an expanding network of seed orchards, as had been originally foreseen in the 1950s. The Centre responded to over 2 500 requests per year, about half of which came from countries outside of Australia. With support from the ATSC, base populations for breeding purposes had also been established in other countries for *E. globulus, E. nitens, E. grandis, E. pellita, Acacia mangium, A. auriculiformis, A. crassicarpa* and many other species (Anon 1988, 2002f).

Overall, according to records, a total of more than 250 000 seedlots have been despatched to growers in Australia and to over 150 countries throughout the world. Seed collection and despatch have continued to be core functions of the ATSC, along with the provision of information about the woody component of Australia's plant biological diversity; research on genetic diversity; and training, as recommended already by the 1st World Consultation on Forest Tree Breeding in Stockholm in 1963 (Anon 2002e,f).

The ATSC presently maintains a useful and widely consulted database of field trials of Australian species. Growth data from these trials are stored in the "TREDAT" centralised performance register, linking growth measurements to site, management and seedlot origin (Anon 2002f). Following early work by FAO expert Lamberto Golfari and his team in Brazil in the 1970s, in which bioclimatic maps were prepared to support species introductions (Golfari *et al.*1978), work has been pursued in CSIRO by Trevor Booth and colleagues to map regions climatically suitable for Australian tree species at the global scale, using new, computerized methods of climatic analysis (Booth 1991). This work is of great help to countries in the testing of species and provenances for future use.

The ATSC, which originally was attached to the Forest Research Institute of the Australian Forestry and Timber Bureau, became part of the Division of Forest Research of the CSIRO in 1975. With this move the Seed Section of the new Division continued its traditional exploration and seed collection activities. Its stated aims were, "*to provide a seed supply service, with particular emphasis on Australian tree seeds for research, and to act as the national seed coordinating centre for Australia*" (Anon 2002f).

In 1983, following several periods of short-term funding from the Australian bilateral aid agency, AIDAB, for collecting and distributing seed for specific purposes in bilateral programme countries, AIDAB - later AusAID- commenced the *Seeds of Australian Trees Project* (SAT), managed by the ATSC. The project aimed to facilitate seed distribution to developing countries collaborating in Australian bilateral programmes (Anon 1988). The SAT Project, and other projects financed by AusAID and ACIAR, soon became a main focus and the core of the international part of the work of the ATSC, and only limited collections were made to replenish general seed stocks (Drielsma *et al*. 1997).

Priorities shifted also on the international scene. Since the establishment of the FAO Panel of Experts on Forest Gene Resources in 1968, the contributions made towards seed collection and distribution from FAO's Regular Programme in the biennium 1968-1969, included support to two national institutes, one of which was Australia; in the "golden years", between 1985 and 1995, such support was provided by FAO to between 15 and 25 institutes. These institutes gradually included a growing number of partners in developing countries, and such traditional Australian seed collection partners as Papua New Guinea and Indonesia. In the second part of the 1990s, support to seed collection and distribution for experimental purposes and conservation, gave way to other priorities. Added emphasis was being placed on the testing, use and development of local species in developing countries; this grossly increased the number of species actually or potentially included in genetic management programmes, and – by necessity - implied a shift to providing support to developing countries in prioritizing target species and genetic resource activities at national, sub-regional and regional levels as a basic, fundamental, first step in such an effort. Prior to such a shift, the list of priority species pin-pointed for attention had symptomatically grown from 4 pages –in large font- in the Report on the First Session of the Panel of Experts on Forest Gene Resources, in 1986, to a daunting 70, tightly printed pages, in the Report on the 6th Session, in 1985 (FAO 1968-2002). FAO and CSIRO, subsequently, joined forces in supporting regional forest genetic resources workshops to help countries prioritize species and activities, and to draw up coherent action programmes, such as the one prepared in a workshop held in April 1999 by countries in the South Pacific (Sigaud *et al.* 1999; FAO 2001f).

Added attention to the use of local tree species was also evident in Australia, the traditional "Radiata Pine Country", and support to Australian growers in the use of Australian species, has been over the past years increasingly stressed in the work programme of the ATSC. Recent activities have included, *i.a.* contractual work undertaken by the ATSC for Sydney Water, involving collection, storage and testing of seed of a range of species for re-vegetation work, from trees to grasses. The ATSC has, accordingly, expanded its species coverage and know-how to include also non-woody species (Anon 2002f). In 1996, the Federal Government of Australia and the Australian industry, adopted a plan for trebling the Australian forest plantation resource to 3 million hectares by 2020, implying an increase in annual planting rate from 25 000 ha/an, to 80 000 ha/an ("*The 2020 Vision*") . Much of this new plantation resource will be based on Australian tree species, and strong support from the CSIRO and the ATSC is both a necessity and an expectation (Drielsma *et al.* 1997; Anon 2002f; Vercoe and Clarke 2002).

