BREAK-THROUGH IN AGRICULTURE

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August, 1994

Content

To the text: - read - comprehend - adapt and - divulge FOREWORD

The project described below is an attempt at harmonizing our agricultural activities with natural processes of life in order to" produce an optimum of diversity and. quantity of high quality fruits, seeds and of other organic materials, without utilizing imported fertilizers, pesticides and heavy machinery. In fact, it is an attempt at finding for each plant those conditions in which it best develops, and of approximating our agricultural systems in any given situation as near as possible to the natural ecosystem to be intervened. This in contrast, therefore to modem approach in agriculture, in which man tries to adapt plants and ecosystems to the "needs" of modern agriculture.

The project has mainly been realized in the humid tropics, but the principles of the method would be the same, wherever crops can be cultivated on our planet Many elements of the techniques for "strategic interventions" described in part I of the following paper were importants tools in traditional farming (see part II).

The experiences described in PART I make part of more than seventeen years of intensive work in practice, and at the same time, struggling to compete in free market conditions without subsidies or grants.

No extra investments are needed for the adoption of the method described below - or single elements of it - in any part of the world, as no external input is needed for its implementation. On the contrary, any modification of actual agricultural techniques in the direction indicated below will have a substancial beneficial impact:

- ✓ firstly, on its user, the farmer, for he will be - additionally to the economic advantage he will gain - deeply satisfied and pleased to feel himself coming to harmony with nature

- ✓ secondly, on the consumer, for the improved quality of foods he will buy and
- ✓ thirdly, on the whole ecosystem for the relief of pressure actually caused by conventional agriculture.

Introduction

Modern agricultural techniques like monocropping, usually combined with the use of herbicides, pesticides and mineral fertilizers lead to a very rapid loss of soil fertility. Similarly, shifting cultivation, the practice of traditional farmers, is no longer viable, as, due to population pressure, soil recovery periods became increasingly short, entailing a decrease in productivity. One possible alternative to conventional agriculture is agroforestry, the practice of combining trees with crops and/or pastures. Sustainable agroforestry has been practiced by many small farmers all over the world for thousands of years. In spite of attempts at adapting traditional agroforestry to modern agriculture, there has not been - to my knowledge - a break-trough in the development of a form of sustainable agroforestry capable of meeting the needs of 1990's and of the 21 st century.

I outline below a method by which abandoned pastures with completely degraded soils can be turned into highly productive and diverse agroforests within a short time of 5 to 8 years. The system allows for a high productivity while even increasing biodiversity and improving soil fertility. The practices described below lead to a rapid recovery of poor soils without the use of fertilizers. Finally, costs are very low as neither pesticides, herbicides or heavy machinery are required.

The method, in essence, is an attempt at imitating nature. In nature, most species live in consortiums with other species, and require these other species for their optimal growth. Similarly, in my agroforests, crop species are planted in consortiums with other species similar to those with which they normally would occur in nature.

Furthermore, in nature, plant consortiums succeed one another in a dynamic, ongoing process called natural species succession . Destroyed, depleated or leached out sites are colonized by pioneer species. These pioneers are succeded by secundary forest species which are, in turn, succeeded by primary forest species. Similarly, I use pioneers to recover soils in the initial phases of the new plantations, and I also use at later stages the dynamics of natural species succession as driving force which ensures the health and vigour of the plants.

Description of the site

Site

The experimental area is situated in the south of Bahia, Brasil, in a region which used to be Atlantic Rainforest but Which has been significantly altered by timber extraction and shifting agriculture. The site was selected because of two unique features: firstly for its classification as "poor soils", and secondly for the presence of one of the last stands of primary Atlantic Rainforest in the region. The terrain had formerly been occupied by small fanners who raised pigs in the lowlands and cultivated manioc on the hill slopes. There were also vast areas of abandoned pastures. Due to decreasing productivity, and, in their words, "poor soils", the small farmers left the site.

Soils

In this region, oxisoils are frequent at lower elevations near the creeks, whereas ultissoils predominate on the slopes and hilltops. Both types of soils are very acidic, with pHs between 4.2 and 5.0.

