



agroforestry as it gives higher income and helps sustainably.

Photo: Bert Lot

forms the colonist consortium into a climax consortium. In nature, pioneer species that are capable of growing in poor soils colonise open spaces. These pioneers, mostly grasses, herbs and shrubs, improve the soil and create the conditions in which secondary herbs, shrubs and tree species can grow. The secondary forests undergo several cycles, during which the life span of the dominant species gradually increases from 3 to 15 to 30 and up to 80 years and their demands on the quality of the environment become more and more specific. The secondary forest species create soil conditions conducive to the growth of primary forest species whose life cycles can be as long as 200 years.

Analog species

Analog agroforestry also identifies natural species, consortiums of species and successions of consortiums. To produce optimal benefits for the farmers, some of the natural species are substituted by more beneficial 'analog' species that occur in similar natural conditions and succession phases. The local natural forest and traditional farming systems are analysed in order to identify situation-specific natural species, consortiums and preferred analog species. The life processes are optimised to stimulate the greatest possible biodiversity by adapting the vegetation to all micro-environments. This may lead to many different combinations of species. Ernst Götsch, for example, planted pioneer species such as elephant grass, manioc, pineapple and *coarana* to improve the soil and secondary forest trees like Jangada preta, Inga, and many primary fruit-, nut-, and timber species to achieve a prosperous agroforest and secure high, medium, and long-term yields.

It is difficult to design an optimal consortium of plants taking all parameters into account. Help comes from the wild annual and perennial species, often called 'weeds', that establish themselves spontaneously on the plots. These fill in many of the niches that have not been occupied by cultivated plants.

Optimal timing and density for planting is identified so that each species can have optimal conditions to establish itself, grow and contribute to the succession process. It appears that the timing of how plants are introduced into the succession process

Regenerative analog agroforestry in Brazil

Patricia Vaz

In 1985, Ernst Götsch started a cacao plantation in the south of Bahia, Northeast Brazil. The land was in very poor condition. After 40 years of slash and burn agriculture the soil was depleted and the wells had run dry. Five years later the land was covered by a young but productive agroforest and water was flowing again. This was the result of the system of 'regenerative analog agroforestry' developed by Götsch and known in Brazil as SAFRA. The original vegetation in the region was Atlantic rainforest, but now only a few stands remain after years of timber exploitation and slash and burn agriculture. The average rainfall is about 1400 mm with average temperature of 25°C in January and 20°C in July. Soils are poor acidic oxisols and ultisols and classified as being unsuitable for cacao production.

However, as early as 1996, a year in which agricultural productivity in general was low, Ernst Götsch was getting yields of 5000 kg cacao per hectare on parts of his farm, 1400 kg more than average for south Bahia (Penereiro 1999). From the mid-nineties an incurable disease caused by *Crinipellis perniciososa* had been ravaging the cacao plantations in the region, and production had declined dramatically. The disease damaged the cacao trees on neighbouring farms but did not affect Ernst Götsch's 'analog agroforestry' system.

This article will look at the principles and practices behind 'analog agroforestry', a remarkable approach that has been used successfully to regenerate abandoned pas-

tures whose soils had become completely degraded. Within a period of 5-8 years they were supporting diverse agroforests and had become highly productive again. These results were achieved without the use of chemical fertilisers, herbicides, pesticides or heavy machinery.

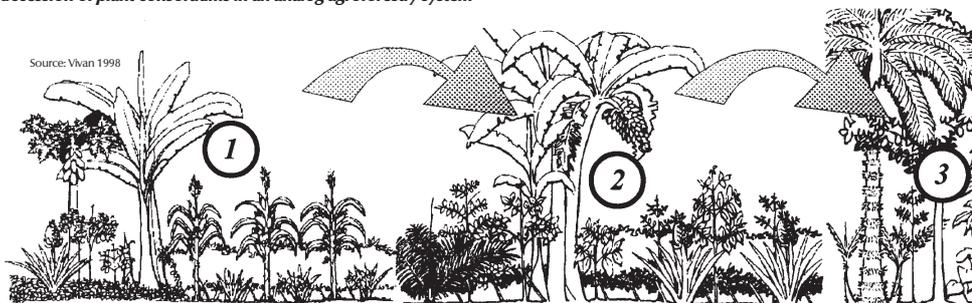
Basic principles

Natural species succession

In essence analog agroforestry attempts to imitate nature. In nature, plant and animal species live in consortiums with other species because they need these species for optimal growth and reproduction. Each consortium creates the conditions for a new consortium with a different composition. Hence, each consortium is determined by the preceding one and will determine the following one. The different consortiums succeed one another in a dynamic, ongoing process called natural species succession.

Species succession is the natural process of quantitative and qualitative accumulation of soil fertility, diversity, complexity, energy and vitality that gradually trans-

Succession of plant consortiums in an analog agroforestry system



Source: Vivan 1998

is a particularly critical factor in how they establish themselves and develop.

