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GENE CONSERVATION AREAS
ON
PALAWAN

A report prepared by

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Plate 1. Bukit Kalamutan, now called Mt. Mantalingajan, south Palawan, as figured in Whitehead's "Exploration of Mount Kina Balu, North Borneo", printed in 1893. This is the earliest printed illustration of a scene from Palawan. Note the extensive forest clearance on the lower slopes at this early date.

1. BACKGROUND

1.1 Present status of rainforest in the Philippines.

Rainforest in the Philippines is still disappearing at the alarming rate of 200,000 ha per year, of which only 27,000 ha is exploited for timber (Wyatt-Smith, 1979).

In 1953 the area of remaining virgin rainforest was estimated by the Forestry Bureau to be 38% of the total land area. Lachowski et al. (1978) using remote sensing techniques surveyed the country with data gained primarily in 1972-73. No figure was given for virgin forest but those for "full closure forest", mangrove and "mossy forest" include virgin and mature secondary forest, giving a total cover of only 20.2%. Dipterocarp forest forms c. 53% of the forested lands i.e. 10.8% of the total (P.C.A.R.R., 1980).

The seriousness of these figures is revealed by the fact that the "ideal irreducible minimum" forest area to maintain the status quo has been estimated at 42% (Wyatt-Smith, 1979).

Palawan has been considerably less degraded than the other Philippine islands and had c. 46% of its land area covered by closed canopy forest in 1972. The ratio of dipterocarp to non-dipterocarp forest is the lowest in the Philippines, being 14:86 (Wyatt-Smith, 1979). A dipterocarp cover of 8% was quoted by P.C.A.R.R. (1980). This seems rather high in the light of the data presented by Wyatt-Smith (1979) and Lachowski et al. (1978) from which a figure of c. 6% dipterocarp forest can be derived for 1972-73.

1.2 The future of Philippine rainforest without intervention

With a population expected to reach 84 million by the year 2000, the pressure on the Philippine forest will increase tremendously. Forest destruction for settlement, agriculture, timber and by deliberate burning will progressively erode one of the nation's most valuable assets.

In reality, tropical rainforests appear not to be the renewable resource they were once thought to be, a fact highlighted by man's inability, to date, to re-create the original forest type.

The forest represents an insurance policy for the future. If a species becomes extinct, the range of tools at the disposal of the forestry or agricultural expert is reduced. A parallel situation in industry would be the disappearance of an inventor together with his plans, all other people with knowledge of his work and the products already made using his methods (Oldeman & Boerboom, 1982).

1.3 Re-forestation and conservation

Strict conservation of the remaining virgin forest (Plate 2) and extensive reforestation are the only ways to ensure the long term survival of Philippine rainforest. Effective the reforestation has met with limited success due to a series of factors, of which, the lack of adaptation of the selected species to the local climate, soils and competition from Imperata cylindrica plus human interferance (Plate 3) have been the main causes of failure. Fires and over-enthusiastic pruning for firewood have reduced many forest areas to savanna-like conditions (Plate 4).

Intensive competition from cogon (Imperata cylindrica) has been a major problem in enabling areas to be reforested economically. Only with the use of species which can out-compete cogon (Plate 5) will land be made economically availabe for planting. Monocultures are the normal type of established plantation. The ecological balance within these is frequently fragile and not in harmony with the local conditions. It is thus sensitive to any extreme, climatic or pathological. Thus, typhoons destroyed wide areas of Albizzia falcataria plantations on Mindanao in 1982; Endospermum peltatum plantations suffered total defoliation from caterpillars in the same year (Plate 6) and pine plantations in the Abra Province of Luzon were heavily attacked by budworm in 1981.

The use of a mixture of preferably native species would utilize genotypes already adapted to local conditions and thus offer greater potential for success. Seed source areas need to be protected and the autecology of the selected species investigated. This can only be achieved within a framework of effectively protected areas.

