**The drawing provides an overview of the different components of an integrated system as developed by CIPAV.**

# Integrated systems: the experiences from CIPAV in Colombia

**Enrique Murgueitio**

In Colombia, inefficient extensive cattle ranching by 10% rich farmers occupies 40 million ha, 90% of agricultural lands. The 90% poor subsistence farmers have access only to about 10% of the land and must produce in an increasingly intensive way. Farming units smaller than 20 ha cover only 13% of the land but comprise 74% of farms. Permanent crops such as coffee, oil palm and sugar cane occupy 3 million ha and short-cycle crops, mainly cereals and tubers, around 2 million ha.

Since 1986, the Centre for Research on Sustainable Farming Systems (CIPAV) has worked in the south-west of Colombia, conducting participatory research studies with peasant farmers and entrepreneurial producers on different aspects of integrated systems. In recognition of the development and implementation of these systems in the humid rural areas of Colombia, CIPAV was awarded the ecological prize "Blue Planet Award" in 1995. Presently, much of the progress made in generating, validating and applying new know-how regarding these systems has been concentrated on issues such as agroforestry and silvopastoral systems, environmental adaptation of livestock, management of micro watersheds, water decontamination and production of healthy food products. In this article the author provides an outline of the basic models.

## The basic components of the peasant systems

The small-scale integrated systems that have been developed with peasant farmers use highly productive annual crops, multipurpose trees and water plants as sources of biomass to provide feed for cattle and other animal species, food and fuel. The systems consist of several subsystems that can be introduced separately or as an integrated farm. These subsystems are: biomass production (crops), ruminants, monogastrics (poultry, fish, earthworms), water decontamination and biogas (see Figure p.26). This basic model is developed for small-scale farms but has been adapted to large-scale as well.

The system can be either based on a crop or on residues and by-products of processed tropical crops. Sugar cane planted at high density, oil palm, coconut palm, plantain, banana or cassava are a few examples of crops that can be used. In the case of sugar cane, the juice is fed as a complete replacement of cereals to pigs and ducks and supplemented with fresh water fern *Azolla filiculoides* and whole soybean grain. Local fodder tree species like *Gliricidia sepium, Trichanthera gigantea, Erythrina fusca, Erythrina peoppigiana, Erythrina edulis, Thitonia diversifolia, Morus alba, Leucaena leucocephala, Moringa oleifera, Cnidoscolus aconitifolius* or *Guazuma ulmifolia* are used depending on which adapts better to the local conditions. The tree foliage is harvested and the leaves are used as a source of protein to supplement sugar cane tops for feeding cattle. Trees are also used as sources of fruits, shade and nitrogen. Animals are partially stall-kept, allowing for easy recycling of their excreta by vermicomposting or through a biogas digester to provide fuel. Biodigesters are part of the treatment for decontamination of waste water from washing animal enclosures and coffee beans. The productivity of these intensive integrated farming systems is 3 - 10 times higher than of traditional farming systems. The system can be implemented gradually at a pace convenient for each farmer. Few farmers set up the whole system at once. Resources required are mainly manpower, manure and plants.

## The "Productive Decontamination" subsystem

This subsystem consists of a plastic-bag biodigester of *continuous flow* (water and organic residues enter and escape continually at a constant rate), aquatic plant channels, fishponds

and associated crops. Waste water goes into the biodigester to produce biogas from organic waste. The effluent is directed through zigzag channels with aquatic plants where suspended solids, phosphorus, nitrogen and heavy metals are removed by bacteria and the plant root systems. The channels have different species of plants that vary in their degree of efficiency to decontaminate (*Azolla filiculoides, Azolla sp., Lemna minor, Eichornia crassipes, Salvinia natans*). Aquatic plants and sediments from the channels are used to fertilise forage and fruit crops. Finally, the water can also be sent into a fishpond where plankton utilises the remaining minerals in the water to produce biomass to feed fish. Fish are produced in a system of multiple association of species (*Prochidolus reticulatus, Cyprinus carpio* and *Colossoma macropomum*). Pressed stalk and stems are also used as fuel. In this integrated system waste products are minimised and the local resources are efficiently used. Fuel production is an added benefit for the family and the environment. In small farming units biogas is used for cooking while entrepreneurial farms use it for warming piglets or generating electrical power in internal combustion engines.