Natural rejuvenation

A degree of stress occurs as different vegetation phases succeed each other. Initially pioneer vegetation dominates because it develops faster than the other species. As the pioneers mature and age, the secondary vegetation is ready to take over but only after the whole system has stagnated for a while. The ageing plants suppress the development of 'young' vegetation. When storms, lightning or floods damage aged or diseased vegetation, the secondary vegetation reacts with accelerated growth and development.

Selective weeding and pruning

In analog agroforestry, the selective weeding, pruning and removal of plants replaces natural rejuvenation. Drastic pruning accelerates the growth of the system as a whole because it increases the amount of light and nutrients available to future generation of plant species. It serves as an instrument to manage species succession by making it possible to influence each plant individually as far as access to light, space and leaf area is concerned. Periodic rejuvenation by pruning, for example, prolongs the lifetime of short-lived pioneer species, and makes them better able to improve the soil. It can also encourage fruit trees to come into flower.

If farmers want to produce annual food crops on a regular basis, it is possible to return to the pioneer succession phase by drastic pruning and (partially) clearing of larger fields when a higher consortium comes to the end of its life cycle.

Soil regeneration

In nature, depleted soils may take many years to regenerate. However, in analog agroforestry the process is much quicker. Critical factors are:

- plant community composition and density;
- order in which species appear;
- timing of when species appear;
- interaction with micro-organisms and wild animals;
- (micro-)climatic factors.

Permanent soil cover

In analog agroforestry leguminous and non-leguminous pioneer species are used to regenerate soils. In addition, the organic material obtained from weeding, pruning and removing plants is used as mulch to protect and fertilise the soil. To enhance soil life and maintain a constant flow of nutrients, rapid and permanent soil cover and regular applications of organic material of different composition and decomposition rates are needed. Under these conditions it is not necessary to plough the soil.

It appears that the critical factors determining growth rates, the health of plants and the productivity of the system, are not the initial fertility of the soil, but rather species composition, planting density, and timing and succession management by selective weeding and pruning.

Analog agroforestry in practice

Preparation

To design an analog agroforestry system farmers analyse the farm system and the wider environment with the help of an

experienced technician and then define their needs and objectives. Ideally the system should include species that regularly produce food in the short-, medium- and long-term and others that are capable of rapidly producing soil cover and high amounts of biomass. There should also be species that have multipurpose functions and produce mulch material, firewood, timber, fruits and medicines. Farmers must therefore select a combination of annual and perennial species that can be harvested at different phases of the succession.

Pioneer vegetation has to fit the succession phase of the original vegetation and at the same time species must also be introduced that have a similar function but are adapted to the next succession phase.

Between the species of the first consortium the farmer can introduce other species with longer life cycles and higher demands, although there is the risk that they may be pushed out of the system because they belong to a later phase of succession.

Farmers have different needs and objectives and start work in a wide variety of conditions such as depleted grassland, bush fallow vegetation, mature forest vegetation, fertile alluvial valley soil and eroded upland soil. There are no blueprints for species selection. It is important that the system is seen as a whole; the different phases of the succession process recognised and any gaps that threaten the succession/production cycle are tackled. To do this farmers need considerable knowledge of the species concerned as well as its functions and environmental needs.

Establishment

First, existing vegetation has to be synchronised. This means that, in a given field, all ageing plants will either be removed completely or, if they still have vigour, coppiced. Pruning brings the vertical structure of the vegetation into equilibrium. A week is taken to plant or seed the selected species. If more time were taken the system, which has to develop as one organism, would no longer be synchronised. This means that nearly all pioneer, secondary and higher species are planted

Training course on Analog Agroforestry

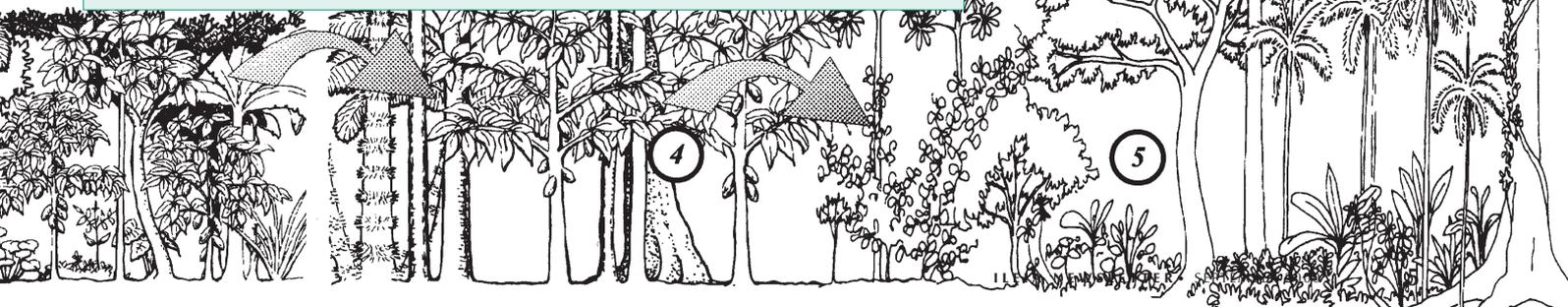
A training course on Analog Agroforestry (or Succession Farming as it is called by the organisers) in the humid tropics will be organised by Ecotop Consultants in Sapecho, Alto Beni, Bolivia on 15-29 July 2001. This course, meant for agronomists and practitioners, will combine theory and practice. Important topics are:

- The principles of species succession
- Management of agroforestry systems to enhance species succession
- Management of pests, diseases and other system damages
- Design of analog agroforestry systems
- Quality control for organic products certification

Demonstrations and practical exercises will be organised in agroforestry systems with, among others, cacao, pineapples, banana, oranges and palm trees. Visits to farmers in the region who working the approach will be organised. The course is in Spanish.