1.4 The potential of using Philippine species

The great potential of many Philippine species has long been realized, although the only non-experimental plantations are those using Gubas (Endospermum peltatum) and Banlag (Eucalyptus deglupta. Almaciga (Agathis dammara, Plate 8) is the most valuable softwood in the Philippines, but seed collection (Plate 7) and storage problems have prevented its widespread use. Special non-destructive collecting techniques do however exist that allow the same mother tree to be visited year

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Plate 4. A "reforested area" in north Luzon illustrating the effects of fire and fire-wood collection. Massive soil erosion, sometimes over 30 tons per hectare per year can occur in such areas. The accepted maximum reported by some authors has been at most, 3 tons per hectare per year.

Plate 5. Acacia mangium a new species suitable for introduction due to its outstanding ability to out-compete cogon (Imperata cylindrica).

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Plate 6. Endospermum peltatum (Gubas) plantations defoliated by an epidemic of caterpillars.

Plate 7. Cone collection of Almaciga (Agathis dammara) in western Palawan.

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Plate 8. The bole of a mature Agathis dammara south Palawan.

Plate 9. Over-enthusiastic resin collecting which has caused the death of a huge Almaciga tree, Palawan.

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Plate 10. A rattan (*Calamus diepenhorstii* var. *exulans*) from western Palawan.

after year. It is thus essential that potential seed trees are protected.

The situation with Almaciga underlines that area protection is not enough and that the individual trees are also at risk. In the latter case, unsupervised resin collection results in the cambium being damaged, allowing insects and fungus to penetrate the trunk (Plate 9). Seed production stops and soon the entire tree dies. Entire populations of Almaciga in Palawan are threatened in this way.

Secondary forest species are also of great importance. Drugs' research, as does that of a number of other phytochemicals (e.g. lignins, proteins, oils), centres heavily on tropical species and other products such as rattans (Plate 10), fruit , sago etc. are increasing greatly in value. These species are dependant even more than the traditional type of forest trees on a secure reserve for the maintenance of parent populations.

'There is every indication that with the growing rarity of intact vegetation and forests, there will be a dramatic increase in the commercial value of wild genomes. Twenty years hence they will constitute a considerable source of revenue for those in control of the areas in which they are found. Nor will this be a temporary source of revenue, since the purchased genomes will become integrated by means of sexual reproduction with the genomes already present in cultivated plants. Thus for every improvement it will again be necessary to resort to the virgin forest' (Oldeman & Boerboom, 1982).

The facit of forest utilization proposed by Hilleshög is thus very compatible with conservation.

