General Comments

Chairman : Sasaki, S. (University of Tokyo, Japan) : I would first like to project a few slides illustrating the problems associated with degraded land. The first two slides show areas which used to be swamp forests. In the first slide the area is covered with white sand and may have been abandoned after unsuccessful crop cultivation. After one year even *Acacia mangium* could not grow. The second slide shows an area with abandoned paddy fields due to the formation of pyrite and the lowering of the soil pH to 3.00. The third slide shows the attempts made by farmers to collect soil in a swamp area to plant *Acacia mangium*. The last two slides show that farmers move to the forest to collect fallen trees and sell them illegally after being forced to abandon agricultural land which has become unproductive. I feel that Dr. Sanchez has given a good definition of degraded land. Many activities are associated with land degradation, including logged-over forests, shifting cultivation, mine spoils, abandoned agricultural land, etc. The establishment of plantations in such lands is difficult due to the considerable decrease in soil fertility. There are two options; planting trees of economic value or trees for environmental protection. I would like to ask Dr. Sanchez to make a few comments.

Sanchez, P. A. (ICRAF) : It appears that we have reached the "what" stage of research, namely an empirical stage, for example we have observed that *Acacia mangium* grows well on certain sites. We now need to proceed to the "why" stage of research, a process-oriented stage to reclaim degraded land. To achieve this objective, research should involve the development of criteria for the classification of degraded land by analyzing the consequences of degradation in order to alleviate some of the problems. In other words, the situation should be characterized. There is a need for accurate characterization of the soil conditions, for example there was an argument about whether the litter of *A. mangium* acidifies soil. It obviously depends on the nature of soil. In sandy soils with a low buffering capacity acidification will occur unlike in clayey soils that are endowed with a large buffering capacity. The international system of soil classification should be used to unify the soil and land constraints. The effect of the measures adopted for alleviating the constraints should be evaluated. For example, the improvement of the soil fertility should be monitored. In the case of weed encroachment, measurements of the weed seed pool or weed biomass should be performed in order to obtain quantitative data. The improvement of the physical condition of soil, for example the degree of compaction should be determined. To evaluate the effect of the treatment applied, information on the accumulation of biomass with time, nutrient uptake pattern, etc. should be obtained. For example it is interesting to determine how *A. mangium* succeeds in supplanting *Imperata cylindrica*. Should allelopathy be considered or other mechanisms? Integrated pest management should be promoted, in particular the use of repellent trees, as indicated by Dr. Ikeda, or of natural enemies should be emphasized. Information on the species used for rehabilitation of the land should be obtained, including the search for improved germplasm, different accessions or different species and varieties. Indigenous species may be preferable to exotic ones while sometimes, the introduction of exotic species far from the center of origin may be beneficial. Regarding the methodology of research and techniques to quantify parameters and charges, it is important to distinguish between the effect of time and site or species variability. Economic aspects should be considered, for example in the case of biologically enriched fallows and ecological fallows versus economic fallows. It is generally recognized that socio-economic and policy constraints outweigh physical constraints such as weeds, pests, soil fertility, etc.

Chairman : Sasaki, S : I would like to ask Dr. Bevege to make a few comments.

Bevege, D. I. (ACIAR) : Socio-economic factors and policies should be considered and objective of management for rehabilitation should be defined along with conceptual methodological issues in relation to the research projects undertaken. Regarding land use policy, it is essential that the research activities be undertaken within a meaningful policy and socio-economic framework, otherwise research becomes ineffective as the target was missed. In this regard, land use policies and social attitude in the communities are important. For example, although in Papua New Guinea teak would

be the most appropriate tree for plantation, this species cannot be used due to the limitation in the land tenure system. A strong research policy framework should be provided for the implementation of biophysical research programs. Regarding the objectives of management in relation to rehabilitation, there are economic and environmental objectives. These objectives are actually linked and complementary because in the long term unless we have sound enviromental policies and programs, the economic aspect cannot be realized. Therefore long term objectives should be emphasized as the objectives of management for rehabilitaion will determine the nature of the problems to be defined as well as the approach taken for research. The objectives of management for rehabilitation should be well defined. It is important to determine what the communities wish to derive from these reclaimed lands: biomass production, bio-diversity, recreation, sustainability, etc. The research programs can be worked out to fulfill the needs of the communities. As indicated by Dr. Sanchez, there is a trade-off between productivity, bio-diversity and sustainablility issues. The appropriate answers must be found to devise suitable research programs. The future use of the land reclaimed must be determined. Indeed *A. mangium* may be an outstanding species for the rehabilitation of sites infested with *I. cylindrica*. However, reclamation is not an end in itself. What do we use the land for once it is rehabilitated must be defined. Will the land be maintained as Acacia plantations or will the plantations be converted to mixed species by underplanting to dipterocarps or rattan? Do we convert the plantations back to cropping systems, pastures or agroforestry systems or do we use them for conservation? These objectives must be defined for the planning of research programs in terms of sustainability. Regarding the use of indigenous/exotic species for reclamation, I do not believe that a clear distinction can be made between these species. Indeed, either indigenous or exotic species will be subjected to various physiological stresses when planted on degraded sites. I would like to consider now conceptual and methodolgical issues in relation to the research programs undertaken, in particular the measurements, monitoring and prediction of the changes in the systems, including soil and climatic changes. Regarding the soil changes, many of the presentations dealt with nutrient pools but with fluxes between these pools. Emphasis should be placed on plant-soil relations and fluxes of nutrients from soil to plant pools and back to soil, for example in the case of phosphorus and organic matter dynamics. Also the determination of the total nitrogen content in soil may not be relevant. What is important is the rate of mineralization of nitrogen in terms of ammonification and nitrification problems as well as species preference for the various forms. The monitoring and prediction of changes are limited by the techniques avaiable and it may be necessary to identify new parameters and indices of productivity in the changes. These consideration also apply to the toxicity of heavy metals, in particular Al toxicity in acid soils in the tropics. The concept of cover crops which show spatial and temporal variations will depend very much on objective of management, for example annual crops like legumes or perennial cover crops like *A. mangium* for the reclamation of weed-infested areas.

