

# China's Eco-Farming

## —An Effective Approach for Conservation and Sustainable Use of Agricultural Biodiversity

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China supports 22% of the world's population with only 7% of the world's farmland. Today, it faces to the pressures of swelling population, shortage of grain and energy, environmental pollution and biodiversity loss. However eco-farming is one of the solutions for coordinating agricultural production and sustainable use of agricultural biodiversity.

Eco-farming has a long history in China, having been practiced in China 1000 years ago. But in recent years, deliberate effort has been taken to integrate modern research findings on ecologically sound agriculture into traditional practices of agricultural production. Protection and sustainable use of biodiversity is a fundamental task for Eco-farming, with objectives:

- (1) To increase the utilization rate of bio-energy, the circulation and conversion of waste materials. One of the prime tasks for eco-farming is to enable the natural resources, especially biological resources, to produce food, feed and fuel, i.e. to ensure that all materials are fully used by mankind.
- (2) To solve the problem of energy for the countryside in China. It is necessary to seek every possible option in light of local conditions by building marsh gas pits, developing small hydroelectric power station, using wind and solar energy, and others, in order to alleviate the pressure of tree-cutting.
- (3) To increase wooded areas and grassland areas. There should be an ecosystem diversity with a proper ratio between forests, grassland, wetland and crop-growing area; It is targeted to protect the existing natural areas as large as possible, especially to develop rationally the resources around protected areas.
- (4) To protect species living in agricultural ecosystems. It is needed to increase species diversity in farmland by cubic cultivation, and by biological methods for control of pests, diseases and weeds. It is also necessary to control alien species by carefully introducing grain crops, feed crops and herbs from other provinces or foreign countries.
- (5) To conserve genetic resources. Eco-farming is required to plant local crop varieties and raise traditional livestock breeds in light the local conditions. And eco-farming encourages to use indigenous and traditional knowledge, renovations and practices

## I THE APPLIED TECHNOLOGIES OF CHINA'S ECO-FARMING

### (1) Eco-engineering technology

Eco-engineering technology refers to the comprehensive application of the principles of the biology, ecology, economics, environmental science, agro-science, systems engineering and principles regarding to the co-existence of populations of the ecosystem and the circulation, re-birth of materials in combination with multi-stage techniques of systems engineering. It mainly includes the following aspects:

a) The agro-technology of three-dimensional breeding and farming, that is, engineering technology dealing with optimum space combinations. Three-dimensional farming is a simulation of the forest ecosystem's multi-tier use of solar energy, like the three-dimensional technology for cultivating of trees, bushes and grass in hilly areas; the three-dimensional technology for inter-cropping and inter-planting crops on the plains; the three-dimensional multi-layer technology for breeding silver carp, grass carp, carp and crucian carp; and the technology for mix-breeding of fish, turtle, shrimp and clams; as well as the three-dimensional technology for cultivation of rice, duckweed and fish.

b) Engineering technology for food chain structure. A simulation of the ecosystem's food chain structure, this engineering technology is designed to establish a workable circle for the multi-stage utilization of materials. The output of one system is the input of another system. Thus, waste materials are used two or more times in production and a stable system for the circulation of materials is formed. By so doing, not only the natural resources fully used, but remarkable economic returns obtained. In some eco-farms, for example, chicken excrement is used as pigs' feed, pigs' excrement as fish feed (put into marsh gas pits), fish pool mud (or the waste materials of marsh gas pits) as fertilizer for crops, and crops as feed for chickens and pigs. This is what is called an enclosed circle of materials.

c) Eco-engineering for the integration of agriculture, forestry,

livestock breeding, sideline production and fishery while the combination of crop planting, livestock breeding and farm produce processing. Eco-engineering refers to a comprehensive eco-engineering technology which ensures an overall, well-projected development of agriculture, forestry, livestock breeding and sideline production by readjusting the structure of crop planting, livestock breeding and farm produce processing. This eco-engineering technology requires that each locality give full play to its advantages in resources, use one economic sector to boost the development of others and conduct a comprehensive harnessing of its rural environment so as to balance the improvement of its eco-environment with its socio-economic development and the growth of its population.

