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Research for the Humid Tropics of Asia**

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## SESSION 2

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### *Indigenous Agroforests in Indonesia: Complex Agroforestry Systems for Future Development*

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INDIGENOUS AGROFORESTS IN INDONESIA:

COMPLEX AGROFORESTRY SYSTEMS

FOR FUTURE DEVELOPMENT

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AGROFORESTRY tends to be largely promoted now but scientists or extension agents dealing with agroforestry programs still do not consider potentials offered by systems evolved from indigenous agroforestry practices. Most agroforestry projects are still promoted in villages from an "outside" will and with "outside" tree crops or mixed-cropping techniques, and often do not explore local "agroforestry" basis and potentialities nor sufficiently integrate local tree species and structures.

This is particularly true in Indonesia. At the last World Forestry Congress in Paris in 1991, the Indonesian representatives recognized the important needs in a near future for the development of agroforestry systems in silviculture and forest management but some complained of the low level of development of agroforestry in Indonesia. Whereas Indonesia is probably the country in the world where agroforestry systems are the most diverse and the most developed.

### Indigenous agroforestry systems in Indonesia: an overview

Until now, only two "indigenous" agroforestry systems are officially recognized and referred to as national forms of sophisticated agroforestry developed by people and forestry services: "tumpangsari", an Indonesian version of the taungya system, first developed by the beginning of this century by the Forestry Services in Java to improve the management of state-owned teak plantations, and "pekarangan", the javanese homegarden, which seems to be one of the most sophisticated homegarden systems in the world.

Apart from these, some systems are occasionally mentioned: the "talun/kebun" system of West Java which is formed of an alternation, on the same piece of land, of perennial crops (bamboos, fast-growing tree crops, fruit trees, which form the "talun" phase) and of a mixture of annual crops and seedlings of perennials (the "kebun" phase, which is a rejuvenating phase of the "talun"). Dry land farming practices of farmers in Java are also sometimes mentioned. But almost nothing from the "outer" islands, which are mainly known for their destructive mode of agriculture, namely shifting cultivation.

Are there really no basis, no knowledge in agroforestry in that country?

For sure not. On the contrary, Indonesia should be mentioned for the development, the diversity, the long history, of agroforestry practices and systems all over the archipelago.

But which are these systems? what are their qualities and their potentials for the development of agroforestry? why are they still misunderstood?

### Simple agroforestry systems

Just look around you in Java, almost every piece of land is planted with a mix of perennials and annuals: most dry fields include trees either as true components (coconut with maize) or as borders (teaks, mahogany, rosewood, in East and Central Java). Trees are also commonly associated with irrigated ricefields either on dikes or along roads, and these are useful trees which hold a real role in the agricultural system.

Plantation agriculture is also deeply marked by "agroforestry": coffee is still commonly associated with *lythrina* trees which give both shade to coffee bushes and firewood to the planter while being beneficial to the soil, associations between coconut and cocoa are spreading and diversification of industrial rubber plantations are being tested -coconut and rubber being more and more considered as "forest" crops and yielding wood for wood industries.

All these systems are obvious agroforestry combinations, i.e. associations of trees and agricultural crops, in which one usually encounters on the same piece of land no more than a small number of components, usually one tree species and one to a few annual -or short cycle- species. Therefore, having regard with the small number of components included, we shall keep calling these types of agroforestry associations "simple agroforestry systems".

But yet? Outside these obvious associations?

## Complex agroforestry systems

For common observers, vegetation bordering obvious agricultural areas -specially in those areas which are still under reorganization from the forest, in the outer islands- is often misunderstood as a mix of "virgin" and "degraded" forest.

But for experienced agronomists or foresters with a minimum knowledge in botany, or for anyone who can just ask the farmers around, it will soon appear that these are not patches of "natural", unmanaged vegetation, but in most cases "kebun", namely gardens, and here tree gardens, which are in fact true agroforestry plots including a complex mix of trees and herbs.

That kind of agroforestry combination which is not obvious but takes the form of a "forest" both in physiognomy and in functioning, we have called "complex agroforestry system" or more simply "agroforest": systems in which a high number of components (trees as well as treelets, lianas, herbs) are associated, and physiognomy and functioning of which are close to those observed for natural ecosystems, either primary or secondary forests.

These "complex" agroforestry systems are encountered most exclusively in peasant agricultures of the humid tropical world.

In Brasil, these systems are mainly "managed forests" evolved from progressive and integrated transformations of the original ecosystem, but in Indonesia, they are true gardens established, after total removal of the original vegetation, through plantation of desired species and natural enrichment.

The javanese "pekarangan" (fig. 1) is one of the many examples of complex agroforestry systems.

But most complex agroforestry systems, which are not homegardens but far more extended gardens, have been conceived outside Java, sometimes for hundreds of years, within shifting cultivation systems.

Developed with either fruit species, local forest species providing timber and other commercial products (rattans, resins, spices) or exotic trees as rubber, these complex agroforestry systems are far from being anecdotic: their diversity, their dynamism and importance, in terms of surface and production make them a major element of smallholder agriculture in the great Outer Islands.

