

Fig 1 Two types of fish pond and field systems in South China.

Ecological agriculture in China

Red deserts turn to green oceans

In the past 30 years fertilisers and pesticides were introduced in Chinese agriculture together with irrigation, machinery and new varieties. While both yields and commercial output from agriculture increased dramatically, sustainability of agriculture faces a great challenge. Soil erosion, desertification, overgrazing, deforestation, over-fishing, and soil fertility decrease occurred in many places. South-China is situated in the tropical and subtropical, humid monsoon area. In the early 1980ies ecological agriculture was proposed as an important approach to solve the problem of growing agricultural unsustainability.

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Ecological agriculture in China emphasises long-term development, which combines the best practices of traditional Chinese farming with the latest achievements in science and technology. It is not only concerned with economic aspects of agriculture but also with sustainability of society and environment. The minimum goal for agriculture is to be ecologically renewable, economically viable and socially compatible. Only those eco-agricultural systems, which not only improve the environment, but also improve net income on a rather short term, can be promoted on a wide scale. So, the appraisal of the efficiency of the existing farmers' system, as a first step, is usually a more effective way to explore the opportunities for an adapted system which can meet the criteria set for ecological agriculture.

Therefore, the concept of ecological agriculture in China is somewhat different from the current concept of ecological agri-

culture in Western countries. Firstly, external inputs such as fertilisers and pesticides are not totally refused. However, harmful products or excessive use of inputs are condemned. Furthermore, emphasis is put on the process of nutrient cycling, biological use of by-products and integrated pest management. Secondly, ecological agriculture is not restricted to small farms only, it can also be practised at the level of a village, a township or a county even.

Farmers and government

Farmers in China have actively been involved in exploring ecological agricultural systems in the past ten years. Systems which showed their socio-economical advantage as well as their ecological advantage have the potency to spread quickly among farmers. In South-China, systems such as rubber-tea mixtures, bio-gas systems, windbreak and shelter belt systems, fish pond and field systems, high bed-low ditch systems created by farmers, are now widely used. The Chinese government recognised that a reasonable use of natural resources, a healthy ecological environment and the control of population

growth are the three pre-conditions for the development of agriculture. The Ministry of Agriculture set up 50 counties as model counties for the development of ecological agriculture. Training is offered to the leaders and technicians of these counties each year. Institutions for ecological agriculture research were set up under the Committee of Environmental Protection, the Ministry of Agriculture and in collaboration with the universities. Now, over 1200 villages or farms, more than 100 townships and 50 counties in China are practising ecological agriculture. Some examples follow below.

From red desert to green ocean

Multi-layer perennial plant communities in some mountainous and hilly areas, simulating seasonal rainforest communities, proved to be highly effective in erosion control and soil fertility improvement. Xiaoliang, a hilly area in the southern coastal part of Dianbai County, Guangdong Province, had a hard course in its development. Because of deforestation, the area used to be a "red desert" with serious erosion. The highest temperature on the land surface was 62.9°C. The first mechanical methods of contour terraces, contour ditches and dams failed due to soil erosion. Later, biological methods were introduced but only one tree species was used, such as pine or eucalyptus. So, soil protection was still incomplete. After detailed investigations, biological methods were combined with mechanical methods and plant communities with various layers and species were set up successfully: the "red desert" has been changed into a "green ocean".

Generally, successful plant communities in hilly and mountainous areas are arranged according to altitude. They consist of protected forest on upper parts, orchards at medium elevations and cultivated land in valleys.

Mixed plantations

This system is arranged according to the biological characteristics and the mutualism of various plants. For example, rubber tree and tea complexes in tropical China are beneficial to both crop yields. Rubber trees are planted in plots of 10-15 m by 2.5 m with one row of tea between two rows of rubber. The tea can reduce soil erosion and promotes the growth of the rubber trees. Under the shade of the rubber trees, the chemical composition of tea is generally improved. In Nanhai State Farm, Hainan Province, the total income per hectare from a rubber-tea complex was 30-40% higher than from a mono-rubber or a mono-tea plantation. ▶

Other types of mixed plantations in South-China are fruit tree-(young stage) peanut, fruit tree-forage grass, or litchi-tea.

Biogas

With the increase of the population, rural energy supply faces a challenge. Due to lack of other fuel sources than wood, farmers have to cut wood for cooking, easily leading to overexploitation and soil erosion. They also burn crop residues, which has a negative effect on the availability of important nutrients for restoring soil fertility. Biogas systems could protect the forest, save crop residues, increase soil organic matter and improve agricultural production.

A comparison of two adjacent villages (Gaozhou County, Guangdong Province) with and without biogas generators was made. The village using biogas saved 622.0 tons of firewood or grass each year. It also saved 932.9 tons of rice and banana residues each year that were then used as animal feed or returned directly to the field. Fuel-saving stoves are also used in many villages.