Life zone

The climate is characteristic of premontane tropical rain forest . The average rainfall over the last five years was 1500 mm. The average temperature is 25° C in january and 20° C in July.

PART I

The recovery of impoverished soils by employing natural species succession

Establishment of the method by trial and error

The development of the method outlined above for soil recovery and for sustainable agroforestry is the result of a long process of trial and error. I first came into contact with the humid tropics 19 years ago (1976), upon arrival in Brasil. I was disturbed by the contrast between the stark poverty of cultivated lands and the wealth of nearby tropical rainforests. This contrast moved me towards my first attempts at designing and planting agroforestry systems in central Europe.

I then came to Costa Rica (1979 to 1982) and developed a program of reforestation employing the strategy of alley-cropping. I planted rows of leguminous trees such as Leucaena, Inga and Erythrina, alternated with rows of fruit trees such as banana, Governor plums, pupunha (Bactris gassipes), Caimito, Zapote, etc. This system was not entirely successful in that as it relied on the use of fertilizers, and in in that as in the second and third year, the young trees inhibited the growth of the annual crops in their immediate vicinity, without substituing for them in terms of productivity.

I therefore made a second attempt at agroforestry, combining mainly four species of fruit trees - Cocoa, Citrus, Avocado and Pupunha - togheter with banana *Erythrina* and *Inga* for shade. This system, forest/orchard plantation, did reasonably well in the fairly rich soils of Costa Rica and of Itabuna, Brasil, but was not possible to be established in the poor soils of abandoned pastures of this farm.

I then worked to improve these impoverished and depleted soils by first planting two pioneer species (Manioc and Cow pea) known to do well in the poor soils of the region. Of these, only Manioc succeeded to establish, but still developed poorly.

A large number of native pioneer plants, however, grew vigorously in the new plots. I therefore chose to be selective with respect to those plants which I weeded out I removed only those grasses, herbaceous species and vines which had matured All other native herbs, trees and palm trees were allowed to grow and fulfill their important function in soil-improving. The cultivated plants now grew well in the presence of the native species. This is how I came to practice which can be described as selective weeding.

I now try to take full advantage of the biological and genetic potential of the flora and fauna which occur spontaneously on the plots. Many invading native plants are, if properly managed, excellent companion plants for the crop species, additionally to the fact that they are well adapted to the existing edaphic conditions. When young, they stimulate the growth of the cultivated plants and fend off pests and diseases. They also protect and improve the soil, as they contribute in a considerable way to the increase of organic matter, constituting thereby a valuable source of organic fertilizer which, indirectly, results in a correction of the pH of the soil.

After two years of selective weeding, however, I observed that the cultivated plants showed signs of decreased growth. It appeared that the maturing native trees and shrubs which had appeared and grown on the plots meanwhile, were now inhibiting the growth of the crops. This proved to be the case as - once mature pioneer trees and shrubs were pruned by (1) cutting all mature plant parts and (2) thinning out crowns by cutting 50% or more of the branchlets, or cut back entirely when substituted by individuals of following consortiums in species succession - the entire plant community was invigorated and burst into new, rapid grow. This is how I came to the practice of pruning.

Pruning has multiple effects on the plantation:

- ✓ the most visible one is the acceleration of the rate of growth in the whole system after rejuvenating maturing plants. (I observed that, in its phase of vigorous growth, a plant stimulates neighbouring ones to grow and that, once a plant of the dominating plant consortium in species succession matures and senesces, it induces others around it to show signs of maturity, such as yellow leaves and growth arrest, and eventually signs of senescence, such as increased susceptibility to fungal and microbial infection, or to pests).
- ✓ The organic material achieved by pruning placed on the ground as mulch both protects and fertilizes the soil.
- ✓ Pruning indirectly produces beneficial changes in the soil, as monitored by changes in soil texture and in the abundance of earthworms.
- ✓ Pruning increases the amount of light available to future generations of plant species.