## (2) Technology for energy development

China has 0.8 billion farmers. Since there is a serious shortage of energy in the countryside, especially of living fuels, it is realistic that many localities use forests and stalks for fuel. Along with the steady development of modern science and technology, some applied technologies for developing new energies have been popularized in the countryside. These technologies mainly include:

a) Technology for building firewood-saving stoves. Since the 1960s, an upsurge in renovating stoves has been launched by various localities all over the country and the new stoves can raise heat efficiency by 30 percent.

b) The technology for developing marsh gas. This technology has also been extensively popularized since the 1960s. Crop stalks, livestock excrement and night soil are used as raw materials to produce marsh gas after being fermented by bacteria. Marsh gas can be used as fuel; its heat efficiency is as high as 60 percent, seven times as high as that produced by the direct burning of crop stalks. The remnants have various uses in crop planting and livestock breeding. Statistics from 1984 showed that China had more than 4 million marsh gas pits, most built by families. The undertaking of marsh gas has thus been developing rapidly all over the country.

c) Technology for solar energy. For example, some rural areas have

built solar-energy stoves, others have built sheet canopies and solar-energy green houses to breed seedlings or grow vegetables in early spring, still others have used plastic sheets and raise the temperature of the surface soil so as to promote the growth of crops.

d) Technology for using wind and water energy. Using wind energy is China's traditional energy technology. In areas abundant of wind resources but short of electricity, wind energy is used for irrigation and power generation. In China there are small, exploitable water resources of about 70 million kW. More than 200 counties have built hydroelectric power stations with a total capacity of 10,000 kW.

### (3) Technologies for Harnessing the Natural Environment

Geography, climate and human factors have left many localities with a harsh natural environment which has not only impaired their agricultural production but has even posed a threat to people's existence. In combating natural disasters, man has created many technologies for harnessing the natural environment in light of local conditions.

a) Technology for harnessing soil erosion. At present, two categories of technology are used for putting a halt to soil erosion in China's countryside. One is planting technology, that is, the planting of trees, grasses, and various locally available tree species to build shelterbelts and protect the headwaters of rivers, slope-protecting forests, dyke-protecting forests and sea coast shelterbelts. There has also been inter-planting of crops with trees, crops with grass, or tree with grass. In sparsely inhabited areas, grass belts may be interspersed among belts of crops. The other category is engineering technology. This mainly refers to constructing terraced fields where trees and crops are planted. This technology is widely used on the Loess Plateau to harness soil erosion. It also includes the construction of level terraces, level terraced ditches and fish-scale pits. In some areas, check dams are built to support the gully-forming process.

b) Technology to control desertization. The technology for harnessing the desert is similar with that of harnessing soil erosion. The most widely used technology is planting trees and grasses by which China has succeeded

in creating an artificial forest in the desert northwest, turning the barren land into an "oasis". In the process of harnessing the desert, Chinese farmers have invented the unique, practical "crop stalk latticework" technology, that is, weaving crop stalks (wheat straw or hay) into lattice to fix sand and then plant such locally available species of sand wormwood, twisted wicker, *Tamarix chinensis* and *Elaeagnus angustifolia* in the lattices, thus building an artificial vegetation and a stable, long-term green protection project.

c) Technology to improve salinized soil. China has 27 million hectares of salinized land, of which 7 million hectares are under cultivation. The technology includes:

The technology to improve salinized soil with water, by digging ditches to drain off water or reducing the level of underground water and wash away bittern or warp salinized land. The technology to improve salinized soil by farming is to plant rice (in order to wash away salt), level the land, mound up the earth around the crops and apply organic manure. The technology to improve salinized soil by chemicals refers to the application of gypsum and black alumen. The technology to improve salinized soil with organisms is to plant trees, forage grass and green manure plants.