In the hills and lowlands of Kalimantan or eastern Sumatra where the last tracks of mixed dipterocarp forest are being exploited and rapidly converted, smallholder "jungle rubber" agroforests (fig. 2) in which

rubber trees are associated with numerous tree species providing either fruits or timber, cover an estimated area of 2.5 million hectares, complementing either irrigated or dry rice cultivation.

In the western coast of Sumatra, an impressive model of complex agroforestry systems based on a Dipterocarp tree exploited for its resin has been developed by villagers for more than 100 years (fig. 3).

The illipe nut gardens of West and Central Kalimantan are also examples of complex agroforestry systems integrating Dipterocarps.

In all parts of Sumatra, various types of complex agroforestry systems associate, under a canopy of durian or kemiri trees, numerous fruit species as well as economic spices (cinnamon, nutmeg, clove) and timber species (fig. 4).

In East Kalimantan, impressive fruit forests have developed ("lembo") which seem to be among the richest systems as far as tree species are concerned.

In North Sulawesi, in Lombok, agroforests are centered around a palm producing sugar.

In the Moluccas, agroforests associate fruit or nut trees to the traditional spice trees: clove and nutmeg.

In terms of production, at regional as well as national levels, these agroforestry systems are of utmost importance: they provide 80% of the rubber latex consumed and exported by Indonesia, roughly 95% of the various fruits marketed in the country, between 75 and 80% of the Dipterocarp resins traded in and outside the country, a significant part of rattans and bamboos, an immense part of the firewood used in the country, and the majority of such items as medicinal plants, handicraft material. Moreover, they ensure the self-sufficiency of most rural households in complementary foods, fuelwood as well as light and heavy material.

It is important to precise, for further understanding, that most of these systems are definitely not homegardens, but more extended systems that have to be attached to the world of "plantation" agriculture more than to subsistence agriculture, as their main "motor" is the search for monetary income in rural households.

## Simple and complex agroforestry systems: two worlds apart

Simple and complex agroforestry systems are related to two different conceptions, demanding different approaches, and mentioning this distinction is worthwhile: it is not only an academic distinction, but also actually appears in present research and development programme: simple agroforestry associations represent what may be called the "classical" agroforestry model as it is the most favoured in research and development programme of most institutions dealing with agroforestry.

Abundant literature is readily available for simple agroforestry systems: hedgerows, wind-breaks, intercropping of commercial tree crops and annuals, taungya systems, fast-growing woodlots in village land... have already received due attention in research as well as in implementation from foresters and agriculturalists. Official services dealing with agroforestry research and extension often only recognize simple agroforestry systems as true agroforestry. Most agroforestry projects until now concentrate on simple associations with quick fuel producing, soil stabilizing or nitrogen fixing forest species either for diversification of plantation agriculture or for reforestation and rehabilitation projects.

Whereas complex agroforestry systems are still prized only by few scientists and not by developers.

This is important to emphasize as a few well-known associations of one or two tree species and few annual crops overshadow the bulk of complex practices directly inherited from smallholder agriculture. This is important to emphasize especially now in Indonesia, not only for programme or debates on "indonesian agroforestry" but also for the future development of agroforestry, in that country and elsewhere.

## Why and for what should we grant a special consideration to agroforests in the multiplicity of agroforestry systems?

Indigenous agroforests, in spite of their relative success in the given conditions prevailing in the areas in which they were conceived, are usually not transferable nor commendable as such to other regions or other countries. Nor should they be considered as the summum of agroforestry practice in the regions where they do exist.

Rather, they represent an invaluable source of inspiration and should be considered right now as models of utmost interest for the development of sustainable forms of agriculture and/or of forestry which could combine profitable economic results and long-term conservation of both soil fertility and global biodiversity.

In spite of their lack of intensification, in spite of the lack of experimentations and improvements carried on them, indigenous agroforests of Indonesia exhibit qualities that are worth to mention and interest both the present and future development of agriculture and forestry, specially in areas where annual food cropping of staples is only possible with very heavy applications of fertilizers and where only perennial crops are capable of sustained production.

For agricultural development, complex agroforestry systems provide an original model of sustainable and profitable commercial agriculture suited to the conditions prevailing in smallholder farms

The development of commercial agriculture, specially for perennial crops, virtually assumes total conversion of existing production systems to monocultures with high inputs of external energy, capital and labour. Experimentations and researches on commercial tree crops are unavoidably conducted under standard conditions which are far from those commonly encountered on smallholder farms.

On another hand, indigenous production systems, and among them agroforests, are invariably considered as mainly devoted to subsistence production, and promotion of commercial agriculture on smallholder farms is more conceived as a total reorganization of the farming systems than as an integrated process taking advantages of the existing structures.

Agroforests are generally considered as “kitchen gardens”, i.e. no more than an anecdotic complement to openfields culture, devoted to self consumption, and providing villagers with complementary foods and light materials like firewood. It should be emphasized here that in fact agroforests usually play a determining role in the farm economy, as the main commercial unit of the production system.