In addition to geographical and species shifts, there has been over the past years, increasing emphasis on the business nature of the ATSC. While the Seed Centre, for some time already, has had to "earn its own living" through grants programmes, projects and commercial scale seed sales, recent moves by decision makers in Australia and at the CSIRO are aimed to make an overall, significant corporate shift from a "CSIRO Research Institute" to " CSIRO Research Enterprise", under the slogan, "*Forestry is a Global Business*". The underlying philosophy is that, in order to deliver outcomes for Australia, the CSIRO, the Division of Forestry and Forest Products, and the ATSC, need to be positioned as "*global players*", with focus on "*strategic partnerships and operational efficiency*" (Anon 2002f). Less philanthropy, more business, in tune with today's world?

GAINS FROM GETTING IT RIGHT

The regional timber trend studies published by FAO demonstrated, already in 1963, a trend towards a coming, greatly increased demand for forest products as a result of rapid increases in population and rising standards of living (Lanly and Allen 1991). Accordingly, the global forest plantation estate increased from

17.8 million hectares in 1980 and 43.6 million hectares in 1990, and to 187 million hectares in 2000. Of these, 39%, 36% and 48% in 1980,1990 and 2000, respectively, were established for industrial wood production. According to the global forest resources assessment 2000, forest plantations presently account for 5% of global forest cover and for less than 3% of the industrial forest plantation estate. However, in the year 2000 forest plantations were estimated to supply about 35% of global roundwood (FAO 1982, 1993, 2002, 2002b; Carle *et al*. 2002).

Provision of wood from natural forests, notably those in the tropics, is frequently not competitive, nor sustainable, in the long term. In many tropical countries there is therefore a rapid transition from natural to plantation forests for productive purposes. Plantation yields are often orders of magnitude higher than those of natural forests; for example, in Brazil, the mean annual increment expected for natural tropical forests is 0.5 m^3–5 m^3/ha/an, as compared to 35, 45, or up to 75 m^3/ha/an in intensively managed plantations. In this country, plantations filled more than 70% of the national industrial roundwood needs in 1997, in spite of the fact that the natural forest area covered over 360 million hectares and plantation forests just 4.5 million hectares (Anon 2002d, FAO 2002b).

Other factors will also tip the balance in favour of plantations for wood production: the economies of scale based on location, and managerial and harvesting advantages of much higher concentrations of wood volume per unit area, increase enormously the relative financial efficiency of plantations. Moreover, and importantly over the last few years, forest plantations, while still needing to be managed in an environmentally sensitive manner, as noted by Leslie in a recent ITTO discussion paper prepared for the Global Environmental Facility , in many countries "bear less of the environmental burden" than natural forests, provided that they do not cause, "an undue reduction in biodiversity values" (Anon 2002d).

In establishing forest plantations, the choice of species and provenance, and their accurate matching to site and end use requirements, are essential for success. The need to do so is even more pronounced when non-native tree species are used, which often is the case in developing countries and in the tropics FAO 1958, 1958a; Mergen 1959).

The practical importance of systematic testing has been convincingly demonstrated. The international provenance trials of *Eucalyptus camaldulensis*, coordinated by FAO in the 1960s, were among the first of a number of such trials. At FAO, these went under the working name, "Operation Camal". Experiments were established on 32 sites in 18 countries, and they showed that the potential gains in growth and yield which could be achieved by selection of the best-adapted provenances for prevailing environmental conditions, amounted to several hundred percent, with differences in growth between provenances ranging from 300% in northern Nigeria, to 800% in Israel (FAO 1977, 1979; Lacaze 1979). Spectacular provenance differences were also found in dry-zone *Acacia* and *Prosopis* species and provenances in a series of FAO coordinated trials in the 1980s and 1990s (FAO 1980; Palmberg 1981; Palmberg-Lerche 1993a, 1999).

In China, yields, following species and provenance selection and the introduction of better silvicultural methods, more than doubled; and rotation times decreased by 30%. In spite of increased costs of plantation establishment and management, the mean internal rate of return in the plantation schemes reviewed, using a 5% discount rate, was 35% (McKenney 1998). In the case of *Acacia mangium*, the productivity of large-scale plantations in Indonesia was doubled by use of better adapted provenances, as compared to yields obtained using as a starting point the relatively poor quality seed previously used. These stands were also of better quality in regard to stem straightness and branching (Midgley 1999).