2. PROPOSED ACTION PLAN

2.1 The 3-zone self-supporting conservation area

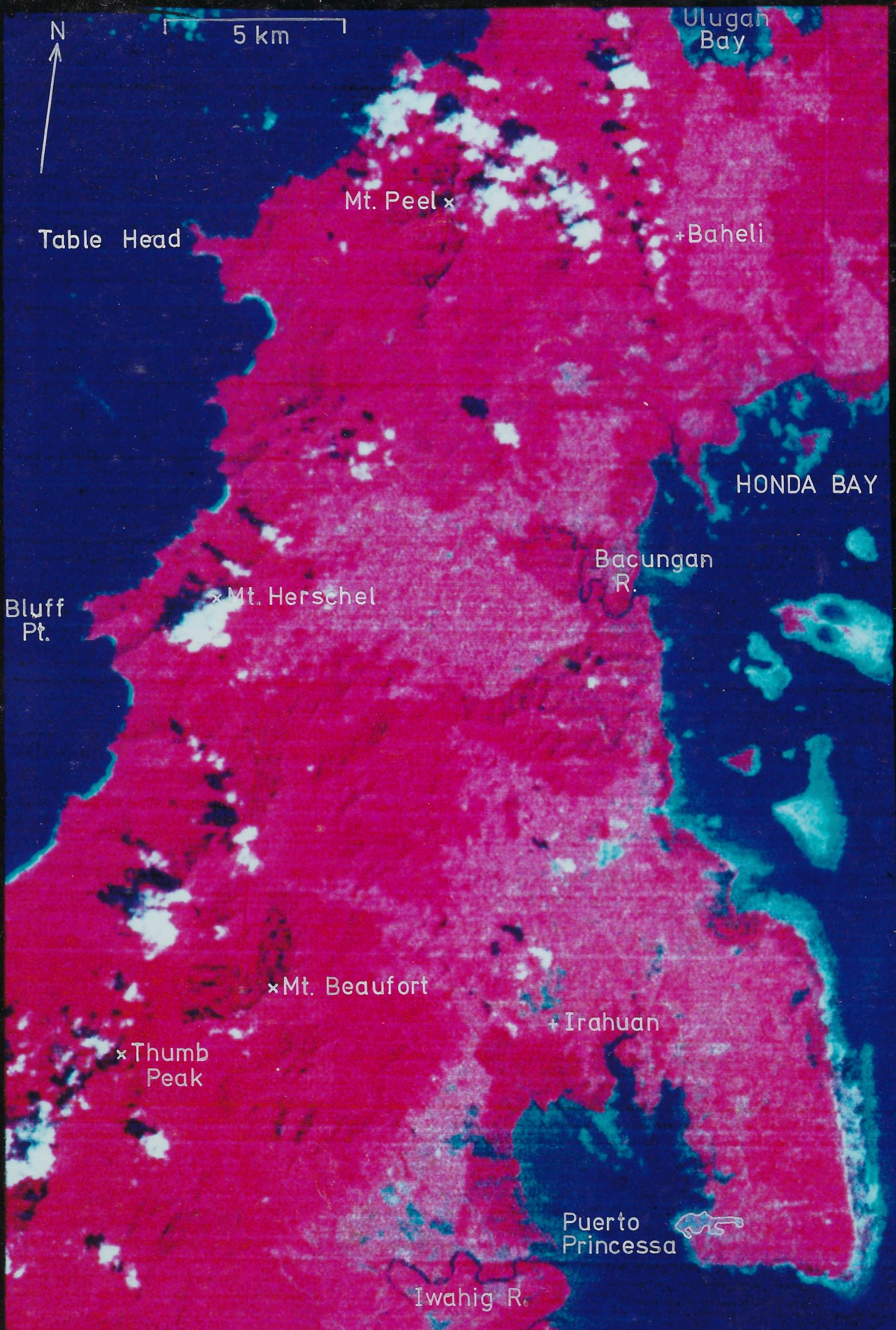
This design has been developed to:

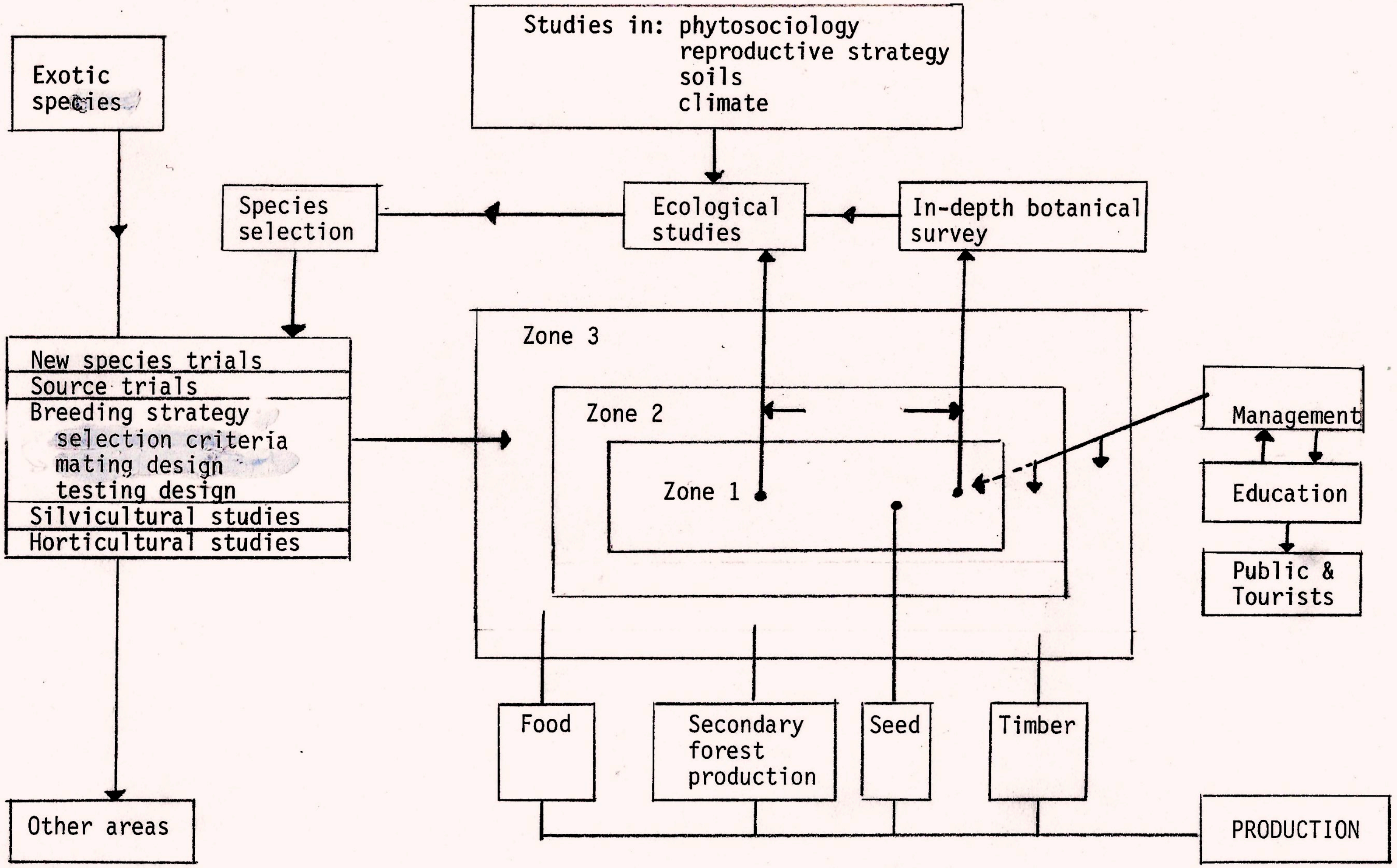
a. Ensure that on-site reserve protection is present continuously.
b. Minimise the cost of maintaining the reserve.
c. Enable the immediate implementation of research findings from the reserve.