Agroforests do have a major economic importance for local communities: indeed, the main role of agroforestry plots is not food nor material production, but supply of immediate monetary income and “capitalization”, i.e. creation of assets, namely building of a patrimony that will increase the wealth of the farmer, the farm production capacity



and that can be transferred to children. Agroforests are often the sole source of cash money for households: in Sumatra, agroforests usually provide between 50 and 80% of total agricultural income of villages through both direct production and activities linked to collection, processing and marketing of it.

The originality of that conception of commercial agriculture (which lies on diversification of structures and components rather than on concentration on a single species: commercial production is compatible with a wide range of productions and functions) has several interesting consequences for the farmers:

- the agroforest makes up an original "bank" through the diversification of income sources and rhythms: agroforest incomes usually allow to cover both every-day expenses, with regularly harvestable products as rubber latex, resin, coffee, cinnamon bark..., and, at least partly, annual expenses, with seasonal products as fresh fruits, clove, nutmeg. Other commodities, as timber, which provide occasional, but important sums of cash money, serve as money savings for exceptional expenses. This diversity of income forms is essential in areas where habits of storing cash money are not developed and where credit is very expensive or unavailable (which represents the bulk of rural areas in the tropics).

- the agroforest provides both security and flexibility through the diversification of commercial crops under a permanent structure: diversity, though not allowing rapid accumulation of capital under the form of immediately realizable assets, constitutes an insurance of utmost importance for the farmers against risks of one crops failure (see the example of clove plantations in Indonesia) or risks inherent to unpredictable evolution of market prices.

Flexibility is an important quality for smallholders: in cases of falling prices of one commodity, the concerned species can simply be neglected in the garden for a while, until its exploitation becomes profitable again. This process does not involve any disruption of the system itself, in ecological terms (the agroforestry plot will be maintained intact and will still be productive, the concerned species will survive in the structure and will be ready for further exploitation, new species can be introduced as well) as well as in economic terms (there will still be something to harvest, or even new productions to try without reorganizing the farming system). Another mark of flexibility is the shift in economic status that some species may encounter: species, present sometimes for decades in the agroforest, may acquire suddenly a new commercial value, according to the market evolution or to

infrastructure changes as the opening of a new road. This was the case for fruits as durian and langsat and more recently for timber in areas where timbers from natural forests have become a scarce resource.

- Lastly, the agroforest, through the diversity of secondary productions, ensures all the subsistence needs of the farmers, **which is an essential asset in their economic independence and welfare**: agroforest acts as a common "kitchen garden" providing complementary food (fruits, vegetable, spices). But also, through the diversity of wild flora and fauna, the agroforest replaces the natural forest for the production of such nowadays rare and precious items as **timber, rattans, fuelwood** (fig. 5), thatching material, medicinal plants, or game.

In the sphere of forestry the indigenous agroforest models offer important alternatives to existing models of industrial silviculture which may efficiently complement social forestry programs.

Forestry policies presently increase efforts on integrated forest management, forest conservation and plantation establishment of timber species. But until now, the integration of local communities in plantation projects or conservation projects, as well as the diversification of forestry models for sustainable and multipurpose management of a forest ecosystem, are either difficult or non-existent.

- Silviculture: simple technics for managing complexity

Agroforests in Indonesia are true gardens established, after total removal of the original vegetation, through plantation of desired species and natural or semi directed enrichment. Establishment and maintenance technics should directly interest foresters as they are efficient and long tested technics of reforestation and forest management.

Complex agroforestry systems already offer simple models of sustainable and multipurpose dipterocarp plantation designed for the village level: the resin-producing agroforests in the south of Sumatra, or the illipe nut gardens of west Kalimantan. Though they are among the rare models of successful Dipterocarp silviculture, as well as an original system of smallholder forest management for wood and other natural resources, until very recently the Forestry Department has never paid due attention to them.

In the very western part of Lampung, Sumatra, between villages and the border of Barisan Selatan National Park, all the land opened in the past by shifting cultivators is now occupied by an original system based on the cultivation of a resin-producing Dipterocarp (fig. 6): *Shorea javanica* K. & L. (damar mata kucing) which is presently associated to several fruit, timber and material tree species, palms, bamboos, as well as to numerous self-established species issued from surrounding primary and secondary vegetations. In West Kalimantan, illipe nut producing gardens are, together with rubber and fruit agroforests, important elements of the farming systems. In both systems, patterns of species diversity and structural complexity are similar to those of a natural forest ecosystem with a high tree canopy, several "layers" of smaller trees and treelets, and an herbaceous ensemble dominated by species characteristic of a forest undergrowth (fig. 7).

Common problems linked to the establishment and maintenance of Dipterocarp plantations (irregular seed supply, lack of seed dormancy, difficult mycorrhization, garden establishment) have been solved by villagers with simple technologies.

As for almost all agroforests, the establishment of dipterocarp gardens is a classic taungya-like process of tree-plantation (fig. 8).