A recent study of 45 reforestation projects in the tropics found that 95% of these were based on introduced species. Sixty percent of the projects carried out species trials in parallel with the reforestation activities. About 60% of these, in turn, gained additional information during the life span of the project which resulted in a change of species, and many more were incentivated to change the provenances originally used. Needless to say, timely species and provenance testing would have constituted a major economic saving in these cases (FAO 2002e).

INTERNATIONAL ACTION AND TRENDS

Discussions on plant genetic resources within FAO were first begun in 1948. Over the more than 50 years of FAO's existence, perceptions of global needs and priorities have greatly changed, and programmes and priorities have shifted, accordingly.

Annex 1 attempts to capture some of these changes in focus and areas of priority in forest genetic resources work, through documenting new and emerging issues and key points raised and discussed in the sessions of the FAO Panel of Experts on Forest Gene Resources, from 1968 to 2001 (FAO 1968-2002).

In 1961, FAO established a Panel of Experts on Plant Exploration and Introduction; the Panel of Experts on Forest Gene Resources, was established in 1968. The first professional post dealing with forest genetic resources was created in the FAO's Forestry Department in 1974. IBPGR, now the International Plant Genetic Resources Institute, IPGRI, was established in 1974 as a semi-autonomous unit within FAO, with the purpose of focusing action on research related aspects of genetic resource management, largely, but not exclusively, in crop plants. Four international technical conferences on plant genetic resources were convened by FAO, in 1967, 1973 and 1981 and 1996; while the main focus of these conferences was food crops, forest genetic resources were also included in discussions (Palmberg and Esquinas 1990).

In 1983, the 22nd Session of FAO Conference adopted a legally non-binding, *International Undertaking on Plant Genetic Resources*, and established a *Commission on Plant Genetic* Resources to oversee and guide related activities. The International Undertaking was created to support a multilateral system of facilitated access and benefit-sharing for the world's key crops.

The legally binding, *International Treaty on Plant Genetic Resources for Food and Agriculture,* was adopted by the FAO Conference in November 2001, after many long years of discussions and negotiations. Central in this Treaty are, *"the conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of benefits derived from their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security" (*Articles 5 and 6). The Treaty covers all plant genetic resources for food and agriculture and thus, in principle, according to FAO terminology, also forest genetic resources. One of the components of the Treaty is a, *Multilateral System for Access and Benefit Sharing*. The Multilateral System covers a relatively small number of, mainly, food crop species, listed in an Annex to the Treaty. The Treaty will enter into force following ratification by 40 countries (Fresco 2001; FAO 2002a).

The Convention on Biological Diversity, CBD, was established following the UNCED Congress in Rio de Janeiro in 1992 and entered into force the following year. The CBD focuses on the conservation of biological diversity and the equitable sharing of benefits from the use of its components. It calls on Parties to create conditions to facilitate access to genetic resources. While the Convention itself makes no specific reference to forests and forestry, the Sixth Meeting of the Conference of the Parties (COP-6) to the CBD, in April 2002, agreed on an expanded work programme on forest biological diversity, including conservation, sustainable use and benefit sharing; the promotion of institutional and socio-economic enabling environment; and knowledge management, assessment and monitoring. The task of priority setting and action in carrying out the work programme, lies with signatory nations (Laird 2001; Le-Danff and Sigaud 2001; Anon 2002b).

The UNCED-Rio Declaration on Environment and Development of 1992, contains 27 principles on sustainable development, including many referring to, or relevant for, diversity and genetic resources of forests and forest species. Agreements related to the *Precautionary Principle; Biosafety-* used in the *Cartagena Protocol* in reference to the release and transboundary movement of Living Modified Organisms; '*Advance Informed Agreement*' ; and *Biosecurity* or *Bioprotection,* which refer to the policy and regulatory frameworks to manage environmental and biological risks; and yet others, have led to a situation in which Governments require effective, improved and up-dated international frameworks and standards to support national action and to help underpin national and international monitoring and reporting (see *e.g.* Foster *et al.* 2000; O'Riordan *et al.* 2001; FAO 2002c). As investments involving both infrastructure and human resources to develop and implement regulatory frameworks are high, the challenge is to generate more consistency across sectors for added efficiency and cost effectiveness (Anon 2001b; Stannard 2002). Australia is, reportedly, signatory to some 20 international conventions, treaties, mechanisms and agreements of some relevance to forestry, in addition to having specific legislation and acts governing national issues, such as indigenous peoples' rights. There are some 75 Acts or laws in the country affecting access to biological resources (Anon 1994,1996).