#### (4) Comprehensive prevention and control technology

Comprehensive prevention and control technology, is meant the comprehensive application of physical, chemical, biological and agricultural technologies to prevent and eliminate diseases, insect pests and weeds. It mainly includes:

a) Agricultural prevention and control technology. This refers to using agricultural technology to prevent and eliminate crop diseases, insect pests, weed and voles. Technical measures now in use include cultivating disease- and pest- resistant seedlings and livestock strains; rotating crops and improving farming methods to reduce the population of insect pests and weed; changing the sowing, nourishing and harvesting periods of crops so as to interrupt the time a plant can be harmed by diseases, insect pests and

weeds; cleaning up farmland by weeding so as to eliminate intermediate parasitic medium of diseases and insect pests; and rational irrigation and fertilization so as to increase crop resistance.

b) Biological prevention and control technology. This is a traditional technology in China which has been developed in recent years. This refers to the use of the natural enemies of insect pests to regulate, control and eliminate them. It includes the use of beneficial insects to prevent and eliminate insect pests and weeds, to prevent and eliminate corn borers by trichogramma and to prevent and eliminate alligator alternanthera (*Alternanthera phukixeriudes*) by aphids; using the parasitic microbes to kill insect pests and weeds; preventing and eliminating dodder (*Cuscuta chinensis*), a parasitic weed of soy beans, with fungus; and using vertebrates to kill insect pests, such as raising fish and duck in rice fields, or chickens in dry farmland.

c) Chemical prevention and control technology. That is to use natural or synthetic chemicals to control hazardous organisms. The characteristics of this technology are quick results, high efficiency and being less restricted by the size of areas. It can rapidly bring under control acute insect pests and weeds. The currently applied measures chiefly include applying high-efficient, low-toxic and high-selective agricultural chemicals with low left-overs, researching new chemicals, improving the methods of application, rationally applying chemicals and using small doses of chemicals.

d) Physical prevention and control technology. As the name suggests, this refers to using physical measures to prevent and eliminate diseases and insect pests by, for example, eradicating weeds with machines and luring insect pests with lamp lights.

In addition, there is a modern prevention and control technology by the combined application of physical, chemical and biological means. For example, there is the sterilization and elimination of insect pests by applying a synthetic hormone and extra-sex hormone.

## II THE DEMONSTRATIONS OF CHINA'S ECO-FARMING

### 1) Type of Three-Dimensional Cultivation

#### (1) Nanhai State Farm's Remarkable Economic Results From Cultivating Forest Trees With Rubber Trees and Tea

Located in a flat area in northeast Hainan Island, the Nanhai State Farm started to plant forest trees, rubber trees and tea in a man-made community in 1975. The canopy of forest trees provides a less windy, high temperature and moist environment for rubber trees in the central layer, promoting their growth and increasing rubber output. The rubber trees in this community reach maturity one year earlier than in other areas. The shadow of the rubber trees facilitates the growth of tea trees and provides ideal sunlight and moist growing environment for them. In turn, the tea trees protect soil, water and temperature for the rubber trees. The symbiosis of rubber trees and tea has greatly increased the farm's economic and the ecological effect. Each year the farm has earned 4,500—6,000 yuan or 30—40 percent more from intercropping one hectare of forest trees with rubber trees and tea trees than what had been earned from the single cropping of tea or rubber trees.