The initial vegetation, which can be primary or secondary forest, or even herbaceous vegetation, is felled and burned. Upland rice is planted, as well as less important food plants and semi-perennial commercial crops (coffee, pepper and *Erythrina* or *Gliricidia*), together with seedlings (produced in small farmer scale nurseries) of the tree species which will later form the skeleton of the agroforest.

After the last harvest time (8 to 15 years in that case), the plot is temporarily abandoned and the planted trees develop amongst the natural regrowth until they become productive.

This period is a phase of intense competition between the planted trees and the pioneer vegetation. In this respect, the intercalation of semi-perennial crops, whose primary goal is to increase the profitability and to lengthen the productive commercial period of the plot, considerably reinforces the competitive advantage of the planted trees over natural regrowth, by delaying the establishment of pioneer vegetation. Another practice to mitigate the effects of competition, used on a large scale for the establishment of rubber agroforests, lies in high densities of planted trees (700 to 1000 planted seedlings per ha).

When the trees begin to be productive, the plot is completely weeded, with the noteworthy exception of useful spontaneous species, which are carefully preserved. The plot, which has passed through a stage of staple food producing field, through a stage of commercial crops, then through an unproductive building phase, now fully enters the productive agroforest phase.

After establishment of the productive agroforest, the silvicultural process is not conceived, as in most tree plantation systems, as a mass treatment applied to an homogeneous, even-aged population of damar trees, but aims at designing a forest-like ecosystem which produces and reproduces without disruption either in structural or in functional patterns. Global continuity is ensured through a balanced combination between appropriate management of individual trees and natural dynamic processes prevailing in tree populations. As natural decay of planted trees is predictable, villagers can easily foresee and plan their replacement. The main task of the farmer is then to introduce regularly young trees in the garden plot in order to constitute and maintain an uneven-aged pool of replacement trees, or to control and favour natural regeneration. In a well managed garden, population size of the replacement pool more or less equals that of the productive stand. When a large gap accidentally occurs in the canopy, villagers have to develop and control the whole regeneration process; young trees introduced in the gap are associated to cultivated sun-tolerant species (bananas, vegetable tree species or clove trees) which they replace natural pioneer species and provide some shade to young trees.

**- Silviculture:** management of a diversified timber production through complex agroforestry systems.

Commercial timber production is considered as the exclusive domain of big private or State enterprises. Existing production from complex agroforestry systems is never mentioned, and current estimates for potential wood production from agricultural areas (FAO 1990) only mentions homegardens in Java. However, both existing and potential resources from the bulk of complex agroforestry systems outside Java, as well as management practices for timber species in different types of complex agroforestry systems, are worth investigating.

As an example, we can mention agroforests in West Sumatra. Under a canopy of high durian trees and various forest species are grown commercial crops (cinnamon, coffee, and nutmeg) as well as various fruit trees, managed forest species, palms, bamboos, and medicinal plants (fig.4).

Timber production from the agroforestry gardens is quite important and original. It relies on both actual cultivation of timber species and management of naturally occurring forest species as well as utilization of fruit trees.

Two species are largely cultivated for their wood. They are native to the local forest ecosystem and make-up 30 to 70% of the canopy tree cover. Both can be harvested after 25-30 years when their diameter reaches 35 cm. Processing in boards is done by village carpenters who also deal with sale outside the area (fig. 9). A third species, is also being much cultivated for roofing works. Managed forest species include mainly Meliaceae, Lauraceae, Fagaceae, Myrtaceae and scattered Dipterocarpaceae. They are not actually planted but reproduce from seeds produced by mother trees conserved in the agroforestry gardens or carried by winds and animals from the nearby forests. Seedlings or saplings are selected by the villagers, they can be transplanted whenever needed, and they benefit from the cares given to commercial tree crops (mainly weeding).

Utilization of the wood of over-aged or bad-producing fruit trees is also important. The preferred species include durian, cempedak, and various *Baccaurea* species.

Altogether, timber production from that particular agroforest relies on about forty species, each particular species being given a preferred use. Some of those species are known to be sometimes used by foresters. Labour devoted to "silviculture" is totally mingled with that needed for commercial tree crops.

Even if more research is needed in order to investigate the potentials for timber production from complex agroforestry systems, these agroforests may be characterized by the abundance of potential timber trees, the large availability in seeds and seedlings, and the fact that the species involved are well known and managed by villagers for long.

- A man-made forest which allows biodiversity conservation

It is commonly acknowledged that the replacement of natural ecosystems by most of the already known agricultural systems involves a drastic reduction in biodiversity. This is less commonly recognized for forest plantations, but, as far as structure and composition are concerned, an Eucalyptus plantation, though being termed "forest", is as different from a natural forest as is a cassava field. It restores a forest material, but not a diversified ecosystem, and although allowing a rather good protection of soils and water, it plays a minor role in the conservation of the world forest heritage.

Complex agroforestry systems, in the form of those observed in Indonesia, have not only proved to be economically profitable, compatible with high population densities, and ecologically viable in the long term.

They also are, to our knowledge, the only land use system in tropical lands which allows to combine intensive agricultural production and conservation of a high degree of biological diversity.