At the end of this month, in South Africa, the so-called "Rio+10" –summit will be held, officially known as the UN World Summit for Sustainable Development, WSSD. The outcome of this Summit is not known at the time of preparing the present paper.

TRADE, ACCESS

In relation to access to genetic resources, all countries are highly inter-dependent. Australia is among the countries with the highest degree of dependency, estimated at between 88% and 100% for the 20 most important crops grown in the country. In relation to forest genetic resources, exotic tree species will continue to play an important role in Australia, and international exchange of forest genetic resources will continue to be fundamental to breeding and sustained production.

Agriculture and forestry have always been based on access and exchange, not on exclusivity; seed has, from time-immemorial, moved along the routes of trade, war and love. International trade and exchange of germplasm of Australian tree species, as mentioned before, has been pursued for over 200 years. Forestry has, over the years, enjoyed a tradition of good will among international collaborators, based on such a history of institution-to-institution connections and scientist-to-scientist contacts. Save some exceptions related to species providing for example foliar oils: *Eucalyptus polybrachtea* in the 1950s, and more recent, largely self-imposed regulations regarding *Melaleuca alternifolia,* there are currently very few restrictions on the export of forest tree seed from Australia, or any other countries, provided that plant health and availability of material of the required quality in the required quantity, are adequately catered for (Anon 1994, 1996; Drielsma *et al.* 1997; Midgley 1999a).

Forestry, and the issues related to forest genetic resources are, however, becoming part of a larger international debate on use and benefit sharing. There are many different policies and regulatory approaches which relate to the ownership and use of biological resources in Australia, where the States have responsibility for management of forests and where the collection of seed from native forests is controlled by State and Territory land management agencies. Emerging social, policy and legal issues will likely increasingly influence the access to, and exchange of, Australian forest genetic resources in the future (Anon 2002).

The range-wide provenance collections of *Eucalyptus camaldulensis,* "Operation Camal", was referred to earlier in this paper. One could mention, as an example, that to gain access today to a comprehensive collection of provenances of *Eucalyptus camaldulensis,* like the one collected and distributed in the 1960s, would require official permits from more than 15 agencies and organisations in six States and Territories, and additional permits from several indigenous communities and other private landowners (Midgley 1999, 1999a).

In the case of the ATSC, the *Material Transfer Agreement* presently accompanying all seed dispatches, requests users to abide by a number of basic requirements (Anon 2002a). The MTA will likely in the future dynamically change in response to new requirements and legislation. In recent Government led discussions regarding access to Australian genetic resources, it was stressed that Australia will control access to indigenous biological resources in accordance with the provisions of the CBD, and that international access to such resources may be granted on the basis that the contracting parties recognize Australia's rights of ownership of the genetic material collected; involvement in research on biological material of Australian origin; and fair and equitable returns on, and proportionate ownership of, commercial products developed from Australian biological resources. It was, further, noted that the Commonwealth and State Governments reserve the right to set fees or royalties, or affect other charges relating to the granting of access to Australia's genetic resources; and to receive all data, materials and reports of research relating to the commercial potential of those resources (Anon 1994, 1996; Voumard 2000).

SCIENCE: INFLUENCE AND TRENDS

A coming era of "*Revolutionary research breakthroughs*", was predicted already in the World Tree Breeding Consultations in 1963 and 1969 (FAO 1964, 1970). They were a reality in the Consultations in 1977 and 1998 (FAO 1979; Matyas 1999).

While providing opportunities for advance, all new technologies bring new risks. Furthermore, no scientific findings will work magic on their own. Success in their deployment requires both careful identification of needs, and opportunities to link new findings with existing technological, social and environmental packages (see *e.g.* FAO 2000, 2001c; Anon 2001, 2001c; Fresco 2001, 2001a; Visser 2001; Dargie 2002; Stannard 2002).

Development of biotechnological and molecular tools has risen to the forefront of science over the past years. Advances made are paralleled only by those in information technologies. Advantage must be taken of the exciting new opportunities these new technologies offer. If applied with intelligence, they will improve the precision and facilitate the work of the tree breeder of the future. However, while it is important to apply sophisticated techniques that can put the finishing touches on advanced varieties, at least as much effort must go to ensuring the development of the basic breeding populations. Findings in biotechnologies can only be capitalized if sound tree improvement programmes are in place within which the new technologies can be applied (Palmberg-Lerche 1999, 2002).

Furthermore, breeding always implies a commitment to greater domestication. Domestication implies good husbandry which, in forestry, means the application of improved techniques for plantation establishment and natural forest and plantation silviculture and management. Without concurrent improvement and application of these, and attention to logistics such as access and diffusion of better seeds to the users, breeding efforts, as well as investments in biotechnological research, will be wasted (Libby 2001; FAO 2002b).