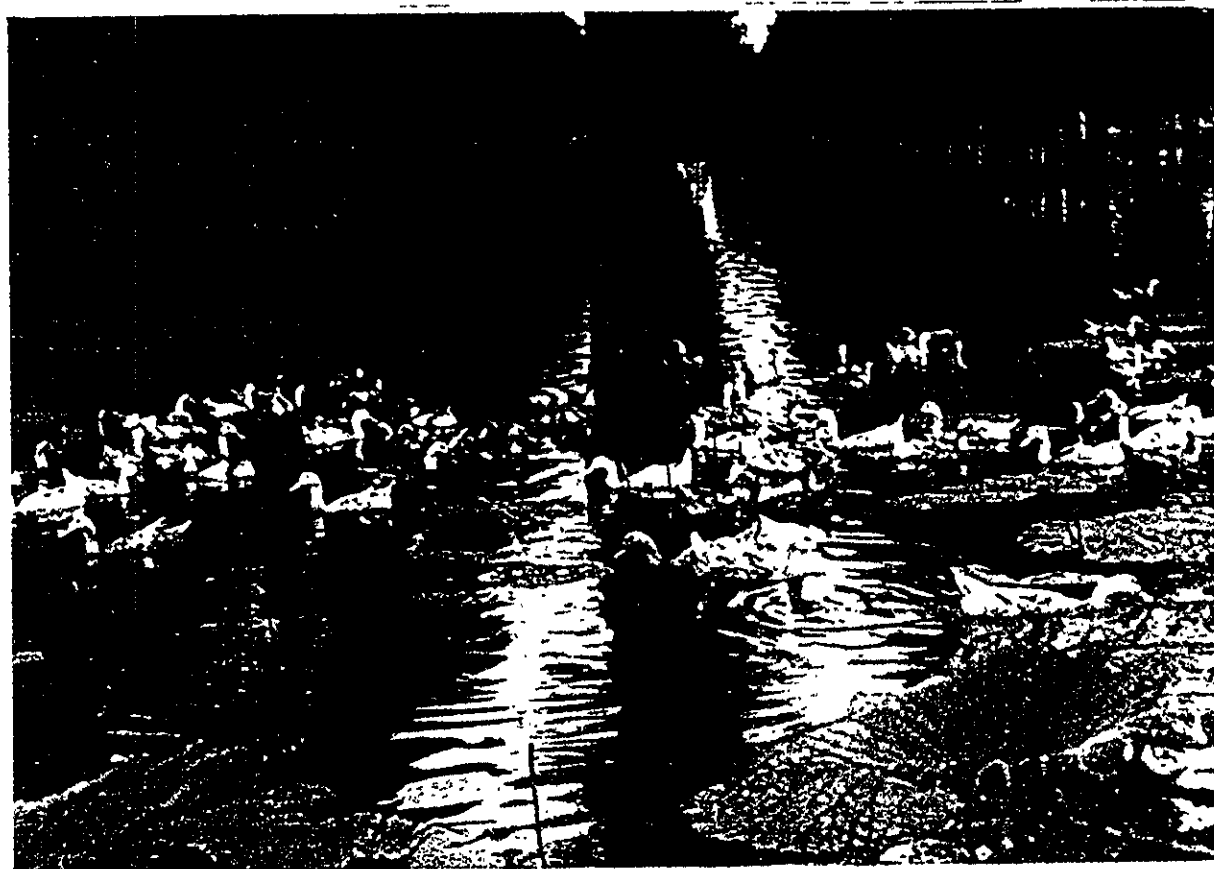
Picture 2 The forest rubber tree/tea tree system in the Nanhai State Farm, Hainan Province.

## (2) Economic Results From Planting Rice and Raising Ducks and Fish

The Daqiao Township in Jiangjin County, Sichuan Province, raised 1,783 duck on 6.7 hectares of paddy-rice fields in 1988. The township raised duck in the rice fields for 84 days from May 10 to July, 31 and harvested 3,031.1 kg adult ducks, generating 10,900 yuan. Also, the township harvested 3,150 kg of fish and took in 12,600 yuan from the 20,300 fish fry in the rice fields. At the same time, the grain output increased by 3,050 kg that year. The township gained remarkable economic results and ecological effects from this method.

The main models are as follows:

- (1) Planting rice with raising algae and fish;
- (2) Planting rice with raising duck and fish;
- (3) Planting trees with raising duck and fish;
- (4) Planting trees with domestic animals and earthworm breeding;
- (5) Planting reeds with raising poultry and fish;
- (6) Planting rice and raising fish;
- (7) Planting rice and raising ducks;
- (8) Planting fruit trees with raising poultry and earthworms.



Picture 3 The tree-duck-fish three-dimensional system in the Zhangduhu Tree Farm in Hubei Province



## 2) Types of Material Recycling and Utilization

(1) The Liuminying ecosystem which integrates plant cultivation with animal farming and biogas utilization

Household biogas pits are widely used in Liuminying village on the outskirts of Beijing. They are usually built in front of the houses or near lavatories and pigpens. Pigpens are small rooms with two parts. The upper part is used to raise chickens and rabbits and the lower part for pigs. Chicken and rabbit droppings fall into pigpens and can be used as part of the biogas pits. This, plus some green grasses and stalks, is fermented and biogas is generated. Biogas can be used for cooking and lighting. Some biogas dregs and water can be used as fertilizer for vegetables and flowers in sheds. The leaves of vegetables can be used to feed rabbits and they can also be put into the biogas pits for biogas fermentation. Thus, a small re-cycling system of “chickens (rabbit)—pig—biogas—vegetable (flower) has taken shape.