Though implying a definitive removal of the prevailing forest ecosystem, they replace natural vegetation with a complex community of perennial species, which not only allows the direct conservation of numerous useful forest species, but also acts as shelter for hundreds of forest species not directly useful to man.

Agroforests actually exhibit forest-like structures, which create, in the agricultural lands, niches in which forest species, either trees, shrubs, herbs, epiphytes or lianas, can establish and reproduce, and in which various animal species can feed: in Padang area, West Sumatra, for example, one of the richest and most densely populated provinces of Outer Indonesia, natural lowland forest have long been replaced by extensive tree gardens in which more than 150 tree species (for fruits, timber, export commodities) are commonly managed. Moreover, it has been estimated that several hundreds of self-established forest species are conserved, such as valuable "meranti" and other wood species, as well as orchids, undergrowth plants, palms and lianas.

It is important to recognize that complex agroforestry systems represent one of the most meaningful and still successful contribution of villagers to conservation of the world's natural heritage. Those villagers who are commonly identified as the first threat for tropical rainforests at the world's scale have actually succeeded in establishing and maintaining over decades sophisticated forest-like production units, which take-over the traditional roles (ecological as well as economic) of the natural forests they have cleared through shifting cultivation while providing advantages of commercial agriculture.

Complex agroforestry systems are far from answering all the problems linked to reinforcement of peasant pressure on forest ecosystems and resources. And in no way could they replace protected reserves of natural forest. But in areas where natural forests, submitted to all kinds of pressures, scope of which largely exceeds village scales, are doomed to destruction, complex agroforestry systems can contribute to maintain in the landscape a useful and diversified forest ecosystem from which peasant is not excluded.

Seen in the present context of global dilapidation of common property resources, and among them of all the forest resources, and given the current trends of “dispossession” of traditional rural societies by development and migration, agroforests assert an original but very efficient social takeover of forest riches by farmers groups, which should not be overlooked as new trends are to harmonize development and conservation of resources at village levels.

For Humid Tropics, complex agroforestry systems provide an invaluable model of a successful low-input transition from shifting cultivation to sustainable and profitable fixed agriculture.

We have already seen above some of the agroforests direct benefits for smallholders economies, diversification of income sources and rhythms, security and flexibility, diversity of secondary productions, but two other points have to be mentioned in order to understand the economic suitability of agroforests to shifting cultivators.

Although the productivity of agroforests is usually considered as low in terms of conventional standards (but we shall see that, because of a misunderstanding of the system, this productivity is biased in favour of the main crop, the others being neglected), it must be stressed that agroforests provide a good return to labour.

The establishment and management processes of agroforests only required very low investments, either in terms of labour or in terms of cash.

These two points are especially important where labour and cash availability are much more scarce than land availability, which is the prevailing case in much shifting cultivation areas of the humid tropics.

In addition to these economic benefits, it is worthwhile to point out a few other important characteristics which help to understand the positive relationship between shifting cultivators and agroforests.

The establishment process (fig. 10) is directly linked to shifting cultivation: one slight change and only one, namely the planting of trees, well known by local people and fully acknowledged for their economic value, inside the slash and burn field, will orientate the whole destiny of the field. This very simple action, which all shifting cultivators in tropical humid countries can manage, is at the crossing between two tremendously different results, stable agroforest on one side and fallow/cultivation classic cycle on the other side.

Lastly the agroforest management process itself does not involve any sophisticated technique, but on the contrary lies directly upon shifting cultivators traditional knowledge of their forest environment.

*For shifting cultivators, the fundamental consequence of the establishment of agroforests is the progressive but unavoidable passage towards fixed agriculture* (fig. 11 ).

The temporary fields, which could formerly be cultivated after a fallow period, are now planted with tree species. The commercial importance of planted trees, as well as their value as standing capital and patrimony, prevent any reuse of the fields, thus removing them from the realm of shifting cultivation.

Given the increasing demographic pressure which characterizes most of the humid tropical regions at present, the ecological advantages of this rupture of the traditional cultivation/fallow cycle in favour of agroforests are obvious: degradation of the soil, which was suffering the impact of ever shortening fallow periods, is stopped, and permanent tree cover reestablished with its entourage of forest species, either flora and fauna...

The economic advantages are by no means less important: the benefits for the farmer himself are obvious and have been discussed above; at a regional level, as can be seen in Sumatra, agroforest based farming systems can accommodate far much higher population densities than shifting cultivation, the rural populations take full responsibility for a sustainable management of their land; last but not least, without losing control over their own development, communities are integrated into the wider economy and contribute to regional and national development, through the medium of commercial productions.

In Sumatra, for example, the land covered with agroforests, could be estimated in the mid 1980s to at least 3.5 million hectares (Vegetation Map of Sumatra, ICITV-BIOTROP), or about 50% of permanently cultivated land.

If that land was still locked in the classic cycle of shifting cultivation, would it not be today in a serious state of degradation? And would' be the social and economic consequences of such a degradation?