Essentially it is a modified version of the Rainforest Reserve design in UNESCO's Man and the Biosphere program. It is a three-zone system divided up as follows:

Zone 1 - A core of strictly conserved virgin rainforest surrounded by,

Plate 11. A satellite image of central Palawan, recorded in December 1972. This clearly shows the areas of burned over and cultivated land (light pink), closed canopy forest including both virgin and mature secondary forest (dark red), water (blue) and bare soil/sand (white).


N
5 km
Ulugan Bay
Mt. Peel
Table Head
Baheli
HONDA BAY
Bacungan R.
Bluff Pt.
Mt. Herschel
Mt. Beaufort
Irahuan
Thumb Peak
Puerto Princessa
Iwahig R.



Zone relationships in the 3-zone Conservation design.

Zone 2 - Forest managed for increased seed yield surrounded by,
Zone 3 - An agro-forestry zone.

The relationships between these three zones are shown in figure 1 and detailed below.

2.1.1 Conservation Zone

The size of this zone is critical. Small strips of forest are totally inadequate as they will be invaded by secondary species which would hamper regeneration, thus leading to the death of the forest over a few decades (Jacobs, 1982). Reserve area based on the minimum population size of a particular species needed to maintain its genetic integrity is one way, probably the best, of estimating the area size needed. The assumptions made by Marshall (in Whitmore, 1977), leading to an estimate of 1000 - 25000 individuals are regarded by Swedish forest geneticists to be incorrect on the basis of experimental evidence from temperate trees. Franklin's estimate (Franklin, 1980) of 500 individuals seems better argued. Using these figures together with those for the density of the species in a particular area, an estimate of the minimum reserve size can be given.

The problem is confounded however by the lack of knowledge of the breeding systems of tropical plants and the travelling distance of their pollinators. While dioecy argues for doubling the minimum number of individuals, apomixy argues for a reduced number. However Bawa (1979) suggested that even some out-breeding species could be suffering from inbreeding depression in nature due to their small, isolated populations or poor travelling capability of their pollinators.

It cannot be over-emphasized that species do not live in isolation, but interact with many others in the ecosystem. There is a very real risk that the irreversible extinction of apparently useless species may bring about the equally irreversible disappearance of a useful species (Oldeman & Boerboom, 1982). An early stage of this could be envisaged in Malaya, where progressive destruction of the roosting places of durian-pollinating bats is leading to a reduced durian crop in some areas.

