General Discussion

Chairman (Willan, R.L., F.A.O.): A range of interesting and diverse reports has been presented at the Symposium and the topics which will be considered in the general discussion can be divided into 4 sections, as follows: 1) Problems relating to natural regeneration, 2) Problems relating to artificial regeneration, 3) Future of the tropical forests as a whole, with respect to conservation, ecological aspects and genetic resources, 4) Miscellaneous considerations dealing with various aspects such as research, the need for more training, regional cooperation, interaction of silvicultural techniques with logging operations, for example.

Plantation forestry in the tropics is of increasing importance and a large number of countries are now establishing plantations on a large scale. Artificial regeneration is probably a sound development, particularly when the conditions are adequate. Plantation forestry in the right conditions can provide much higher yields than natural forests. When one takes into account the increase in population, the aspirations for a better way of life, pressure on land, it is unrealistic to think that large areas of low-yielding forests can be maintained. Forests should be made as productive as possible and in some cases, plantation forestry may be the answer.

However, problems relating to ecology and gene resources should not be overlooked. One must preserve an adequate area of representative samples of the natural forests. If parts of the existing natural forests were changed into plantations, the yield could be increased ten- to fifteen-fold. Parts of the remainder could be maintained as strict natural reserves of which the main object of management is conservation of viable ecosystems, so as to preserve genetic resources of the constituent species. In other words, it is necessary to strike a balance between the need for establishing high-yielding plantations and the need for conservation of natural forests. There is a clear progression between extremes. For instance, one has to consider a watershed management where emphasis should be placed on conservation of soil, prevention of floods in the case of steep slopes. In these circumstances, even selective felling should not be allowed. Such forests should only be managed as protection forests. In other instances, some selective felling could be undertaken while clear felling would not be permissible. The next stage could include the uniform system of natural forest management and go as far as the establishment of plantation forestry.

As far as natural regeneration is concerned, in Africa, it was felt that there were two reasons for adopting the use of monocyclic felling in preference to polycyclic fellings, in other words a uniform type of management rather than a selective one. The arguments were as follows: 1) The crowns of the commercial species in Africa are so wide in proportion to their stem diameter that excessive damage would take place if felling had to be repeated every thirty years. 2) Such trees are inefficient because they need a very large crown room for a given size of stem. Also, they appear to be incapable of growing for many years as suppressed poles and if released by the felling of the big trees over them they are unable to respond to the increase in light. In contrast, the *Dipterocarpaceae* which have a narrower crown seem to do less felling damage. Also, they are capable of recovering from many years of suppression ("gap opportunists").

The discussion on natural regeneration is now open.

Tun Hla (Burma): Teak is an important species in Burma from the economic point of view. Natural regeneration has not attracted much attention because teak can be easily raised artificially and in most deciduous forests, teak fails to regenerate naturally. Compensatory plantation in natural forests to enrich natural reproduction is now being advocated. Since 1911, the uniform monocyclic system has been applied in Burma to promote natural regeneration. As teak needs a rotation of 150 years to reach maturity, it was suggested that the rotation be reduced from 150 years to 120 years divided into 6 periodic blocs of 20 years. Each bloc was divided into 4-year interval with intensive management. However, such system requires too much labour and is too costly. Yet uniform system will be reinstated because it is believed that it should enable to promote natural regeneration of teak if proper subsequent operations are carried out.

Sambas W. (Indonesia): As stated before, I am somehow pessimistic about the future of

natural regeneration of tropical forests. Selective cutting system is successful in only a few areas of small islands of Indonesia because the growing stock of the *Dipterocarpaceae* is abundant, in contrast with the situation prevailing in most Dipterocarp forests of Kalimantan. On the other hand, population pressure makes the use of this system very difficult as sustained yield cannot be maintained in natural regeneration of tropical forests. Therefore, it appears that artificial revegetation is preferable.

Choob K. (Thailand): In natural stands of dry deciduous Dipterocarp forests the volume for the large trees which have reached the cutting size is only 8 m^3/acre while in mixed deciduous forests it only amounts to 23 m^3/acre which is small compared with that in plantations. When teak grows in natural forests, to reach a girth of 2.13 m (7 feet in circumference at breast height), it takes 85 years on alluvial soils, 130 years on soils derived from lime stone, 160 years on soils derived from sand stone and 170 years on soils derived from metamorphic rock. Therefore, when the time required for a tree to reach a merchantable size and when the soil conditions are taken into account, natural forests of teak do not appear suitable. Furthermore, fertile alluvial soil is being used for agriculture. As for the dry deciduous Dipterocarp forests, only 20 species are found and it takes from 133 years to 424 years a tree to reach a commercial size. Therefore, natural forests should be changed into artificial forests from the economic point of view. In Thailand now, timber supply is decreasing and wood is being imported from Malaysia, Indonesia and the Philippines.