Chairman: Sasaki, S: I would appreciate it if Dr. Kashio could make a few comments.

Kashio, M. (FAO/RAPA): During the symposium the discussions dealt with technical solutions to rehabilitate degraded and denuded forest lands. However, these problems do not result from natural disasters but are closely related to human and social activities and their consequences. Technical options can be adopted but other aspects must also be considered. During my work at FAO, I became aware of the fact that forestry trained at universities who subsequently assume positions in governments or universities, in particular natural scientists, tend to focus on problems of their own interest. The causes of the problems are seldom analyzed. To achieve this objective it would be desirable to carry out research on multi-disciplinary basis involving the participation of social scientists or experts in other fields. I would thus like to emphasize the weakness of the present education and training systems the foresters receive to address problems such as those relating to the increase of population. In addition, the problems we describe occur in remote areas, in mountains far from the urban centers. People involved directly or indirectly who live in such areas are seldom consulted about their requirements and about the technical or financial assistance they need. These people cause the problems because they are subsistence farmers and their agricultural practices are not sustainable and they have no options. The involvement of the people directly concerned is es-

sential. Their needs must be identified to focus assistance and thereafter to convince the government, land use planners, forestry agencies, etc. The opposite approach is generally adopted, top to down in ignoring the grassroot reality. The third aspect I would like to deal with is the fact that agricultural expansion through the promotion of land demand has been the main agent in driving away the forest resources. In the tropics, agricultural expansion which aims at increasing the production based on yield/ha usually reaches farmers who own land and benifit from water and funds, while marginal areas are not involved. Emphasis is placed on the increase of productivity of crops through the expansion of farmland. When the productivity decreases, the farmers must move to other areas, in particular forest lands. The land use planners and decision makers should be convinced of the need for changing this policy. Agricultural development based on the use of forest land has reached a limit. Although it is necessary to increase crop yield, to save the forests, land use planning must be changed to reduce the pressure on forest land.

Co-Chairman: Udarbe, M. P. (Malaysian-German Forestry Project): I believe that we do not have a clear understanding of the concept of degradation of tropical forests. Do we include logged-over forests? For example, Papua New Guinea does not adopt any measures to rehabilitate such sites but concentrates on plantations while Malaysia is considering the rehabilitaion of logged-over forests in terms of finding a management model that can address all the problems, for example socio-economic conditions and site quality classification. We should adopt a holistic approach by developing a model system that would incorporate various aspects such as socio-economic, physical, chemical and environmental requirements. Logged-over forests must be considered as degraded forests and should be rehabilitated as early as possible to avoid further degradation. Emphasis should be placed on research to protect the natural forests, in particular the logged forests to preserve the bio-diversity, climatic conditions, etc. Research should also be directed toward the rehabilitation of degraded land such as mine spoils, shifting cultivation areas, etc. The strategy should include planning at the macrolevel to involve the assistance from international organizations, developed countries and support from bankers, politicians, policy-makers, etc. Thereafter, based on the policies adopted, management level of planning should be addressed, including drafting of guidelines for the implementation of the research programs. Finally planning at the operational level could start, including site surveys, site mapping, evaluation of bio-diversity, etc.

Srivastava, P. B. L. (PNG Forest Research Institute): I would like to refer to the comments made by Dr. Bevege regarding the controversy about exotic versus indigenous species for planting. Many countries have faced problems with exotic species at some stage in their planting programs. The tendency is in general to search for equally suitable indigenous species, for example in India and Malaysia. In India, plantations of *Eucalyptus* species extend over one million hectares but the farmers in many areas have complained because the planting of such trees has resulted in the lowering of the water table, thus adversely affecting the cereal crops. It is not solely a matter of exotic versus indigenous species, the problems arise when planting on a large scale is initiated.

Bevege, I. D.: As I mentioned previously, the classification between exotic and indigenous species is irrelevant. When the species are planted in degraded lands they all somehow behave as exotic species since they are likely to experience various stresses. Once more everything depends on the objective of management. Regarding the definition of degraded land, I would like to suggest that the problem is centered on the transition from one potential state to another. The ease one can move from one potential state to another will depend on the resistance encountered, for example socio-economic or biophysical factors. In a sense, the measure of degradation is the degree to which the resistance can be overcome to move from one potential state to another. Therefore the term degraded may not be appropriate and the objective of management should be defined.

Kumar, S (Central Arid Zone Research Insititute India): The question of sustainability on a temporal scale in the development of degraded lands must be given due attention. For example, the introduction of irrigation for crop cultivation in arid lands in India and Pakistan resulted in the development of salinity and waterlogging which hampered the growth of crops. However it was found that such degraded lands could be used for raising buffaloes, which led to the development of a very productive dairy industry in such areas.