For more information:

j.milz@ecotop.via.t-online.de ; f.augstburger@ecotop.via.t-online.de and www.ecotop-bolivia.de



at the same time. Because the same planting distances are kept for each species as in monoculture cultivation, the overall plant density will be very high.

High densities and possible competition can easily be kept under control by pruning or by eliminating the plant completely. It is questionable to what extent there is really competition between plants. Experience shows that plants that function in different succession phases do not compete. Also species that grow at varying rates and end up in different layers of the vegetation do not compete, even if they come from the same species consortium and have similar demands.

Management

If there is good species planning, it will be possible to harvest products at each intervention. In this way, for example, it would be possible to harvest radish, then beans and maize, and subsequently animal fodder, pineapple, banana and later timber, resin and other non-timber products.

At the same time, the system is synchronised again by weeding, pruning and eliminating ageing and diseased plants. Older herbaceous plants are weeded, then fodder grasses are cut, and finally trees and shrubs are pruned and felled.



Why not change this degraded rangeland into a diverse and productive agroforestry system?

Pruning is an art. Correct pruning requires that the farmer bears in mind particular factors including the characteristics of the plant and the environment in which it grows. There are some basic principles but the uniqueness of each situation has to be taken into account. In general the farmer must take into account:

- the capacity of the species for coppicing;
- its physiological age;
- its place in the succession process and the vertical stratum;
- whether it threatens the development of any higher plant
- any damage being inflicted by predators or parasites

A sustainable system

There are important similarities between indigenous forest farming (see Box p13) and analog agroforestry. Both imitate nature by using analog species and species succession. In traditional shifting cultivation fire is often used for natural rejuvenation. However, where fallow periods are short, natural succession may be halted in the pioneer phase and there will be no increase in soil fertility, diversity or vitality because too much valuable organic matter, plant nutrients and soil and plant life is lost. In modern agriculture chemical fertilisers, herbicides, pesticides and machinery have replaced natural processes. Slash and burn agriculture and modern farming are evolving in ways that lead not only to depleted and degraded soil and loss of species diversity but also to simplified natural environment and decreasing productivity and sustainability. The strength of analog agroforestry and indigenous forest farming is that it is sustainable because it improves agricultural productivity and the environmental health of the production system.

Research results

Penreiro (1999) compared the analog agroforestry system on Götsch's farm with a 12-year-old, natural succession bush fallow. The vegetation in the agroforestry system was more diverse and better balanced and the succession in the system was more advanced. In the analog agroforestry system the topsoil had a high soluble phosphate content. In the top 5 cm layer there was 7 times more phosphate and between 5 and 20 cm there was 4 times as much. At the 40-60 cm level the phosphate content was about the same. These concentrations can be explained by the combined effect of nutrient pumping by deep rooting trees and the effect of soil microorganisms stimulated by pruning and the permanent organic mulch layer.

Spreading the approach

Spreading analog agroforestry concepts requires a different approach to that used when passing on technologies via extension services. The construction and organisation of knowledge plays an important

role. Initially, there must be an intensive exchange of knowledge between farmer and technician in order to create a common understanding of how people interact with nature. The older members of rural communities and small-scale traditional farmers know a lot about the species native to their area and are well aware of the interactions that take place between the various plants. Farmers still know how these plants were used for food, medicine and other domestic purposes.

This common understanding can be used to improve the system through continuous farmer experimentation. Several groups in Minas Gerais, Espírito Santo, Paraná (see Petersen et al p17), Rio Grande do Sul, São Paulo and Bolivia are experimenting with analog forestry. Some farmers will not commit themselves to the whole system and their results are, therefore, limited. Others are wholly committed to the approach and have developed creative solutions that meet local needs and conditions.

Centro Sabiá in Pernambuco, in Northeastern Brazil is one of many organisations working with analog forestry. Here there is farmer to farmer exchange, experimentation and some farmers are being trained on Ernst Götsch's farm. Demonstrations are also held on the farms of particularly successful farmers. Several farmer promoters have been selected from this group and they distribute information on analog agroforestry. These initiatives should be intensified in order to provide an alternative to the present dominant but unsustainable production model.

Patricia Vaz, Av. D. Maria Elisa, 563. Piracicaba, SP. 13405-125. Brazil; ppsilva@carpa.ciagri.usp.br

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