- ✓ Pruning also serves as an instrument for speeding, intervening and directing the organic process of species succession by the possibility it offers to influence each plant individually in terms of access for light, space and leaf area.
- ✓ Finally, periodic rejuvenation by pruning prolongs the lifetime of short lived pioneer species, thereby enhancing their ability for soil improving.

The current practice, in summary, is as follows:

On one hand, maturing trees and shrubs are rejuvenated by pruning, and trees which have fulfilled their function in soil-improving and substituted by individuals of succeeding consortiums are cut back. On the other hand, potentially each plant of the community is pruned in order to influence and control access for light and space on an individual basis.

Species composition, plant density, and the timing of the introduction of each species:

When the new cocoa trees which I had first planted began to bear fruit I observed, to my surprise, that those plots which initially had richer soils where less productive than those which initially had poorer soils and vegetation. In sites with initially richer soils, the cacao and banana trees had grown vigorously during the first three to four years in the shade of the abundant and vigorous Corindiba- (*Trema micrantha*) and Embauba branca-trees (*Cecropia hololeuca* Miq.) (both species belonging to the first cycle of secundary forests trees on more privileged parts of poor sites in this region). Once these secondary forest trees had depleted their capacity for coppicing after pruning, and they therefore had to be cut back, cocoa-trees did not bear fruits arid banana-plants died back. Furthermore, both showed signs of increased susceptibility to insect and pest attack. Those cacao- and banana-trees in the same plots, however, that occasionally were in the shade of a transitional-to-primary forest- or a primary forest-tree were healthy and highly productive. (The future shade trees had been planted at what was to be their final distance (12m to 18m), taking into account the diameter of the crowns of the adult trees.)

By contrast, on sites which initially had poorer soils, banana-trees did not establish, nor did their counterparts of natural vegetation, such as Corindiba and Embauba branca. On these plots, poor vegetation and open spaces had challenged me to plant at high density a large number of species known to do well under similar conditions. I planted pioneers such as Elefant grass, Manioc, Pinapple, Coarana, etc. in order to improve the soil, and trees of the secunary forest like Jangada preta, Inga etc., and fruit-, nut-, and timber-trees in a great multitude in order to achieve a prosperous agroforest capable to produce high medium and long term yealds.

This operation was highly successful, but only on those parts of the fields where we had heavily pruned or cut back the maturing individuals of pioneer trees of the already established vegetation at the time of introduction of the complementary species. In these plots then the whole plant community began to thrive and now represent the most productive parts of the plantations.

It therefore appeared that the critical factor in determining health- and growth rate of the plants, as well as the productivity of the system, was not the initial quality of the soil, but rather the composition and density of individuals of the plant community.

It also appeared that the order in which crops were planted was important, as most species only grow vigorously if they enter the flow of species sucession in such a way that they can come to dominate and to thrive the system. This is ilustrated by the following example in wich four species were grown togheter on the same plot:

1. Manioc (*Manihot* sp.), a herbaceous annual pioneer plant with a life cycle of one to two years;

2. Corindiba (*Trema micrantha*), first colonizing tree in the local secundary forest with a life cycle of four to six years;
3. Inga (Inga sp.), leguminous tree, (secundary forest / transitional to the primary forest) with a life cycle of 20-80 years;
4. Caimito (*Crysophyllum caimito*), (primary forest), fruit tree with a life cycle of roughly 200 years.

These four species grew vigorously if they were planted in the order in which they are listed above, which is the order in which they would succeed each other in nature, and if each species was planted when the following one in terms of species succession was introduced and established at the point of the beginning of the phase of vigorous growth of the preceding one. If the four species were planted at the same time, they did fairly well, but Inga and Caimito had difficulties to establish. A caimito-tree could successfully be established in the shade of a fully developed manioc-plantation, or beneeth a young or adult corindiba- or inga-tree, but the reciprocal combinations were not succesfull. Inga did not establish beneath a fully developed Caimito, though it grew well in the shade of vigourous manioc plantation or a corindiba-tree or both combined. Similarly, corindiba failed even to germinate under a fully developed inga- or caimito-tree though it did extremly well in the dense shade of a vigourous manioc plantation.