In recent Sessions, the FAO Panel of Experts on Forest Gene Resources noted with concern the widening gap between science and practice, and stressed that successful application was at risk if knowledge produced at scientific level was more advanced than what the operational level was able to absorb and implement. A major constraint in the use of new biotechnological tools in forestry was, at present, the lack of skilled tree breeders able to understand and utilise the information generated by scientists and to ensure its application in practical, large-scale programmes. Inadequacy of funding for field level activities further hampered progress (FAO 1968-2002; see esp. 11^{th} and 12^{th} Sessions, 1999, 2001).

The Forest Gene Panel also noted that problems arose when sophisticated techniques were applied to un-developed genotypes, and when efforts were focused on advanced techniques without due attention to development of the basic breeding resource (Namkoong 2002; Namkoong *et al.* 2002.).

Appropriate allocation of resources to biotechnology, classical breeding and field activities, will not of itself ensure the right outcome, but it is a crucial prerequisite for it. The clear message is that the adoption of biotechnological tools must be part of a substantially increased commitment to genetic improvement and to forestry in general, rather than a switch of effort away from classical breeding and silviculture. Efforts must, in other words, be *additive,* rather than imply a replacement or substitution of one kind of activity with another (Burdon 1994; Namkoong 2001).

Furthermore, the gap in mutual understanding is widening in the presently on-going international policy dialogue, between "the international forest policy jet-setters" on the one hand; and on the other, the managers of forestry programmes at various levels, in national Forest Departments and forestry institutions. Field level, practical foresters are still further removed from high-level decisions and commitments made in international fora, however they are expected to implement, monitor and report upon field and follow-up action. The increasingly multi-disciplinary nature of today's forest policy dialogue, in which a range of political and environmental concerns are super-imposed on forest policies, frequently dominating the outcome, tends to further alienate the conceptual and practical levels.

In this scenario, the attraction of further isolating science from practice is a big temptation, as in so doing, the complex issues of needs, feedback, implementation and links with other fields related to forestry, can be left aside, as somebody else's problem. The glamour surrounding cutting-edge science (Fresco 2001) and dreams of major profit opportunities, can easily distort research priorities, drawing investment away from traditional fields and field level application, without which, however, science is a blind alley.

The statements of a powerful private company executive, who participated in a recent discussion forum on biotechnologies in plant breeding, were truly amazing. He noted that, "c*ompetition from conventional breeding poses a barrier to attracting funding and support for new biotechnologies".* This, according to him, was due to the fact that, "*most breeding programmes are now in only their second or third generations and, therefore, traditional methods can still yield sizable gains"* (Anon 2002c). He thus implied that the fact that traditional plant breeding could yield "*sizable gains*", was indeed lamentable! Underlying these statements was the fact, also discussed in the forum, that getting a GM crop or plant variety on the market would cost in excess of $US 30 million, to which regulatory costs added a further $US 5-6 million; while developing new varieties using traditional plant breeding methods, would cost only a fraction of this Fresco 2001a). The question, then, was: was investment in unknown technologies really necessary, if selection and breeding, coupled with good resource management, could make major advances?

Reviewing presently used new biotechnologies in forestry, the most useful application is in the field of molecular and genetic markers. The value of these tools, if used wisely, is unquestioned (Burdon 1994; Haines 1994; FAO 2001c; Namkoong 2001).

Regarding genetic engineering, while 60% of all processed foods in the USA are today genetically modified, including mostly products from soybeans, corn and canola (Fresco 2001a), no commercial plantations of GM trees have been established to date. However, according to records, genetic modification is under experimentation in some 25 species of poplar, eucalypt and pine. Techniques include recombinant DNA and asexual gene transfer and, most frequently, aim to introduce herbicide and pest resistance, or to reduce or modify the lignin content of wood (FAO 2001a,b).

As noted by the late Gene Namkoong in his retirement seminar last year, present assumptions underlying work in gene transfer, generally grossly under-estimate the complexity of genetic systems and physiological processes. Interactions are the paradigm for gene actions in forestry, and epistasis is strong and complex. According to Namkoong, general effects which might be defined for genes, are not fixed, or even estimable as approximations or as average and variable effects. In regard to the present debate on biotechnologies in forestry, he noted that it unfortunately reflected, "*a mechanical view of the world, in which it is increasingly thought that moving around pieces will make all the difference*"; and that it misleadingly publicised the potential of single gene effects and transgenic technologies, with the underlying assumption that "*genes for growth*", or "*genes for overall adaptation to harsh environments*", could be found. Namkoong dismissed this as, "*pursuing a Phantom"* (Namkoong 2001). Needless to say, strong genotype x environment interactions, which will influence all traits, old and new, over the long life-cycles of forest trees, will further (from Man's point of view) complicate the matters when targeting so called "agronomic traits" in forestry.