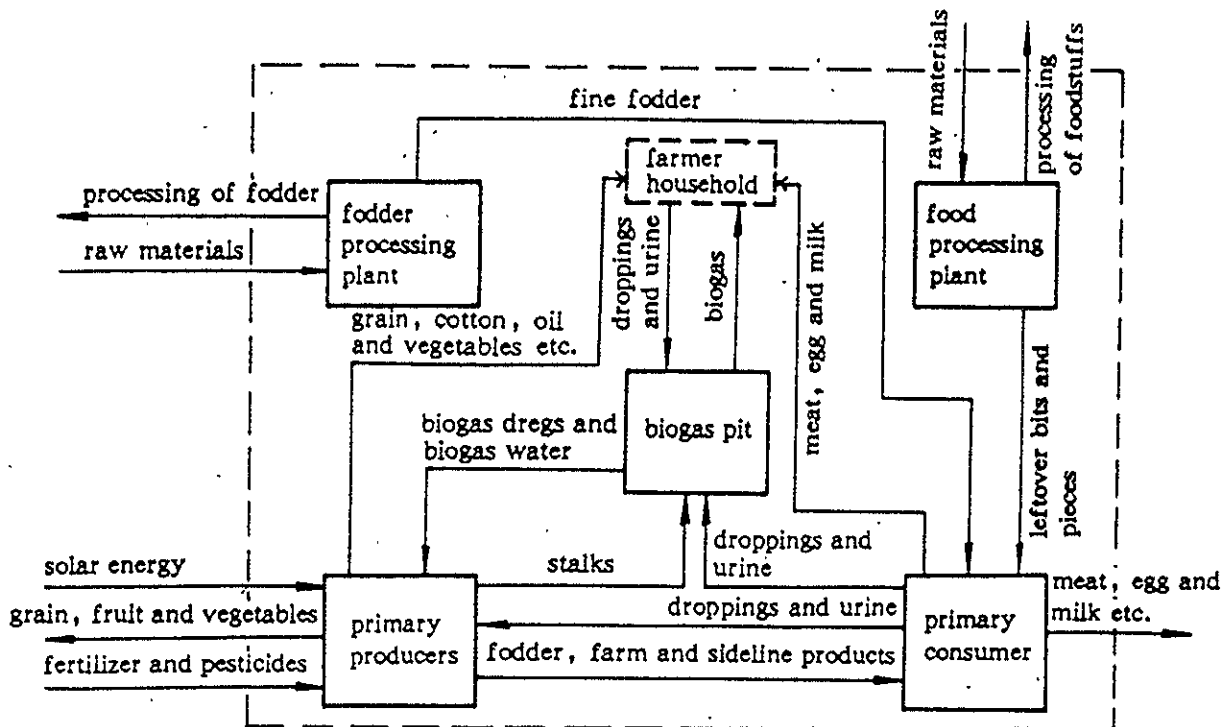
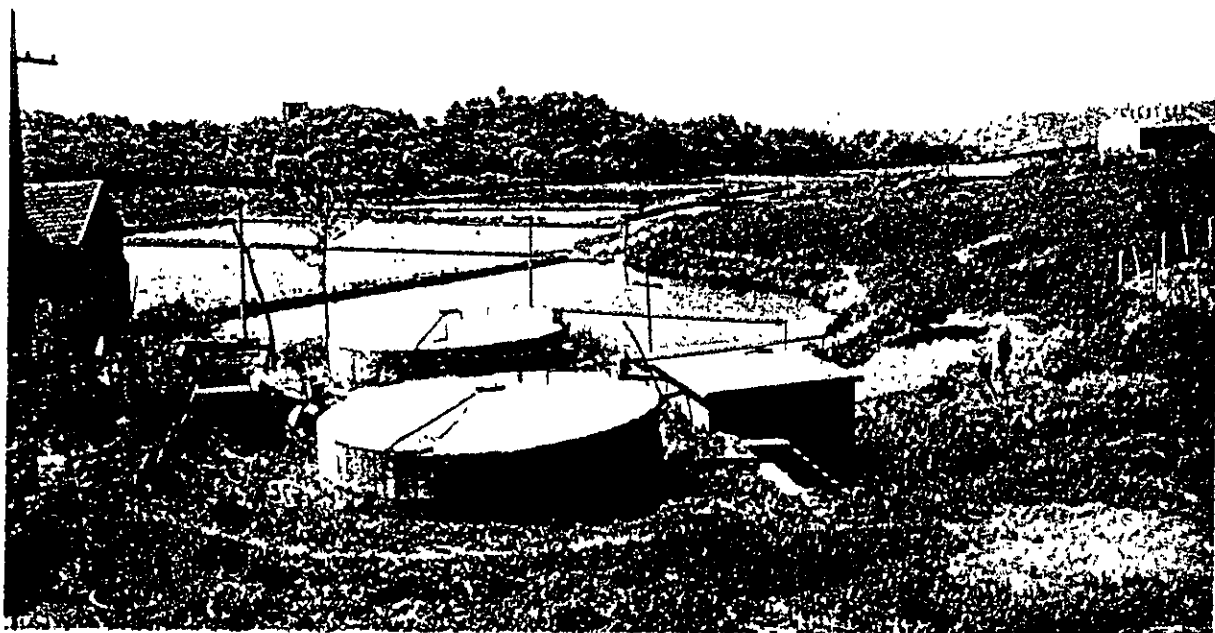