It seemed that the critical factor for the establishment and development of a plant which makes part of a given system is not as much the factor of light but the order and timing of its introduction in the natural succession.

I concluded from these observations described above, since repeated numerous time, that the most successful plots were those in which I had best considered the natural processes of species succession, described below.

Furthermore, these same observations suggest that natural species succession is one of the driving forces of life.

Species succession in nature

Diverse forms of flora and fauna have occurred and developed on our planet in the course of time. They have adapted to a vast diversity of situations in order to transform and organize the optimum amount of entropic residues into living systems. On increasing, therefore, they complexify the system, which results in more. diverse forms. The living beings of each place and in each situation form consortiums in which each member contributes with its particular capacity to improve and to optimize its conditions as well as those of the members of its consortium to grow, prosper and reproduce. Furthermore, each consortium gives birth to a new. consortium different in composition. On each place, the different consortiums function as a macroorganism of high complexity which undergoes a process of continuous transformation and complexification. Each consortium within this macroorganism is determined by the preceding one and will determine the following ones. This ongoing process is called natural species succession.

Plants corning in their phase of exuberant growth stimulate and activate all members of the plant community in their vicinity. Similarly, mature and senescent plants of the dominant consortium induce all neighboring plants to stop growing and to show signs of maturing and of senescence atypical for their stage of development.

When, as is often the case, two plants of different consortiums in a community germinate and begin to grow at the same time, that of the dominant consortium will direct the growth of the other one, which will only come to dominate when its consortium becomes the dominant one. Only when the dominant consortium has matured and died, will the succeeding consortium come to dominate, and begin a new cycle of growth and transformation.

Natural species succession in soil recovery on sites where climax-vegetation is forest

In nature, pioneer species capable of growing in poor soils colonize open spaces. These pioneers, mostly grasses and herbs, improve the soil, prepare the conditions for secondary forest species to grow. The secondary forests undergo several cycles, during which the life time of the dominant species gradually increases from 3 to 15 to 30 and up to SO years. The secondary forest species create soil conditions conducive for the growth of longer lived primary forest species, with life" cycles of an average of 200 years.

In the initial phases of the process of soil recovery, dominant species in succession are generally ones which have a high lignin content, and which produce small seeds and large amounts of organic matter which does not readily decompose. Once these species have died, they are replaced in the next cycle by species with a higher protein content and whose carbohydrate, instead of being fixed primarily in lignin, is also stored in the form of starch or sucrose. This natural progression in the succession is favored and accelerated by the effects of herbivores, wind, lightning and flooding, and are duplicated in my agroforestry systems by practices such as selective weeding and pruning.

Natural species succession as a driving force in agriculture

In nature, complete recovery of depleted soils by species succession may take up to centuries, but can occur - under favourable conditions - in a much shorter period of time. The critical factors in determining the time in which natural soil recovery in a given life zone advances are:

- ✓ the composition of the plant community
- ✓ the order in which species appear
- ✓ the timing of the appearance of these species for each cycle
- ✓ the nature of their interactions with microorganisms and wild animals
- ✓ climatic factors.

I therefore devise ways of optimizing the critical factors and of accelerating the process, as follows:

- ✓ firstly, I identify the optimal species, consortiums of species and successions of consortiums that occur in similar soils and climates. Then I plant these species or substitutes thereof in their natural consortiums.
- ✓ secondly, in order to optimize life-processes, I try to come to the widest possible biodiversity by filling in all the niches generated by the same system.
- ✓ thirdly, I identify the optimal timing of the initiation of each cycle, i.e. the planting of a new consortium, so that each species will find optimal conditions to establish and grow, and finally to come to drive the growth of the community
- ✓ fourthly, I accelerate the growth rate and the progression of species succession by pruning and removing plants once they begin to mature and therefore have accomplished their function in soil-improving.
- ✓

Each step is an attempt at entering and being carried along by the stream of life called "natural succession of species".

If we want to imitate natural processes of species succession, or to successfully intervene in natural forests, we need to have an intimate knowledge of the biotope in which we wish to interfere. We need to identify the niches of those plants we intend to cultivate, as well as of those we wish to substitute for, and we must strive to understand the interactions of these crop and native species with all other elements of the community to be intervened.