Biotechnologies, which often today in public debate are equated with genetic modification, are in many countries distrusted by the public, which sees these techniques as "meddling with evolution", as part of negative aspects of globalization and privatization, and as "anti-democratic". GM technology in food crops is thought to further foster farmers' dependence on biotechnology companies and reduce farmers' autonomy and right to decide, thus touching upon basic food security issues. Uncertainty about safety for humans and the environment, and a lack of perceived benefits for consumers, have further limited general acceptance of the very idea of genetic modification. Questionable research and questionable science is unfortunately increasingly published even in some of the world's leading scientific journals, and this has been quickly and selectively picked up by other parts of the media, further firing the debate. Consequences include at times restrictive legislation, based on what my fisheries colleague Devin Bartley called, "policy makers' perception of public perception" (Bartley 2002). Hopefully, in the future, the human fear driving such moves will, instead, lead us to good science-based risk assessment and good science which is perceived to, and does, benefit all groups of society.

CONCLUDING REMARKS: PAST AND FUTURE OF THE ATSC

The ATSC makes a unique Australian contribution to national and international efforts in the conservation and wise use of forest genetic resources and, in so doing, conforms to the mission and objectives of the CSIRO and fulfils the ATSC's stated aim of "..*exploring, domesticating and conserving Australian forest genetic resources*".

The quality of science undertaken has been consistently of a high order, as recognised in 1994 by the award to the ATSC of the CSIRO *Medal for Excellence in Science*; and the many other rewards, honours and international tokens of acknowledgement afforded CSIRO and Seed Centre staff over the years.

From the 1940s to today, Australian expertise, experience and goodwill have been drawn upon in international circles, and international action has benefited from the work of great men, such as Max Jacobs, Lindsay Pryor and others. Through participation in the work of the FAO Panel of Experts on Forest Gene Resources ever since its establishment in 1968, experts from the Australian Forestry and Timber Bureau, CSIRO and ATSC, have also more formally contributed to forest genetic resources discussions at international level. Such international contacts have, in turn, influenced the programme and focus of the Australian Tree Seed Centre and the institutions that have hosted it over the years.

Priorities at international level, reflected in the work of the ATSC, have changed from early focus on seed collection and genecological studies underpinning species and provenance research of a few major Australian timber species used in plantation forestry in the 1960s and early 1970s, to collection and management of genetic resources of a range of native Australian trees and shrubs for a great number of purposes and end uses. Such a shift, due largely to changes in the perception of the place and role of forests and trees in national development, was accompanied by increased attention in all countries to native species which provided alternatives to introduced species and which, at times, were part of traditions and therefore more commonly accepted by local human populations for use and domestication.

The meetings of the FAO Panel of Experts on Forest Gene Resources, clearly reflected such trends at international level through an exponential increase over the years in the *number of species* listed as being in need of attention. In the first meetings of the Panel in 1968 and 1969, some half a dozen species were prioritized for international action and support; in the 6th Session of the Panel, in 1985, the list of priority species had grown to cover 70 pages. Simultaneously, the prioritised *activities* shifted from collection and international seed exchange, to research, genetic studies and holistic gene management, including conservation *in situ* as part of comprehensive, sustainable natural resource management (FAO 1968-2002).

The above shifts led to a need for national priority setting among many alternative species and to recent increased attention, at international level, to providing support to developing countries in the preparation of sub-regional and regional action plans, in which priority species and activities, and sharing of operational responsibilities, are determined by countries concerned.

As institutions and expertise in developing countries were gradually strengthened, international action increasingly stressed institutional networking. CSIRO and the ATSC have, rightly, laid added stress over the years on building *partnerships* with developing country institutions, rather than just providing support to them; and on pursuing collaboration resulting in increased benefits to both parties.

A recent issue of the FAO Journal, Unasylva, went under the working name, "*The Delphi Issue*", as -like the Oracle of Delphi- it attempted to predict coming scenarios in forestry (FAO 2001e). While predictions especially in the field of science have proven difficult and generally have gone badly wrong in the past, humans, according to their nature, will always wish to look into the future. Some issues are predictable, others are not. Expectations in science often outrun achievements, and seemingly promising strategies and methodologies are frequently replaced by developments which may have been beyond imagination before.