Ashton (1976) suggested that an area of 2000 ha. of unmodified virgin forest was necessary in two Bornean sites. Based on his field-work on Samar, he suggested (pers. comm.) that at least 2500 ha. would be needed in a homogenious habitat in the Philippines.

The conservation zone should only be subjected to non-destructive studies e.g.
a. Inventory studies.
b. Ground survey, including edaphic studies.
c. Mapping individuals of species of interest.
d. Phenology of selected species.
e. Seed collection.

To preserve the strict natural balance between organisms in of this zone, it should, as far as possible, be left untouched by human activities. The importance and significance of this zone and the others would be explained to both local people and tourists by means of an education program which would run for the entire length of the project.

2.1.2 Modified zone for seed production

The modified seed production zone is situated outside the conservation area. The vegetation cover is the same as that of the conservation zone. Its purpose is twofold:
a. Seed production.
b. A protective buffer for the conservation zone.

It will serve as a permanent source for seed of the valuable species identified from both zones. Endangered or threatened species as well as un- or under-exploited species with a great potential for afforestation, agricultural crops or for special purposes may be represented there. The seed produced in this zone will be tested in the agro-forestry zone, if successful they would be grown on a larger scale elsewhere in the country. The objective is to create a permanent seed-source of high quality seed of valuable species. All action taken in this zone would be directed towards a secure long term seed supply.

Individuals (ie. single genotypes) of the species identified in this and the conservation zone will not only form the seedsource, but also the basis for breeding to improve the future yield.

To do so the genetic variation within each species must be maintained. The number of genotypes needed varies with the breeding system of each species.

The number of species that will be dealt with is dependent on the results of the botanical survey and the tests carried out in the agro-forestry zone. As the programme advances the number of species will be reduced by selection using data on performance under actual growing conditions. Initially the number of species will be high.

It is important that the knowledge gained is implemented as soon as possible. The most important factor is the supply of seed. Seed supply can be improved by different treatments such as crown opening, fertilization with both macro- and micro-nutrients, hormone treatment and localized landclearing. The latter to enable collecting the natural regeneration which is of importance in the initial stages of cultivation for species with seed of very short viability.

To effectively implement this program, the infrastructure has to be improved. Existing roads must be expanded and tracks cleared. All trees and plants will be marked to make a permanent activity possible. Individual plants will be mapped to keep record of the valuable material and to ensure an efficient operation over a long time.

A permanent organization is needed to carry out this work and must consist of a staff with knowledge not only in botany, forestry, agriculture but also knowledge in local conditions such as terrain, language, social structure, etc. Hilleshög together with its subsidiary, Swedish Match-Hilleshög Philippines Inc. has the knowledge.

2.1.3 Agro-Forestry zone

Present cropping system: out-of-date

The conflict of interest between agriculture and forestry, which traditionally resulted in there being practised separately is now steadily being eroded by a number of factors. These are causing us to move towards systems of cultivation that are far more integrated than has been in the past.

Many countries are feeling the pressure of increasing population in the form of decreasing capacity to supply domestic demand for food and wood. This is not so much a final limit on production as a sign that traditional cropping systems are outdated and need to be reviewed.

Shifting cultivation has in the past proved to be a stable form of land-use in the tropical rain forests Now, increasing numbers of cultivators have caused situation in which full forest re-growth and restoration of fertility is not allowed to occur before the vegetation is cut down again for cropping. The result is a net loss of forest and a decline in overall fertility and capacity to sustain human settlements.

The establishment of monocultures,be they of oil palms or pines, in the tropical rain forest region gives cause for concern for long term production.

Economic land use in the humid tropics clearly demands a much more sophisticated level of design than is used at present. As future agro-forestry systems could be producing wood, food and other products on a sustainable basis, the benefits would be very substantial indeed.

The development of multiple-use systems

The development of multiple land use practises is one way of both increasing production per hectare in the short term and maintaining it in the long term.

In tropical rain forest areas the silvicultural techniques must include an agricultural component if shifting cultivation is not to continue as a cancerous growth in the forest estates.