Liew T.C. (Malaysia): As far as the Dipterocarp forests are concerned, production of hardwood under natural process should receive the highest priority. This is because Dipterocarp forests have been found to be one of the most stable ecosystems. Plantations should only be established to supplement wood production when necessity arises, for example, as a result of pressure on land. Selective management system which is a form of polycyclic system is currently practised in Sabah. The primary objective of the system is to save the pole-sized trees which occur abundantly in the forest (about 10 to 25 stems of 1—6 foot girth per acre). Should this management objective be achieved, Dipterocarp forests could be harvested at shorter intervals. In addition, different Dipterocarp species exhibit different growth rates and it is clear that the monocyclic system may not be applicable. This is because this system aims at producing even-aged stands. Also natural forests should be preserved as they provide food for the wildlife and contribute to the conservation of the soil.

Chairman: It is obvious that individual solutions must be related to the local conditions. However, if there is a considerable pressure on the land, plantations will become an urgent necessity.

Lee H.S. (Malaysia): I believe that natural regeneration is important for the two following reasons: 1) Natural regeneration, if successful, is the least expensive method of reafforestation of an area. In Malaysia, the cost of establishment of a plantation is fairly high (600 M$/acre for a pine plantation) while treatment of forest under natural regeneration system amounts only to 20 M$/acre. Of course, when comparing these figures, the value of the end-product and the yield must be taken into account.

2) Most tropical countries have not been able to identify species of as high a value as that of the original stand, except for teak occurring in Burma and Thailand. Japan, in contrast, is fortunate in that she has two species native to the country which are being used extensively for reforestation by artificial means. In most tropical developing countries, the major constraints to artificial regeneration are the lack of technology, finance and skilled manpower.

Toda, R. (Japan): As far as forest genetics is concerned, although natural regeneration is economical, the genetic make up of the forest population tends to deteriorate as usually the good trees are felled first and trees of poor quality are retained in the stand.

Satoo, D. (Japan): I would like to make two comments. 1) I doubt if natural regeneration is cheaper than artificial regeneration as, in Japan, the former often failed owing to lack of funds or to insufficient tending of regeneration. 2) As for conservation, only specified untouched areas give valuable results.

Domingo, I.L. (The Philippines): My presentation was focused on regeneration of Dipterocarps. If Dipterocarp forests have to be regenerated into Dipterocarp forests and not into forests with other species, only natural regeneration or systems not allowing too much light should be applied. In case of clear felling of virgin forests, seedling or sapling growth is usually hampered by the aggressive growth of weeds. On the other hand, if natural regeneration is practised in using selective cutting, seedlings will grow well. It has been shown that Dipterocarp seedlings do not usually grow well under full sunlight when they are young and are likely to be attacked by insects owing to modifications of the environment. Finally, it must be emphasized that artificial regeneration is more expensive when the high cost of seed production, planting techniques and site preparation is taken into account.

Chairman: We are now going to consider some of the problems relating to artificial regeneration.

Artificial regeneration is in its very early stages in most tropical countries and many problems have yet to be solved such as insect attacks, particularly in the humid tropics. Successful examples of plantations can be found at high altitudes such as the cypress and pine plantations of highlands of Africa or in the monsoon climates such as the teak plantations in Burma and India. The possibility of site deterioration under plantation monoculture as a result of soil changes has to be considered and thoroughly investigated. However, if the plantations are well-sited, well looked after and if the right species and provenance are used, they are capable of giving markedly increased yields while offering the opportunity of carrying out tree breeding.

Prasert B. (Thailand): As a result of timber shortage, *Casuarina junhuniana*, a fast-growing species which had been introduced in Thailand about fifty years ago is now being actively planted. Propagation is chiefly vegetative through cutting of shoot enabling to get roots. This fast-growing species reaches a height of one foot three months after planting and with a 5-year rotation a d.b.h. of 12—15 cm can be obtained. Such species can be planted on saline soils which are not suitable for rice cultivation and appreciable returns from posts and poles can be expected. If such trees are left for a period of 10 years, sawn logs can be obtained to feed sawmills. For an input of 50 m^3 a day in a sawmill, 3,200 acres can be planted, otherwise a concession of 50,000 acres would be necessary. Furthermore these trees which are sterile have a good form and are straight with small branches. They can grow on a large variety of soils, from the sandy soils near the seashore up to the mountains.