Without using a *Crystal Ball* - or intoxicating fumes like the Oracle of Delphi did- likely future scenarios and priorities in forest genetic resources work can to some degree be determined. Then, what is the likely future role in such developments of the ATSC?

<u>Some focal areas of attention which have been proposed[1] and which are supported are:</u>

1. Further strengthen partnerships and strategic research links with Australian Government agencies, educational and research institutions, the private sector and non-governmental organizations. In addition to fostering overall operational efficiency, such cooperation will help underpin genetic conservation efforts to ensure that valuable seed sources are not lost; and facilitate taxonomic studies and the collection of provenance samples, with special reference to still little-known promising species (such as *e.g. Acacia crassicarpa*). Strengthened partnerships will also help enhance ATSC support to the realization of the Australian "*2020 Vision*", and the related renewed interest in the use of Australian trees on-farm.

2. Help foster enhanced capacity in developing countries through training, institutional twinning and academic exchange programmes, noting that benefits from such support are mutual. As an example, breeding work can often be done at a faster pace and at lower cost in neighbouring countries, and may result in earlier availability of improved material both for Australia and for the country carrying out the work than would be the case with purely domestic research in either of them.

3. Catalyze and support networking and inter-institutional collaboration. Recognizing that high levels of adaptation and productivity are achieved only when the genetic and physiological potential of the genetic materials used are well matched with management practices, consideration should be given to possibilities to extend areas of collaboration to nursery practices, plantation establishment and silviculture.

4. Continue the international exchange of scientific knowledge of taxonomic variation, genetic improvement, silviculture and pest management of Australian species, much of which has been developed in other countries. Help extended and apply existing genetic knowledge, breeding theory and domestication strategies developed by or in collaboration with CSIRO, to non-Australian species, with special emphasis on species which have affinities to Australian taxa.

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[1] See Drielsma *et al.* 1997; and information found in Anon.2002f.

5. Vigorously promote active feedback systems between research and the field, and apply methods to ensure effective transfer of research results into practice. Develop methodologies for the monitoring of diffusion and use of high-quality reproductive materials as an integral part of tree breeding and planting programmes in Australia and in partner countries, promote their wide application and use.

6. Continue outreach in Australia and other countries through publications and information materials, targeting, respectively, policy makers, technical/scientific and popular levels.

7. Carry out studies and document financial and economic benefits of the use of quality seed as a basic step in domestication, and review ecological and social aspects of tree growing and domestication as a basis for lasting success.

8. Continue to be closely involved in national and international efforts related to the development and application of regulatory frameworks and legislation governing access and benefit sharing, biosafety and bioprotection, through:

    - Pursuing cooperation with Australian States, landowners and managers to facilitate access to domestic forest genetic resources on mutually agreed terms,

    - Promoting continued international availability and access to reproductive materials of Australian trees and shrubs on bilaterally or multilaterally agreed terms and conditions, through mechanisms such as Material Transfer Agreements, in the spirit of the Convention on Biological Diversity, the International Treaty on Plant Genetic Resources for Food and Agriculture and other similar mechanisms.

    Success in the above will likely, in turn, help ensure continued access to vitally important introduced genetic resources on which Australia depends, and maintain and enhance existing goodwill which can be capitalised in joint ventures or in marketing of Australian skills and technology.

9. Develop policies for engagement in fair and transparent commercial activities, consistent with the CSIRO/ATSC research mission for public benefit as well as the increased emphasis on the business nature of the Seed Centre and the corresponding corporate shifts; ensure that the newly adapted CSIRO slogan, “Forestry is a Business”, transmits an unequivocally positive message at all levels.

Going back to the origins of the Australian Tree Seed Centre, and the focus on eucalypts, I would like to pose a final -rhetorical- question, in reflection of the one-sided environmental debate over the past decade related to “biodiversity”, in which the present state of nature is viewed as the ideal one, nature is intrinsically static, and human intervention is considered to be always negative: Are eucalypts, and other tree species grown widely, more, or less, variable today than 100 years ago?

Regarding the reoccurring issues of perceived negative environmental and social effects of eucalypts, let me state that to me, many eucalypt species can be categorized in the same way as the Goat in dryland ecosystems: ugly in the eyes of some people, but tough, versatile, invaluable and, in many cases and occasions, irreplaceable. There is nothing intrinsically wrong with the goat, nor with the eucalypts, or other fast-growing, widely-introduced or used pioneer tree species. The problem, when and if there is one, is in the management of these species by Man.

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ANNEX 1.