It would be difficult to design and plant the very optimal consortiums of plants in which all parameters are taken into account. Help comes from local species, often called "weeds", that establish spontaneously in the plots. These fill in may of the niches which have - either temporarily or permanently - remained unoccupied by cultivated plants. By pruning or removing only those plants which are maturing or which meanwhile had been substituted by ecophysiologacally similar species of our choice we can intervene in the succession spatially and temporally.

Natural local species and invading plants complement the cultivated species and help to overcome many weak points in our agricultural systems.

Conclusion

My experiences in soil recovery and the development of agroforestry systems have reconfirmed that the critical point for a success in the establishment of sustainable agricultural systems is the comprehension and modeling of natural processes in species succession. This is also fundamental for the recreation of natural forest areas.

In order to apply the described method in other life zones, an intimate knowledge of local flora and fauna is required. Many older members of rural communities and small traditional farmers are familiar with native species of their regions and of the nature of interactions between different plants, and they still have remnants of the knowledge peoples had of the uses of plants for food, medicine, construction and various other purposes.

Proximity to fragments primary forest was highly beneficial for this work but is not an indispensable requirement for the success of the method, as many native species can be substituted by ecophysiologically similar cultivated ones.

In order to guarantee that the extraordinary potential of native species will be available at present and in the future, alternative technologies must be developed and adapted while islands of preserved forests still remain.

PART II

Analysis of systems

Species succession In general, and species succession in natural soil recovery are phenomena known in ecology and in forestry. Many elements of the dynamic ongoing processes were - and still are being employed in agriculture. To the present, however, there has been - to my knowledge - no comprehensive and at the same time an agriculturally direct useable and beneficial interpretation of this phenomena. Additionally, in the past few decades, those traditional methods, which were based on this principle of life, have been more and more displaced by methods dependent on the use of external sources of energy. This has brought entire ecosystems to collapse and contributes significantly to the actual endangering of the whole biosphere.

Therefore, only a profound and ample approach towards a harmonization of our agricultural practices with the ongoing processes of life and of natural species succession can lead to a real solution and help to overcome this dilemma.

By presenting and analyzing two agroforestry systems, and outlining a third one, in which the dynamics of species succession are directly (en the progressive side of this process) being employed in a genius and successful way, I will show that working in harmony with nature can be a fruitful undertaking. And by contrasting the first and the second systems to what actually is being considered as normal (slash and burn in the production of corn and beans in the humid tropics and as the best of the solutions in the cultivation of coffee), I will focus on the functioning of each of these systems in order to demonstrate the principles on which they are based.

The frijolar

A compact example, and at the same time an ingenious employment and coordination of different factors of the dynamic of species succession, in combination with minute strategic interventions in this process, is the frijolar, developed and used by some Indios, descendants of the Mayas,in Central America. It is a plot, a system, where beans - sometimes together with corn - are cultivated. The tradition seems to be quite old, for the fact that the outstanding element of the vegetation of such a frijolar, a huge canopy tree of the primary forest, Ceiba pentandra, is considered as sacred by all Indies in that region, whether they know or not the potential of this giant of their forest for its beneficial employment in agroforestry.

This tree grows to a height of up to 70m and more, and has a crown of the same diameter elevated upon the rest of the canopy of the rainforest. On sites with a ceiba-tree, where the tradition of planting beans is still alive, there is a dense stand of fast growing leguminous species, about 40% of which are Inga sp. which normally occurs where windfall or flooding are frequent, all of them showing signs of regular heavy pruning. In less dense spots, young trees of the same species composition are coming up. The ground layer of such an agroforest is formed by herbaceous species, main by Piperaceaes.