Chairman: Could you tell us where this tree originated from?

Prasert B. (Thailand): This tree originated from Indonesia and was subsequently brought to Australia. The trees introduced to Thailand are of Australian provenance.

Liew T.C. (Malaysia): Although provenance trials are of major importance for tree plantation projects, it appears difficult to obtain seeds for trials. Organizations such as IUFRO and CFI have recently provided us with seeds of *Pinus Caribaea* and *Pinus oocarpa*. However seeds of other species are not readily available.

Chairman: For the last two decades the FAO has been active in promoting seed provenance collections. Collection of provenances has also been active in Australia (CSIRO) in the case of Eucalyptus species, for example. As for pines, the efforts have been concentrated on *Pinus Caribaea* and *oocarpa* through CFI. Southern provenances have been collected in Mexico along with four sets from Central America. Teak provenances were collected mainly in India. Collections of *P. merkusii* have been made in cooperation with Indonesia in addition to collections of *Pinus kesiya* in the Philippines. Efforts should now be concentrated on other species such as *Casuarina junhuniana* or *Acacia mangium*.

Sasaki, S. (Japan): I am concerned about the fact that the population of Dipterocarps is decreasing. Therefore, plantations of Dipterocarps should be attempted. The Forest Research Institute in Malaysia has carried out such trials in 1910 and trees are growing well even on bare land. Also vegetative propagation is possible.

Lee H.S. (Malaysia): In Sarawak there are Dipterocarp plantations which are thriving, the

oldest one dating back to 1930. In connection with the efforts to establish plantations of Dipterocarps, research on the rooting of cuttings is essential.

Chairman: The problem with plantations of Dipterocarps is that seeds come irregularly and are difficult to store.

Glori, A. (The Philippines): I interpose no objection to the use of artificial means of regenerating open lands. In fact I am totally in favor of it. But one important thing that should likewise be considered is the aspect of protection. In many of the dry areas in the tropics forest fire is one of the major perennial problems. For instance, in the northern part of the Philippines, about 30% of the outplanted seedling mortality is attributable to fire occurrences. Considering therefore that any effective silvicultural practice would be practically useless if the fire problem were overlooked, I suggest that protection of established plantations be seriously given equal consideration.

Chairman: This is an important remark. Measures aimed at supplying enough funds for protection and tending practices are indeed of paramount importance for the establishment of plantations. We should now proceed to the third section of the general discussion and consider some aspects relating to the future of the tropical forests, such as conservation of genetic resources and ecosystems.

There is a danger that plantation forestry and tree breeding itself, if not wisely applied, may lead to a narrowing of the genetic base. Provision should be made for the conservation of the fullest possible range of genetic variability at the species and the provenance levels. A reserve of additional species and provenances should be made available. This is what genetic resources is all about, namely the conservation of heritable variability.

Kikkawa, J. (Australia): Future management plans for tropical forestry are not likely to result from the application of established practices in the northern hemisphere but will have to be based on new knowledge gained through the experience in the tropics. This is recognized by IUFRO which has created a new section of "Tropical Ecology" for intensive studies. Also UNESCO is supporting research projects in the tropics. I would like to emphasize the need for conducting research aimed at increasing our understanding of tropical forests. The research strategy should take an ecosystem approach. For example, we would like to know more about 1) environmental relations of plant phenology, 2) the role of animals in pollination and seed dispersal, 3) defence mechanisms of plant against insect damage, 4) litter breakdown and mineral cycles in relation to logging operations and 5) vegetation structure in relation to soil fertility and water drainage. The question of natural versus artificial regeneration cannot be solved without proper understanding of tropical ecosystems. Also we do not know what is the optimum size of area to be set aside as reference. Opportunities for discussions and if possible cooperative research with tropical ecologists working in other organizations should be created. We must recognize the non-wood value of forest for future forestry and it is important, particularly in the tropics where natural and semi-natural forests still remain, to widen our horizon in forest research. Tropical rain forests do not appear to be stable systems and the reason for the maintenance of species diversity must be ascribed to the fact that the systems are unstable locally, making it possible for more species to be packed in a region. Stochastic processes should therefore be thoroughly investigated.

Takasu, H. (Japan): I would like to refer to the problem of abandoned land as a result of shifting cultivation, which is relevant to the long-term future of the tropical forests. The problem is to know what to do with such areas. Should they be left as they are or should they be restored? I would therefore like to ask the following questions to the representatives from overseas: 1) What is the status of abandoned land in each respective country, 2) What kinds of counter-measures are being taken? and 3) Are there any other problems?