Diagram 8 · The comprehensive re-cycling and utilization system in Liuminying Village

(2) The Guquan Farm mode of integrating plant cultivation with animal farming and biogas utilization

The Guquan Ecological Farm in Nanjing has rationally combined the production of pig and fish farming, the biogas project, the raising of ducks, the raising of earthworms, the growing of mushrooms and fruit trees into an integral sound re-cycling system. Chicken droppings are used as part of the feed for pigs. Pig droppings in the biogas pits are used as raw materials for fermenting biogas and the generated biogas used for cooking and lighting. Biogas liquid and dregs can be used to feed fish, cultivate edible fungus, raise earthworms and as fertilizer for orchards. The fish pond also provides a space for raising ducks. Duck droppings can be used as fish bait in the pond and the pond silt can be used as fertilizer for the orchard. Earthworms are raised in the orchard, droppings and mushroom dregs can be used as bait for earthworms. Earthworms can improve the orchard soil and earthworm droppings provide fertilizers for the orchard. Earthworms can be used as the feed for chickens. The various production systems of the farm are co-ordinated with each other so that their productivity is comparatively high and able to yield sustained growth. It has shown the marked advantages in practice.

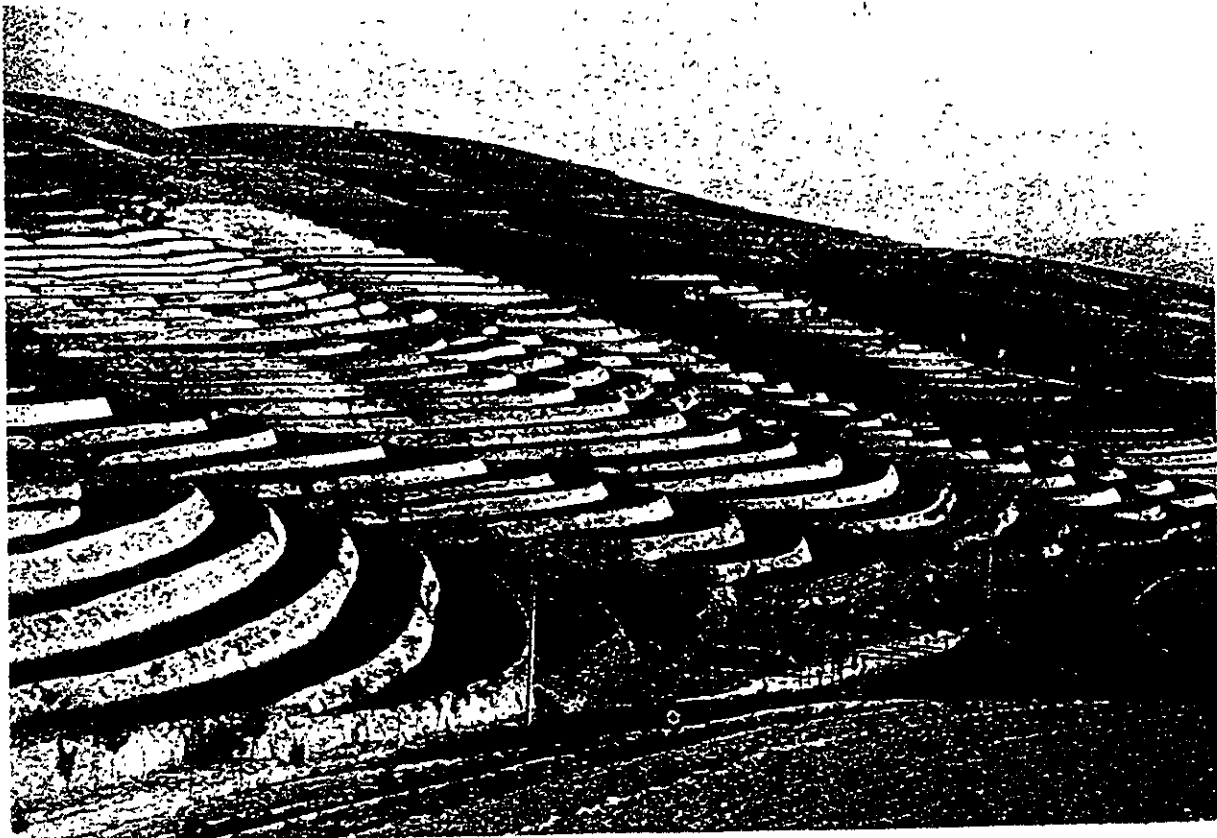


Picture 5 The Nanjing Guquan Eco-Farm

### 3) Type of Desertization Control

Shabianzi Village is located in an arid and semi-arid area with annual precipitation of less than 300 mm. The village covers an area of 4,822 hectares. Of which drifting and semi- drifting sand dunes make up 30 percent of the total area, semi- fixed sandy land of medium- degree desertization occupies 5.5 percent, fixed sandy land of light desertization, 50.9 percent and potential desertization saline-alkali land, 12.5 percent.

In 1985, they conducted a survey of the county, and decided on a comprehensive control programme based mainly on readjusting the land use structure and the development, utilization of underground water resources by biological measures. They made an overall plan and a reasonable distribution of agriculture, forestry and animal husbandry resources. They proposed growing grass and planting trees, developing fruit trees, carrying out eco- farming construction and setting forth different measures for controlling desert land of different types.



Picture 6 A new look after transformation of the loess plateau area of Guyuan County in Ningxia Hui Autonomous Region.