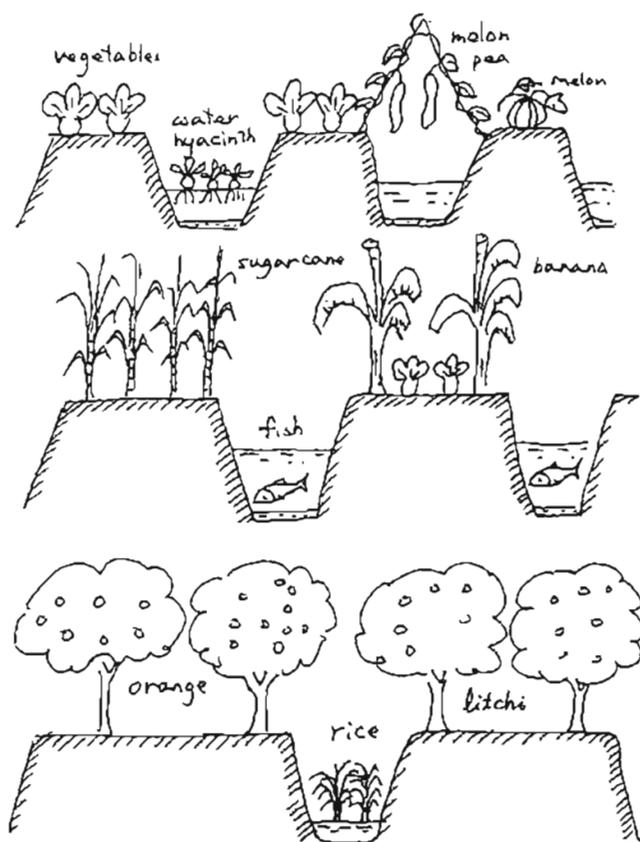
Intensified cropping

In South-China, because of high temperature and abundance of water resources, it is very suitable to have a multi-cropping system. In this region an average of only 0.04 hectare of land is available per person. The increase of the cropping index can not only increase production and net income, but also improve the chemical and physical property of soils and reduce the damage caused by insects, weeds and diseases. The most popular rotation systems are: rice-rice-vegetable, peanut-rice-vegetable, rice-soybean-sweet potato, rice-rice-green manure and sugar cane-peanut.

Rice has a beneficial effect in the rotation systems. Few weed species and soil-borne pests can survive in both submerged and dry conditions. Under water in the paddy field, both the decomposition rate of organic matter and soil erosion were reduced. The nitrogen fixing rate increased.

Fish pond and field

These systems are mainly used in the Pearl River Delta of Guangdong Province. In lowland areas, because of a high water table, the growth of crops is inhibited. By digging fish ponds in lowland areas, the field surface is raised (figure 1). The fish ponds range from 0.1 to 1 ha in size with a depth of 1 to 2 m. In the fish ponds, various fishes are raised. On the elevated fields, mulberry is the most common crop, while other crops include sugar cane, elephant grass, bananas, orange, litchi, flowers and vegetables. Many farmers raise ducks and pigs along the fish ponds. In this way, the formerly unproductive areas



become ideal for both fish and crop production.

Fig 2 Several types of high bed - low ditch systems in South China.

High bed-low ditch systems

These systems are mainly practised in the alluvial plains of the Pearl River Delta. Farmers dig 0.6 to 1.5 m deep ditches and make 1.2 to 7 m wide beds (figure 2). The water stays in the ditches ready for the production of rice, fish or snails. On the high field beds, vegetables, upland crops or fruit trees are planted. Comparative research by Luo (1991) showed that high bed-low ditch system can promote the growth of roots. Low ditch systems help to reduce soil erosion and to preserve nutrients and organic matter.

Shelterbelts and windbreaks

To protect crops from damage by typhoons in the rainy season and cold spells in early spring and late fall, shelterbelt systems were first set up in the late 1950ies along the southern coast of China. The main tree species in shelterbelts along the sandy beach is *Casuarina equisetifolia* Linn. In the coastal plains, the main species used in the windbreak network, which is perpendicular to the prevailing wind direction, is *Metasequoia glyptostroboides*. Many fruit tree species and other economic species can be used for the auxiliary belt, which is parallel with the main wind direction.

Investigations in 1979 and 1981 showed that the rice yield in protected areas was 24.4% higher than in unprotected areas. The rotting rate of rice seedlings in the cold spell in late February to early March of 1980 and 1982 declined by 30-40% because of the windbreaks. Also the direct economic return from shelterbelts is high, because the auxiliary belts consist of

fruit trees and other species with an economic value.

"Green Food" production

Tea produced by Seagull Farm (Xuwen County, Guangdong Province) won the "Green Food" certificate from the Ministry of Agriculture in 1990. This certificate is granted to products grown in a healthy environment and without use of toxic chemicals during the whole production period and postharvesting stage. On this farm, pests are controlled by natural enemies. Most of the nutrients in the tea plantation originate from pig waste, sugar cane leaves and leguminous plants. Chemical fertilisers were used carefully. The price for "Green Food" products was 20% higher than products from other farms. The farm not only enjoys a high economic profit, but also a sound environment for its employees.

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