### Components of the commercial systems

In the larger-scale commercial systems, the biomass subsystem is divided into four components (sugar cane, silvopasture, grassland and aquatic plants). The cattle are of a dual-purpose type for both milk and meat production. The silvopastoral subsystem consists of grass (*Cynodon nlemfuensis, Panicum maximum* or any other Gramineae), associated with a legume tree like *Leucaena leucocephala* or *Erythrina fusca* (10,000 or more plants/ha). Grazing on these pastures allows the animals to freely browse on the fodder trees, which regenerate naturally. Grazing is rotational and pastures are fertilised with manure and effluent from the biodigester. Calves are kept under a restricted suckling regime supplemented with sugar cane tops, grass, urea-molasses blocks and a mixture of tree foliage and palm oil. Commercial feed has been completely replaced with excellent biological results. These systems eliminate the costs of nitrogen fertilisation, allow an increase in the number of animals per unit area up to 5 animals/ha (national average: 0.5/ha) and increase milk production above 12,000 l/yr. Given the fact that the system is environmentally friendly and highly productive, some areas of land can be freed for conservation.

Diversification in the use of sugar cane has resulted in the production of certified organic *panela* (dark sugar loafs) for export using animal manure as fertiliser and substituting herbicides with hair sheep and manual weed control. Sugar cane has also been used in steer fattening (stalks and tops) combined with tree forages such as *Gliricidia sepium* planted in densities between 10,000 and 20,000 trees/ha.

In commercial swine production, water is decontaminated using biodigesters that allow 20-25% reduction in the cost of electric power by using a mixture of biogas and fossil fuel (diesel or gasoline) in internal combustion engines.

The use of tractors for low-weight cartage is restricted through the use of animal draught, mainly buffaloes and mules, with a 50% reduction in the cost of these activities and environmental (emission reduction) and social (employment generation) benefits, while maintaining efficiency.

### The approach is spreading in the humid tropics

The CIPAV system is ideal for the humid tropics in Central and South America and Southeast Asia, where biomass production is not a limiting factor but conservation of natural resources and the environment is a priority. For the last 10 years these systems have been tested, adapted and adopted (either all or some of the components) by small farmers in different climatic conditions in Colombia. Currently this technology is being transferred and adapted to the Philippines, Cambodia, Vietnam, El Salvador, Barbados, Trinidad and Tobago under FAO assisted projects. ■

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*CIPAV has produced many how to do publications, available in Spanish only.*

## Native tree species for silvopastoral systems

Currently, CIPAV is working with local communities in the central and western Andes of Colombia on the integration of native tree species in silvopastoral systems. Two examples of research on such trees are:

### 1. Nacedero *Trichanthera gigantea*

This species, native to the northern Andes, is traditionally used by rural indigenous and small farmer communities in Colombia and Venezuela. Its main uses are related to its medicinal properties and to increasing spring water. The water-attracting capacity has been mentioned by different authors but has not yet been proved through formal scientific methods. Researchers from CIPAV learned from the farmers how to use this species as a fodder plant. Since then participatory research has allowed for considerable gain of knowledge related to this species. Some important products and results of this research are:

- Intensive cultivation in protein banks in more than 20 departments in Colombia and 12 countries in Central America, the Caribbean, Venezuela and Southeast Asia
- Fast asexual propagation techniques
- Germoplasm collection in Colombia and Venezuela
- Inclusion in most Andean micro-watershed reforestation projects in Colombia
- Commercial products for natural medicine

### 2. Arboloco *Montanoa quadrangularis*

This is a tree species from the Andes of Colombia and Venezuela that grows fast in unforested habitats. For more than a century this species has been used for construction of houses and buildings, animal enclosures, coffee-drying sheds, corrals, furniture, fences etc. Its white pith is used in handcrafts.

Work done by CIPAV with this tree relates mostly to phenology, regeneration, growth, rehabilitation of degraded pastures, plantations and agroforestry systems. Young farmers trained to conduct rigorous periodic observations participate as co-researchers. In less than 5 years and with a limited budget these studies have benefited small farmers and institutions in the form of:

- Guidelines for the restoration of deforested micro-watersheds
- Plantations for the rehabilitation of degraded pastures
- Low-cost technology for establishing habitat corridors, live fences and tree-lines for erosion control.

The results of these research programmes have been presented in the electronic conference on 'Agroforestry for animal production in Latin America' organised and run by FAO and CIPAV (see http://www.cipav.org.co).