# Ecosystem Engineering and Modern Agroforestry

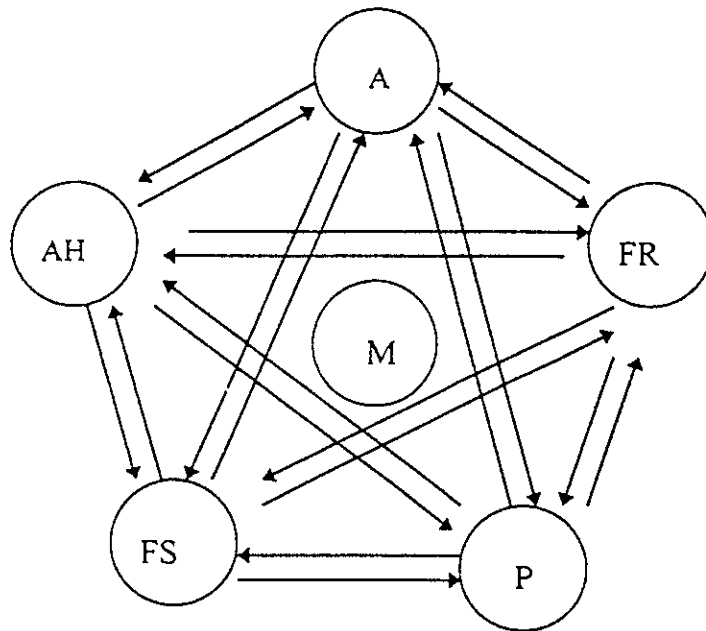


Figure 1: Production Systems of Modern Agroforestry  
 A = agriculture    AH = animal husbandry    FR = forestry  
 FS = fisheries    P = processing    M = marketing

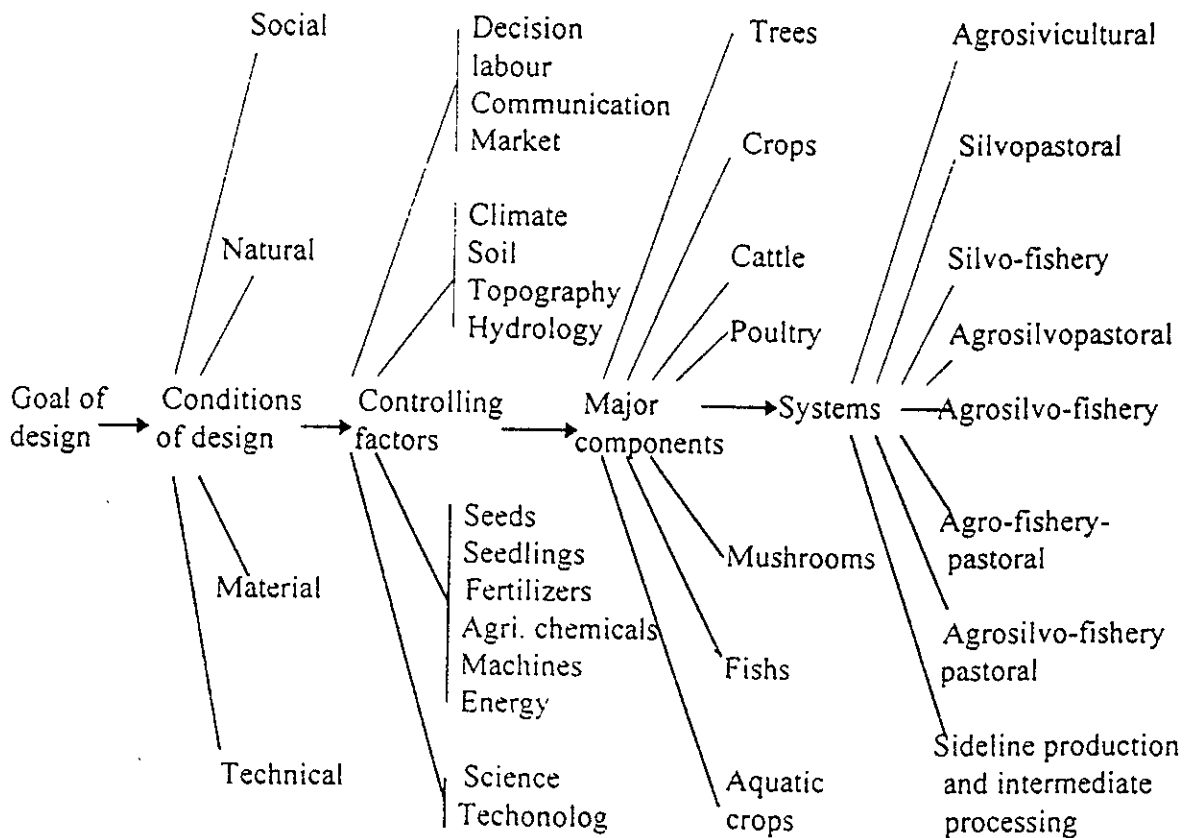


Figure 3: Design Process of Comprehensive Agroforestry Systems