We may well ask, as we may wonder whether the state of today's degraded humid tropical land would be better, along with the social and economic conditions of the people living on this land, if it was covered in agroforests...



Those people who developed agroforests were shifting cultivators. But they are not anymore, and agroforests were the key of their success on their way to permanent agriculture.

This is in fact a very crucial point, because it means that agroforests, with all their ecological and economic benefits, can evolve from shifting cultivation. Moreover, it also means that the agroforest path should be considered as one of the most suitable way to ensure a successful transition between shifting cultivation and a sustainable and profitable fixed agriculture (fig. 12).

### Why are agroforests still misjudged?

Except for the homegarden system in Java which has been thoroughly studied (Padjadjaran University in Bandung, Gadjah Madah University in Yogyakarta, LIPI), complex agroforestry systems are being relatively poorly investigated and much ignored in agroforestry development

Complex agroforestry systems in Indonesia, though covering several millions hectares, are not mentioned in land-use categories currently adopted in Indonesia. There is no concept for such systems, either in agriculture or in forestry. Denying conceptualization is also denying existence and future for such systems.

How and why are these complex agroforestry systems not taken into account?

This results mainly from several misinterpretations of the structures and qualities of the agroforests themselves, and partly from some taboos or preconceived ideas regarding both agroforestry in general and the practitioners of complex agroforestry in Indonesia.

### Misinterpretations about agroforests

- The first problem for a global acknowledgement of complex agroforestry as a system per se is that agroforests are not easily recognizable: the multiplicity of forms they can take, their resemblance with natural vegetations and consequently their unclear differentiation in the field from other forms of vegetation make it difficult to establish common and obvious signs for recognition: as we have mentioned above, agroforests are often mistaken for natural vegetation, either for secondary forests as for rubber agroforests or for primary forest as the Dipterocarp agroforests of Kalimantan or Sumatra.

Most agroforests are presently mapped as “secondary forests, shrublands and degraded vegetation”. They are therefore taken together with the bulk of actually degraded lands that new policies want to rehabilitate. For example, a “reforestation” project in the west coast of Lampung planned to convert thousands of hectares of such mapped degraded vegetation, which in fact is....good, balanced, sustainable dipterocarp plantation, to Acacia plantation!!! Fortunately, after field surveys which allowed the recognition of the existing dipterocarp agroforest, forestry services abandoned this plan, and now encourage farmers in their traditional practices...

There is an obvious need for specialists in remote sensing to work out this problem: how to recognize agroforests on the common documents that are available for mapping? Only such recognition from modern geographers can induce a shift in the conventional categorization of land-use systems, and lead to a wider acceptance of agroforests as an integral part of that land-use.

- The second problem, and probably the main one, is linked to the diversity of components, and to its consequences on the physiognomy of the agroforests:

-the great number of components and their spatial arrangement give the agroforest a disordered, “dirty” aspect..... which invariably leads most of the observers, and particularly agriculturists or agroforesters used to the obvious order of monocultures or simple associations, to interpret it as a sign of carelessness, if not abandon. And how come can a neglected plantation be worth considered?

Foresters should be able to appreciate complex agroforests, as they are close to a natural forest and, technically, represent a remarkable success in silviculture. But they don't, as most of them have an epidemic reaction against all types of anthropogenic forests, as most of them consider that a forest should be definitely out of the range of common farmers.

It will be difficult for scientists used to the simple order of monocultures or to the virginity of forests to admit the value of agroforests, but this is just a matter of education. Agroforestry itself has just entered University curriculum...

-the lack of appreciation of their qualities.....: agricultural economists, which are also used to a certain range of crops and crop arrangements, are quite reluctant to appreciate a tangle of tree crops and useless plants, which is for them no more than a kind of exotic pantry.

They usually completely lack the necessary background to identify trees or herb species of economic interest.

The conventional means worked out for measuring the benefits from a given agricultural systems are too narrow to integrate the diversity components of an agroforest: calculations of global profitability are not easy in a system where you have a variety of products, of production rhythms, of products utilization and valorization or income allocation, and also a variety of functions and benefits which are difficult to calculate but are nevertheless essential.

Another reason for misinterpretation of the economic value of agroforests is the relatively low yields of single components: usually, due to the utilization of unselected genetic material, to the lack of fertilization and sometimes to poor collection practices, individual yields of economic species in complex agroforestry systems are lower than those obtained in monocultural systems, which renders the system, at a first glance, far less profitable than monocultures in terms of yields per unit of land.

The case of rubber agroforests is exemplary: based on a reductionist approach, it is usually considered as a primitive and non profitable model of rubber culture, in its establishment as well as in its regular maintenance and reproduction, that has to be totally eradicated and replaced by the conventional monocrop model.

In the initial stage, rubber is associated to annual food and cash crops (rice, bananas, vegetables, pineapple,...), which is said to slow down the growth of rubber seedlings but which are of key importance for the farmer: they diversify his income (and sometimes are the sole source of income for one to three years) and allow him to be partly self-sufficient for their staple food, providing a basic security in cases of falling rubber prices. Besides, they provide protection against weed invasion and give an immediate return to weeding labour that is needed for protecting rubber seedlings.