Liew T.C. (Malaysia): 1) Dipterocarp species were evolved 15 to 70 million years ago. Though it may be difficult to find two identical Dipterocarp forests at different localities, there is a distinctive pattern of distribution of species. For example, *Shorea argentifolia* can always be found on podzolic soils. IBP studies on the ecosystems of Dipterocarp forests indicated that the system is

an efficient one as far as nutrient cycling is concerned. This may suggest that the system is fairly stable. 2) Shifting cultivation has been widely practised in Sabah in the past. Approximately 10% of the land (1.5 to 1.8 million acres) has been cleared because of shifting cultivation. This practice is now being discouraged by the Government as extensive plans have been formulated and implemented to resettle the local inhabitants. Steps have also been taken to reforest the grasslands created by shifting cultivation.

Chairman: We should now move on to the last section of the general discussion labelled as "Miscellaneous". Items to be taken up could include research, training, cooperation needs, relationship between silvicultural technologies and other aspects of forestry such as management and logging operations and shifting agriculture which may lead to the subject of agri-silviculture. The combination of agriculture with forestry is one possible way of converting shifting agriculture into a useful symbiosis of the two disciplines. As foresters, we feel that if agro-forestry is such a good practice we would like to see not only agriculture being combined with forestry on forest land but also forestry carried out on agricultural land. It would be beneficial if the farmers could be persuaded that it is worth planting 10% of their land with trees which could provide them with fuelwood, poles and even fruit. A two-way movement should take place, whereby trees would be spread on agricultural land and agriculture on forest land.

Yunus, K. (Indonesia): As for policies dealing with the status of abandoned land following the practice of shifting agriculture, in Indonesia, about 20 million hectares are covered with weeds (alang alang). The Government intends to rehabilitate this unproductive land through reforestation schemes or to convert it into agricultural land. Resettlement programs are also being planned. As regards the practice of agri-silviculture, emphasis is now being placed on taking into account the direct needs of the local communities living near the forests ("forestry for people"), while in the past forests have mainly contributed to the development of industries supplying the needs of the nation as a whole. There is presently a transition from industrial and even protection forestry toward social or community forestry, as illustrated by the tumpangsari system in Java. The need for caring for the rural poor is now being emphasized. Although the silviculturists tend to be inspired by biological and ecological considerations of forestry, sociological aspects should not be overlooked. I would like to add that agri-silviculture requires a good organization of the forest farmers along with political stability. Otherwise, occupation or even destruction of forest land may take place.

Domingo, I.L. (The Philippines): Agro-forestry is being practised on agricultural land in Eastern Mindanao. The private company guarantees to buy the timber crops *(Albizzia falcata)* that a particular farmer plants on his private land. The company supplies the seedlings free of charge while the Development Bank of the Philippines extends loans. In 1974, more than 3,000 farmers had participated in this program (14,000 hectares have been planted). The farmers are now supplying wood for the pulp and paper plant of the company. The program is very popular with the farmers as the standard of living of the people in the surrounding communities was markedly improved. In this area, shifting cultivation in concession land is now only practised by the non-Christian community.

Sambas W, (Indonesia): The practice of shifting cultivation does not always result in abandoned land because the farmers will come back to the areas after the fallow period is over. On the other hand, alang alang is not necessarily an indication of soil infertility because in some areas of Kalimantan it is supplanted by other weeds. Also in Bali, people even plant alang alang which is used for making roofs, for instance. Shifting cultivation is the early form of agri-silviculture which has become an established practice in Java since just before World War II. Coconut trees, fruit trees, banana trees and flowers can be observed among plantations of *Albizzia falcata.* I would like to emphasize the need for carrying out studies so as to back up the revegetation programs in East Kalimantan to ensure sustained yield of the tropical forests. In this connection, regional cooperation should be strengthened along with the organization of conferences and seminars.

Tun Hla (Burma): In 1856 Dr. Dietrich Brandis solved the problem of shifting cultivation by establishing the taungya system. He had proposed the selective cutting system to prevent

overexploitation of teak. While conducting surveys, he noticed that through the practice of the taungya system good natural regeneration of teak was taking place in abandoned land. He then decided to adopt this method to plant teak along with the cultivation of agricultural crops. After 1932 the system was abondoned due to the recession. Now hill tribe people have received land where they can cultivate agricultural crops in the teak plantations.