Similarly monoculture plantations must be planned far more carefuly than in the past, with the intelligent blending of different species as well as integration with areas of natural forest, if the climatic stability, nutrient cycling and other factors crucial to a successful long term production are to be maintained.

Multiple use systems can be developed with two different approaches:

1. Multiple land use systems
2. Multiple tree crop systems.

Multiple land use systems

The agro-forestry zone is considered as one homogenous area in which the following strategies will be tested and developed with respect to productivity, stability and profitability.

A. Different use of adjacent sub-areas which together form a composite multiple use area.

B. The phasing of alteration in time of different uses of the same area.

C. Multiple use of cropping space at one time, utilizing horizontal and/or vertical (multi-layer) alternation of crops.

Multiple tree crop systems

Trees used in afforestation schemes are increasingly chosen according the the multiplicity of crops and functions obtainable from them. Many genera of trees capable of multiple use are ignored, or regarded as weeds by foresters, yet they might be capable of producing fuelwood on short rotation, protein rich pods or valuable chemicals for the pharmaceutical industry.

We shall concentrate on their cultivation in multiple use systems in the close integration of plantation crops with forestry operations to give a better overall land use with less environmental/ecological degradation.

It is important to remember the great value of a small number of such plantation crops to the world economy and to the economics of developing countries.

Philippine situation

Large areas of the Philippines consist of land covered by cogon grass *Imperata cylindrica* due to former kaingins. Logged over areas also cover substantial parts of the nation. To date these areas have not been effectively utilized as the present technology to make these areas fertile and productive is too expensive to the rural poor. The demand for fertilizers and chemicals is too high. A new technology with new but already existing species in the Philippines is needed.

Analog ecosystems

The concept that Hilleshög is developing is that of analog ecosystems, i.e. the more similar a created ecosystem (the planted crops), is to the original ecosystem the more balanced and productive the artificialy system is. It entails a combination of different species in vertical and horizontal distribution. There is also a variation in time and with succession stages of the created system. In short, instead of removing weeds in a forest plantation, a crop could be harvested. Besides the obvious fact that the profitability will increase significantly as less fertilizers and effort will be needed to fight insect and fungal attacks. This concept will be will be developed in the agro-forestry zone within the framework previously described.

To take full advantage of the two already existing but disturbed ecosystems, cogon land and logged over areas, the different sucession stages must be considered to get the maximum output per hectare.

In the cogon case, pioneer species must be used that successfully can compete with the cogon (Plate 5) and place for shade tolerant species. For example cardemoms can be harvested and give an income while the pioneer trees still are growing.

For logged over areas, shade tolerant species and those that need the existing stems to climb on must be used with already known species, rattans and Manila hemp can be mentioned.

In the agro-forestry zone new species selected for investigation in the zones, collected in the form of seed in the seed production zone, will be tested and introduced. Species not endemic to the zone or to the Philippines will also be tested and their importance to the country evaluated.

Intensive development

In the agro-forestry zone a field research station should be constructed. At this station, production of plants and seedlings of new species will be developed. It will serve as the center for all activities in the project. Seedlings that will be grown in this zone will be produced in a nursery managed by the station. The modified seed production zone will also be managed by the personnel on the station.

2.2 Social involvement

Traditionally, rural people have depended on forests to supply food, energy, shelter and goods for barter and income. Forests have provided a land bank to be drawn upon to meet the agriculutral expansion demanded by population growith and changing patterins of life brought about first by settlement and later by industrialization.

The demand for land for food production is increasing and the pressure on logged over and even virgin forest is increasing not only from the native tribes but also from forest occupants.

In spite the fact that all afforestation projects are beneficial to the population in the long term, they may cause an even higher pressure on existing land. The reason is obvious, large areas are not creating any income to the local people, for a number of years nor are they producing food or money.

A social dimension is necessary if the gene bank area project is going to gain the support needed from the great mass of people and if the zones 1 and 2 are going to remain secure against random incursions for food and fuel. The development of the agro-forestry zone is beside the fact that it will develop new cropping systems with un- and under-exploited species in such a way as to satisfy human needs and at the same time maintain ecological and environmental stability.