In mature gardens, yields in latex are far lower (roughly from  $1/3$  to  $1/2$ ) than those of monospecific stands of selected and carefully fertilized clones, mainly due to the low genetic quality of trees, the inappropriate tapping practices, and probably the concurrence with the non-rubber component, which are therefore considered as "weeds" by conventional researchers and extension workers.

But these "weeds" (see fig. 2), which may represent up to 50% of the tree stand and cover all the herbaceous species, provide fruits, vegetables, medicinal plants, which provide an significant output in household nutrition and health. They also provide material among

which wood for fencing (used for the next plantation cycle, against animal pests, which saves the farmers needs for purchasing barbed wire), bamboo for rafts (fig. 13), and timber, which is presently acquiring a real monetary value as natural forests are being exhausted in the surroundings.

All those minor productions, though usually poorly marketed in remote areas, play for the villager an important role and, added one to another, increase the economic value of rubber agroforests.

The agroforest also provides firewood which, though being of very low economic value, is of utmost importance in villages as most households just use dead wood as domestic fuel. Agroforests, which can supply firewood regularly and in abundant quantities (fig. 14), represents for the farmers an invaluable advantage over monocrop plantations, advantage which can not be understood through figures of direct monetary value but has dramatic consequences for the balance of household economies and that of the rural ecosystem as well.

This “weedy” component has also other important economic functions: during the first years of establishment of new rubber gardens (after the phase of association with annual crops), whereas agronomists only consider that it induces a negative competition with rubber trees, it minimizes external inputs against aggressive weeds and mammals.

Spontaneously established bushes act as efficient and low-cost cover crops against the worst competitors to rubber (*Imperata* and *Chromolaena*) which would require costly herbicides to be controlled and, once established, increase the risks of burning down in dry years. It seems also that spontaneous vegetation protects young rubber trees against wild animals as well as a woody or barbed wire fence. It has been estimated that such a bush cover saves the farmer half a million rupiah in materials, herbicides and labour that would otherwise be needed for crop protection before tapping.

The non-rubber component also provides longer economic life to the plantation, through spontaneous regeneration of rubber trees, than for conventional monocrop plantations: when initial trees are decaying, farmers can start to tap younger ones that have spontaneously established, and exploit the same piece of land for 40 years (against 28 years in estates) before replanting

Therefore, analytic means and methods for a precise economic estimation of agroforests still need to be worked out thoroughly. Approaches based on common analyses devised for monocultures in settled farming systems, which usually focuses on the yields of the main economic species, on one point in time and on return per unit of land are not appropriate as too reductionist.

Agroforests evaluation requires a global approach which gives importance to productions as well as to functions, and which integrates quality as well as quantity.

- Lastly, complex agroforestry systems are often considered, specially by native scientists or developers, only as a relict form of primitive agriculture which they are not proud of as a mark of constant underdevelopment and that, as shifting cultivation, forest dwellers and skin tattoos, should not exist any more in modern Indonesia. The interest of some scientists in those systems is regarded as just the interest of a city dweller for a cute and exotic rural antiquity.

We need to stress out that, due to the constant changes in ecological, economic or population conditions, due to the rapid development of commercial exchanges during pre- and post- colonial times, specially from forest areas of the Outer islands, traditional agroforestry systems encountered, from the very beginning of their conception, continuing processes of innovation and modification.

Present indigenous agroforestry systems should be considered as the modern result of such long evolved adaptations and innovations, trials and failures, incorporation of new species and new agroforestry strategies.

### Taboos and preconceived ideas

Among taboos and preconceived ideas regarding indigenous agroforests, we can quote the following:

- First of all, the "agroforestry label" is sometimes denied to complex agroforestry systems as the presence of the "agricultural" component is not obvious: annual crops, cultivated herbs, which are generally thought of as the only "agricultural" component in production systems, are indeed under-represented in indigenous agroforests. Nevertheless, because of their establishment process, we can argue that in the classical classification of agroforestry systems, agroforests could be attached to "temporary associations between trees and annual crops". On another hand, they may be likened to the taungya system of Forestry Services because of their establishment process.

But, much more than this establishment phase of complex agroforestry systems, it is the "mature" phase, which is made of an intimate mixture of crops and actually deserves the name of "agroforest", which fully concerns the interface agriculture/forestry.

- Most complex agroforestry systems in Indonesia have been conceived outside Java, within shifting cultivation systems. Due to the common negative perception of shifting cultivators and practices in the official research and development spheres, specially in the forestry domain, the acknowledgement of the validity of agroforestry practices devised by such people and in such farming systems seems to be a difficult matter. It is indeed difficult to accept the idea that people who are commonly perceived as uneducated, uncontrollable, unorganized, as forest destructors living below the poverty level and regardless of the future, who really need to be educated to enter the "development" age, can be skilled agroforesters intellectually able to design and technically able to establish complex systems planned for a long term production and reproduction.