NEW AND EMERGING ISSUES, KEY CONCEPTS & FOCUS DISCUSSED IN SESSIONS OF THE FAO PANEL OF EXPERTS ON FOREST GENE RESOURCES 1968-2001[2]

1968 (1st Session)

Focus on:

- Coordination of efforts, identification of priority species for international attention.
- Provenance collections, international species/provenance trials.
- Seed collection and handling guidelines.

1969 (2nd Session)

Focus on:

- Tropical tree species.
- Conservation *in situ*, *ex situ*.
- National seed certification schemes.
- Need for technical manuals and guides, equipment notes.

Panel noted that, all priority-1 species, listed in 1st Session of Panel in 1968, were expected to have been collected by the end of 1971.

1974 (3rd Session)

Focus on:

- Transfer of technologies and know-how.
- Monographs on individual species.

Panel noted that:
- Global Programme on Forest Genetic Resources had been developed and published, with a view to increasing support and efficiency and better coordinate action.
- FAO Forest Genetic Resources Newsbulletin started (1972); "Methodology of conservation" published (1975).
- Professional position in forest genetic resources created in FAO.
- In 1974, Committees had been set up in each Australian State to advice on needs and methods of conservation of forest genetic resources.

1977 (4th Session)

Focus on:

- Environmental benefits of forests.
- Training, capacity building.

Panel noted that, the Australian Forestry Council had appointed a sub-committee to prepare a statement on the status and methods of conservation of forest genetic resources.

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[2] FAO 1968-2002.

1981 (5th Session)

Focus on:

- Social benefits of forests: food, fodder and energy.
- Policy level awareness.
- Incorporation of conservation in productive forest management.
- *Ex situ* conservation stands.

1985 (6th Session)

Focus on:

- Role of forests in environmental stabilization and improvement.
- Production of a range of forest goods and services compatible with conservation.
- Incorporation of conservation in forest and protected area management, and in tree breeding strategies.

Panel noted that, priority species for attention covered 70 pages in the Report on the Session.

1989 (7th Session)

Focus on:

- Contribution of forests to sustainable development.
- Role of forests and woodlands in the conservation of other species of plants and animals.
- Active gene management.
- New biotechnologies.

1993 (8th Session)

Focus on:

- Environmental values of forests.
- Problems of deforestation, landscape fragmentation.
- Conservation and ethics.
- Need for partnerships, twinning, networking.
- Access and benefit sharing.
- Biotechnologies as supportive tools.
- Computer-based systems for information storage, retrieval and analysis.

Panel noted that**:**

- FAO International Undertaking on Plant Genetic Resources had been adopted and ratified.
- The Convention on Biological Diversity had been adopted and ratified
- The REFORGEN global information system on forest genetic resources was under development.

1995 (9th Session)

Focus on:

- Emergence of the criterion of biological diversity in sustainable forest management: defining, measuring, conserving, monitoring diversity.
- Problem of pollution of native genepools.
- Widespread institutional turmoil, and the need for consistency in funding and effort.
- Safe movement of forest reproductive materials.

Panel noted that, the International Technical Conference on Plant Genetic Resources for Food and Agriculture.- “The Leipzig Conference on Plant genetic resources”- had been held.

1997 (10th Session)

Focus on:

- Role of forests in food security.
- Need for coordination between sectors and among increasing number of actors.
- Decentralization, privatisation, institutional and macro-economic shifts.
- Innovative mechanisms for collaboration and funding support; national forest programmes.

Panel noted that, the 13th Session of COFO had recommended that FAO support regional forest genetic resources workshops and the development of regional/sub-regional action programmes.

1999 (11th Session)

Focus on:

- Need for strengthened partnerships with governments and national institutions, international, regional and bilateral organizations, NGOs, the private sector, communities.
- Sustainable resource use; compatibility conservation, use and genetic management.
- Importance of traditional methodologies as basis for advanced techniques.

2001 (12th Session)

Focus on:

- Work and complementarity of action with Conventions on biological diversity, climate change, desertification.
- *Bio*logical diversity, *bio*technology, *bio*safety and *bio*protection.
- Need for harmonization of concepts and terms.
- Role of fire, drought and other adverse environmental factors in breeding.
- Need for facilitation of exchange of reproductive materials on mutually agreed terms
- Role of trees grown outside the forest, agroforestry; desertification control, CO_2 capture.
- Need to adaptat conventional and new genetic technologies to local species.
- Need to bridge increasing gap between science and practice.

The Panel noted that:

- The International Treaty on Genetic Resources for Food and Agriculture had been approved in FAO Conference November 2001.
- An CBD Work Programme on Forest Biological Diversity had been approved by the 6th meeting of the Conference of the Parties.