To be able to solve this task, the agro-forestry zone must be divided into lots on which the individual farmers grow and harvest crops. Seeds and plants will be handed out to the local people at a very low cost. The growers are guaranteed a market for the products since the company will oblige itself to buy the products at a minimum price.

3. MANAGEMENT ASPECTS

General

To be successful this project has to be carried out jointly between the following parties:
1. Ministry of Natural Resources
2. Hilleshög AB
3. Swedish Match-Hilleshög Philippines Incorporated.

A close cooperation between these parties is necessary. It is of ultimate importance that the development follow the guidelines of MNR to fit into their strategic planning for the development of the Philippines.

Personnel

The personnel needed for the implementation of the continuous activities, development of the seed production zone and the agro-forestry zone are:

Local project manager in the Philippines, Manila (technical manager of Swedish Match- Hilleshög Philippines Inc.)

Resident manager, Palawan

Senior forester from Swedish Match-Hilleshög, specialized in agro-forestry and seed production.

Nursery foreman

Field supervisor

Permanent labourers (10), seed collection, plant production.

For the parts of the project where more specialized knowledge is needed specialists from Hilleshög will carry out these tasks on temporary basis. Parts of the research and development will be done in the advance physiology and tissue culture laboratory of Hilleshög in Landskrona, Sweden, where demanding analyses such as different forms of chromatography will be made.

Equipment

A field station has to be constructed on Palawan in the agro-forestry zone of the project.

Requirements:

Nursery
Residence
Roads and trucks

Equipment:

Nursery equipment
Jeep
Trailer
Radio
Office equipment
Generator

3.1 Area selection

Various criteria for area selection have been listed by Jacobs (1979, 1982). An underlying assumption is however, that the flora of an region is well known. This is not the case for Palawan.

The picture that has emerged is that although collecting has been very intense in four areas (Puerto Princessa to Ulugan Bay, Victoria Peaks eastside, Mt. Mantalingajan eastside and Balabac Is.), the greater part of the island is totally unexplored botanically. There are no records at all for the entire northern third, including the island's only lake. Further, the western slopes of Victoria Peak and Mt. Mantalingajan, together with the southern tip of Palawan and Bugsuk island are also unknown. It is clearly impossible from the available data to optimize area selection on an island-wide basis.

An important practical consideration is that the reserve area should be of relatively easy access to allow close control of the field management and reserve protection. This factor currently limits the choice of area to within a distance of c.50km of Puerto Princessa. From a botanical point of view this is both good and bad. Good, because that is botanically one of the best known on the island; bad, because most of the forest has been felled or at least badly disturbed in that area.

Using the information presented in appendix 1 and referring to other literature sources it would be quite practical at the present time to prepare a preliminary field-guide to the woody plants of Palawan. This would greatly facilitate study of any selected area and would be an invaluable working tool during exploration. It has been estimated that about 10 months would be needed to prepare this document. More detailed work on the flora coupled with further exploration would lead to the production of a prestigious illustrated field-guide suitable for publication.

Area selection and exploration would be greatly facilitated by reference to satellite imagery (Plate 11) and aerial photography. These techniques would give valuable advance information on the distribution and homogeneity or heterogeneity of the existing forest. Such basic advance planning streamlines field-work and makes it much more cost-effective.

The Palawan Expedition reports (Bruce 1981, 1982) suggested that there is an extensive strip of rainforest west of Mt. Mantalingajan based on their observations of an area near Ransang. Examination of the 1979 satellite image of southern Palawan suggests that the band of rainforest is in fact quite narrow. Only a survey from a light aircraft or a ground survey could confirm or refute this.

Once interesting, unexplored areas of forest have been selected, then expeditions could be made to investigate the flora more fully. The expeditions should consist of professional botanists already working on the SE Asian Flora (e.g. staff of the Royal Botanic Gardens, Kew, England; Rijksherbarium, Leiden, Holland; Philippine National Herbarium, Manila) and members of Hilleshög to represent the commercial interest.