For agronomists and rural economists, it is difficult to forget a century or more of misperception of smallholder agriculture in forest areas. For foresters, it is even more difficult to accept, after centuries of tradition of opposition with peasantry, that those peasants have invented an interesting model of integrated and multipurpose silviculture, and play an active and meaningful role conserving forest genetic resources.

### And now? What can we do with those indigenous knowledge in agroforestry?

We first need a total recognition from scientists, developers, administrative institutions, extension agencies, etc...of the existence and of the merits of these indigenous systems. This will only be achieved through a global approach of the systems, implying a full cooperation of biological and social sciences, pointing out precisely the importance of the systems, in terms of surface, production, various kinds of services,, percentage of population involved, etc...

### Further experimentations and improvements of existing models

Improvements of existing models have to be worked out thoroughly before any extension of the systems can be proposed. As we have already mentioned, due to several categories of reasons, existing systems are far from being at the maximum of their potentialities, both in terms of production and in terms of valorization of their productions.

Basic causes for low productivity lie schematically in the field of plant material, cultivation and collection techniques and market organization.

Experimentations should be conducted in these three fields.

- increasing the productivity of the main crops: indigenous agroforestry should also benefit, as did subsistence agriculture several years ago with the "green revolution", from genetic research on plants conducted in all kinds of Research Institutes. The use of improved varieties in agroforestry systems is still non existent, for three reasons which should be solved right now:

..cropping systems for existing improved plant material are invariably designed as monocultures or as very simple associations. Multiplication and plantation technics, cropping patterns and the technical package of crop establishment suited to complex agroforestry associations have still to be invented and tested.

..improved varieties have been selected for maximum and fast yields in the standard environments of monocultures (i.e. for example sun tolerant, fast-growing tree crops totally unadapted to agroforest conditions: low-branching rubber clones, grafted varieties of durian and rambutan). New varieties specially designed for an agroforest environment have still to be searched for.

..for most of the important crops encountered in indigenous agroforestry systems, genetic research is still non existent. Rather than importing new "agroforestry" species, we should concentrate on making inventories and improving existing varieties in indigenous agroforests.

Besides genetic research on plant material, improvements of planting technics, of fertilization habits, and of product collection should be worked out:

- better output of the secondary productions: secondary productions are generally poorly utilized, mostly not because of production but because of weaknesses of product processing and market organizations. In order to allow a better valorization of those secondary productions, which can be fruits or nuts, timber or other material, several types of action can be undertaken:

- promote farmers associations... which could constitute a force against locally or regionally monopolistic market channels or which could organize by themselves the first steps of the market channel, in order to decrease the number of intermediate salesmen

-increase “on the spot” processing of products, which, again, implies a real organization at the village scale around agroforest productions (import small-scale technical processing units as portable sawmills for timber, organize processing schemes at villages scale, with unemployed population)

.. look for new marketing opportunities in particular, the development of new trends in Europe and United States for “green labeling” of tropical products could be fully beneficial for agroforestry products, ranging from fresh fruits (from “biological agriculture”) to chocolates (with “forest” fats), yoghurts (with “forest fruits”), and timber (from a sustainably managed forest)...

- development of new productions to reinforce the commercial value of agroforests. With regards to the growing importance of income generation as a production objective for farmers, this reinforcement should mainly be undertaken through the widening of the markets for underutilized agroforestry products. In this respect, the systematic and rationalized utilization of timber from existing agroforests, as well as the integration of timber production at least as a side-production of newly established agroforests, should be highly recommended.

Until now, the main biomass component of agroforests, i.e. wood, is largely under-utilized: timber actually constitutes only a side-product, used for household purposes or sold on local markets.

*The integration of agroforest trees as a source of material for wood industries could open a new and promising era for rural economies based on complex agroforests: this new source of income should be quickly considered by peasants as a strong incentive to reproduce and expand their complex agroforests, with all their ecological advantages.*

With these directions in mind, we could easily propose the promotion of “jungle rubber” agroforests with improved rubber clones and intensified secondary productions like fruit or timber or Dipterocarp based systems with sustained hardwood production.

### Integration in future development programs

Foresters have now to assume a new role in rural development: with the urgent needs for improved social forestry programs, with the promotion of the “buffer-zone” concept for national parks, they have to integrate forest production with forest conservation, and not to forget rural communities in the meantime.



On the other side, given the failure of many agricultural programs promoting annual crops in previously forested areas, agriculturists have also begun to think of trees as sustainable agents of development.

Simple agroforestry associations have been largely tested and promoted, their limits have also been felt, in the fields of both biological performance, farmers acceptance, diversification potentials, etc...

As suggested by Clarke some 15 years ago, "to achieve rural development without destroying valuable resources, it is appropriate that we return more systematically not only to several universally recognized "agroforestry" species of either fast-growing or multipurpose trees, but also and mainly to local tree species traditionally known, used and managed by peasants".

Similarly, we should seriously explore all the range of traditional agroforestry management systems as a basis for the management of "modern" agroforestry systems: not only home-gardens, but specially those systems that rely on hundreds of local tree species and use natural forest management techniques "impossible" for conventional agroforestry and forestry enterprises.