In the second half of the rainy season, a the time when the ceiba-tree loses its leaves, beans and corn are broadcast in this area. After that, the herbaceous vegetation on the plot is moved and all branchlets of the adult fast growing trees on the area are cut off. The huge amount of organic material achieved by this activity, is evenly distributed and cut into small pieces. Beans and corn soon grow vigorously and reach to cover the thick layer of mulch within a few weeks. (The Indios, who invited me to participate in their planting-harvesting activities, told me that they had always used the same variety of bean and corn on that particular place.) Employing this system, weeds are unknown. The trees that have been pruned, within five to six weeks react with a profuse flush of new branchlets and leaves. Two months later, at the beginning of the dry season, the ceiba-tree renews its leaves. Three or four weeks later, beans are physiologically mature and being gathered and layed out in order to finish the process of maturing and drying. Two or three weeks after that, Corn begins ripening too. Cobs are bent down and. at the same time the male inflorescence of the corn-plants are being cut off. In both years we harvested slightly more than 2100 kg of beans and 1520 kg and 1340 kg respectively, of corn calculated per ha.

In comparison to 800 kg of beans and 1000 kg of corn are considered as excellent, after slash and burn in the same region and on similar sites. By the employment of this method, weeding by cleaning, once to twice, is an intervention necessary in order to ensure a reasonable development of the crops. Additionally, this method allows for one crop only every 10 to 12 years on the same place.

Only a small fraction of the immense organon of dynamics in species succession - though in a highly efficient way - is being employed by the use of the method of the Indies. This is:

- ✓ The efficiency for soil improvement of fast growing, mainly leguminous trees with a high capacity for regrowth, which naturally dominate on sites where windfall and / or flooding are frequent.
- ✓ The appearance and prosperous development of fast growing and lender herbs and vines with broad leaves and a short life-cycle in new clearings of lush forests.

All the time when the ceiba-tree loses its leaves, the needed clearing for the introduction of beans and corn partly is given. The rest then is, by a proper timing of the intervention, being achieved by. mowing the herbaceous vegetation and by pruning the adult fast growing trees of the site. Additionally, the strategic intervention of pruning induces a rejuvenation of the affected vegetation, which -by finding the necessary conditions for their regrowth - will resume its task in soil-improving and, as a byresult, they will create the preconditions for a successful repetition of the described cropping activity in the following year. The rejuvenation of the employed vegetation with the resulting increase of life is therefore of major importance and at the same time the decisive condition for the functioning of this system. The deep-rooted ceiba-tree contributes to- and ensures the stability of the system by furnishing - changing its of leaves - the rest of the vegetation with the needed minerals from the subsoil. Characteristic for this method is the systematic employment and dynamisation of ongoing processes in a living system, achieved:

- ✓ by strategic interventions (mowing and pruning) that, for their side lead to a stimulation for new growth of the affected vegetation and - due to the nature of the same one - to a reactivation of their potential for soil improving

- ✓ by the introduction of a type of vegetation in the form of cultivated plants (crops) That naturally would occur under similar conditions and on similar sites
- ✓ by a proper timing of the two former activities (in this case by entering at the time when the ceiba-tree loses its leaves).

The growth of Corn and Beans, in the employment of the slash-and-bum method is, by contrast based on a forced liberation of nutrients built up and stored by the vegetation that, in the course of time, naturally had come up - driven by the dynamics of species succession in soil recovery. Characteristic for this method is the regressive dynamic being instituted in the process of species succession and fertility, beginning by cut and burn in an indiscriminate way the whole vegetation. Weeding by cleaning just reinforces this tendency once again on two frontiers: Firstly directly, by accelerating the mineralisation of the organic matter stored in the soil (necessary in the employment of this method in order to increase and ensure the growth of the crop), secondly, in an indirect way, by the temporal elimination of pioneers, the so called "weeds", which naturally had come up in order to carry out their task in soil recovery.

Indiscriminate cutting of the vegetation, burning, and weeding by clearing, therefore, cause a setback in the processes of life, species succession and natural soil recovery.