The following proposals are thus made:
a. Areas for the project should be selected initially from satellite imagery and aerial photographs.
b. These areas should then be investigated in the field to determine their suitability.
c. A working field guide to the woody plants should be prepared.
d. The selected area should be surveyed in detail.
e. Exploration of other areas on Palawan should proceed to determine the full island flora.
f. On completion of the above phases, a "Field guide to the woody plants of Palawan" should be prepared for publication.

3.2 Organization needed

3.2.1 Botanical Survey

The following steps should be followed in zones one and two:
a. Accurate topographical maps at a scale of c. 1:5000 should be made of the selected area.
b. A detailed inventory of all plants, both woody and herbaceous, should be made. All species must be represented by by herbarium specimens. The latter must be collected with at least 4 duplicates of each, the sets being distributed to the Philippine National Herbarium (Manila), Hebarium Bogoriense (Java), the National Herbarium of Malaya (Kuala Lumpar), the Rijksherbarium (Holland) and the Royal Botanic Gardens, Kew (UK). Further duplicate sets could be collected for sale to other herbaria. During the inventory work, a preliminary map of vegetation distributions could be made.
c. Using the inventory list, each species of known interest would have its individuals mappped whenever this is practical. Samples of other species would be taken from zone two for testing.
d. In zone one the autecology of selected species would be investigated i.e. species associations, interactions, soil and microclimate preferences, reproductive biology and natural seedling establishment.

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e. A soil and microclimate survey of zone three would indicate which species associations should be established in different areas in this zone.

The ecological studies are an important part of the this proposal. Oldeman and Boerboom (1982) summerize this well, "....the study of processes which determine the natural development of a forest will result in more efficient methods of silviculture, management and exploitation. These improved systems will probably in turn lead to reductions in the cost of silviculture since they will require less chemicals, intensive labour and machinery......will allow timber production on land outside forest reserves to be at least trebled during the next twenty to fourty years". Silviculture only is mentioned in that quote, but it must be remembered that Hillehög proposes to use many different types of species and this should further enhance the end result.

3.3 Financing

Though the project is a fabric of activities aiming at the same target i.e.a valuable production in rural areas, the three different parts, zone 1 - 3, might be financed differently.

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REFERENCES

Ashton, P.S. (1976). Factors affecting the development and conservation of tree genetic resources in south-east Asia. In: J. Burley & B.T. Styles (eds). Tropical Trees: Variation, Breeding and Conservation. Pub. Academic Press.

Bawa, K.S. (1979). Breeding systems of trees in tropical wet forest. New Zealand Journal of Botany, 17: 521 - 524.

Bruce, M. (ed., 1980). The Palawan Expedition: Stage I. Pub. Traditional Explorations, Sydney.

Bruce, M. (ed., 1981). The Palawan Expedition: Stage II. Pub. Associated Research Exploration & Aid, Sydney.

Franklin, I.R. (1980). Evolutionary change in small populations. In: Conservation Biology, ed. M.E. Souté & B.A. Wilcox, Pub. Sinauer Associates Inc.

Jacobs, M. (1979). Botanical philosophy on the selection of rainforest reserves in Malesia. Flora Malesiana Bulletin, 32: 3247 - 3250.

Jacobs, M. (1982). Unpublished.

Kaur, A. et. al. (1978). Apomixis may be widespread among trees of the climax rainforest. Nature, 271: 440 - 442.

Lachowski, H.M., D.L Dietrich, R.M Umali, E.A. Aquino and V.A. Basa (1978). Landsat-assisted forest inventory of the Philippine Islands. Natural Resources Management Center Research Monograph, No. 4 Manila.

Oldeman, R.A.A. & Boerboom, J.H.A. (1982). Life insurance for tropical hardwood resources. In: R.A.A. Oldeman (Ed.). Tropical Hardwood Utilization.

P.C.A.R.R. (1981). State of the art for the Philippine dipterocarp forest (as of 1980). Timber and Timer Products Commodity. Mimeograph.

Whitehead, J. (1893). Exploration fo Mount Kina Balu, North Borneo. Pub. Gurney and Jacson, London.

Whitmore, T.C. (1977). A first look at Agathis. Tropical Forestry Paper, No. 11, Commonwealth Forestry Institute, Oxford, England.

Wyatt-Smith, J. (1979). Management research of Philippine dipterocarp forest. FAO Report, FO: DP/PHI/72/006.