Another example of a direct and methodical employment of the progressive ongoing processes in species succession in a crop-system, I will point at and analyze, is the traditional coffee-cultivation in some parts of Central America and Colombia:

In the canopy of this type of agroforests, there are in a distance of 20m to 30m deep rooted trees, common in local rain forest, which normally loose their leaves in a period coincidentally with the end of the coffee-harvest and which remain thereafter without leaves for two or three months. Underneath them, there is a dense stand of mainly Inga and Erythrina, Every year, at the end of the coffee-harvest, these fast growing trees are pruned on cutting all the branchlets. At the same time, banana-plants cultivated in between are cut back letting only the young shoots. Also the coffee-trees are being pruned and the same is being done with fruit trees (mainly citrus) and palm trees, Pejibaye (*Bactris speciosa* (Mart) Karst), which are integral parts of this system. The organic material achieved by this intervention is evenly spread and cut to small pieces. Six weeks later, the whole system bursts in a new flush, culminating in a prolific flowering of the coffee and fruit trees. Regular and high yields of coffee and fruits over decades are attained by the employment of this multiple-crop system without the use of fertilizers brought from outside. Erosion does not occur, not even on steep hill slopes, due to the thick layer of organic material achieved by annual pruning. Furthermore, diseases and weeds are not of significance, which makes unnecessary their, control.

Characteristic to this agroforestry and poly-croping system, once again is the use of deep rooting canopy-trees of local primary-forests, and the employment of fast growing trees in the same way as done by the Indios described in the "bean-and-corn-system" - in a different crop system, but with the same results. A further strong contributing factor to the success of this system is the refined employment of synergetic potentials, achieved by a genius plant composition: Both Coffee and Citrus grow more vigorously when cultivated in consortium with Banana, and Banana has less problems with diseases like sigatoka or panama-disease being cultivated in consortium with Citrus. Additionally, Banana in its natural habitat comes up in new clearings in the rainforest where organic matter mainly in the form of leaves and woody material is abundant: conditions duplicated by the annual pruning of shade trees and by the simultaneous rejuvenation of banana plants. Coffee and Citrus need, in order to flower prolifically, abundant light. In the phase of the growing- and the maturing-process of their fruits, however, shade is beneficial to them, as it contributes to prevent pests and to improve quality and size of their fruits. The vegetative growth of Banana is more vigorous without shade; its fruits, however, develop better and to better quality under shade.

The tradition for the employment of this technique has nearly disappeared, although the advantages of "coffee-under-shade" have been rediscovered by modern science in the last few decades. But the highly important details, such as the introduction of different crop species which, by means of synergetic interactions between them, and the fortification and intensification of this potential by punctual strategic interventions are being neglected. Effort is being focused on an "appropriate" (static) amount of shade with the "best" species of trees in a - in fact - monoculture of coffee.

Employing this modem "Coffee-under-shade" method, the use of imported fertilizers and the control of weeds, pests and diseases are essential for obtaining reasonable yields. Though it is at advantage over the pure monoculture (without shade-system), as it diminishes in a substantial way soil erosion and costs for pesticides and fertilizers, it either does not meet the needs for 21st-century agriculture, for, similarly, as it is the case in the monocrop system, the use of fertilizers and the employment of pesticides are indispensable requisites for a reasonable production, as it is based on the same - static - principles of functioning. This means: growth and productivity of the employed crop is not carried along and driven by organically ongoing and progressive processes in natural species succession, but forced by the introduction of fertilizers. Additionally, the crop, (plant), treated in this way is appearing in a position within species succession on the given place, where it would not have appeared by virtue of its own ecophysiological quality, and where it is unable to contribute to an increase of life and to a progress of the natural processes in species succession. It therefore has to be eliminated. This important task is done by "pests" and "diseases", which - by eating and weakening these plants - contribute - in an indirect way - to an increase of life and life conditions in these systems.

The continued use of fertilizers and pesticides on one side and weeding by cleaning on the other side are, (demonstrated once again), no sustainable ways to resolve present or future problems in food production. On the contrary, the effect of theses interventions are more a kind to sabotage against this effort.

By contrast, in the traditional polycrop system described above growth, vigor, health, and high productivity of the crops are achieved by a direct, synchronized and dynamized employment of different contributing factors to ongoing organic processes of species succession, such as:

- ✓ the use of deep-rooted trees of the canopy of local ram forest, which, in their yearly biological rhythm are synchronized with that of the crop-system is of multiple beneficial value: (1) shade for the main crops at the time needed, (2) wind-protection, (3) rich habitat for additional flora and fauna (more life!), (4) capturing and assimilation of minerals from the subsoil, also in benefit of the - in their majority - mainly flat rooted species of the system

→ increase of life and dynamization of the system

- ✓ the introduction in the upper middle-storey and use for shade and soil-improving of fast growing leguminous trees known for their high capacity for regrowth after heavy pruning.

→ dynamization of the system

- ✓ the timing of the intervention of pruning: realization of this strategic intervention at the time when coffee and citrus, (the main crops), which in most part of the year prosper better with shade, depend on a short period with a lot of light in order to develop abundant flowers with the by result of a burnt-out in a new flush of the whole system.

→ synchronization with the biological rhythm of the main crops, resulting in a dynamisation of the whole system.

- ✓ a rigorous cut back of the banana-plants at the same time when the shade trees are pruned, (light and abundant organic matter), leads to conditions in which they naturally would occur and vigorously grow up in their original habitat. (One of the byresults of this strategic intervention is, therefor, a yearly simulated reintroduction of the bananas, prolonging thereby their life-span, and improving their vigor and health

→dynamisation of an important element of the system

- ✓ the use of a set of crop species with synergetic potentials between the different species which lead to an improvement of the conditions for each one of them and to a mutual stimulation for growth, health and vigour, and - indirectly, but in a considerable way - to an increase in terms of productivity of each species.

→ dynamisation of the crop system

Two examples, picked up in the - in relation to the species man - most vulnerable ecosystem (vulnerable in relation to the nature, the original back ground of man himself, whose lieu of origin are the steppes). Man has managed to amplify his herited habitat, he has managed to colonize vast parts of our planet; but he has difficulties to develop synergetic forms of living together with the rest of life of his amplified habitat.

In order to show that the principles outlined above and developed by some Indios or small coffee-farmers, respectively, in the humid tropics of the Americas are -in terms of their employment - not limited to that type of ecosystem, I briefly will point at some strategies developed and employed by many groups of Middle-European small farmers in the time between 16th and the 19th century: (1) Agroforestry, (2) polycrop-systems, (3) adoption of successional elements in order to dynamize and optimize life processes within their agricultural systems, (4) a wide and ample incorporation in their systems of deep rooted trees of species which made part of the canopy of local primary forests, (5) intensive and multiple employment of fast growing trees and bushes of secondary- and transitional-to-primary-forests species of their region as single elements as well as planted at small distance in the form of hedges, (6) strategic interventions described above, such as rejuvenation by pruning, (7) selective weeding, and additionally, and combined with all the elements above referred to, (8) refined forms of crop-rotation, and (9) plant-communities with synergetic interactions between them, were fundamental elements which contributed to the strategies for survival of many closly nit up rural communities in some "disprivileged" parts of Center Europe between the 16th and the 19th century.

I have the privilege to have grown up in a community where remnants of an old tradition for the employment of all these elements and strategies mentioned above still were alive. It was this form of agriculture which created the conditions necessary for a dignous and pacific survival of generations of families on a smal spot of earth of 2 ha to 3 ha, and it was this tradition, which ensured a continuance over more than 400 years.

"Biodiversity", "harmonization of agricultural interventions with life-processes in local ecosystems", "successional crop systems", "low energy input technologies" etc. , had other names or were unnamed, but constituted important elements to the strategies for agricultural interventions.

A thorough analysis of this Middle-European "small-farmer-agroforestry-system" outlined above does not fit in this small paper, due to its complexity. It will be one of my future subjects to describe, to analyze, and to compare it with former feudal- and present "modern" agricultural-systems on the same continent and in similar climatic and ecological conditions.

The observations made in PART II, (Analysis of Systems), as well as the results of my experiences in the recovery of depleted soils suggest that our present concept of plant growth - of life in general - needs a reformulation and radical change. The result of this process will be a new paradigms. A proposal to meet this urgent demand I will present in PART III (to by published in a separate paper).