Chinese Ecological Agriculture: a holistic approach to sustainable agriculture development

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Introduction

Four stages of agricultural development

1. Neolithic or New Stone Age (10,000 years ago)
   - Rice (*Oryza sativa L.)* planting and livestock raising in China dates back 7000 years
- Plow innovated around 4000 B.C.

2. The New World found by Spanish explorer Christopher Columbus in late 15th century.
- Connecting of the New World and the Old World promoted the exchange of farming products and methods.

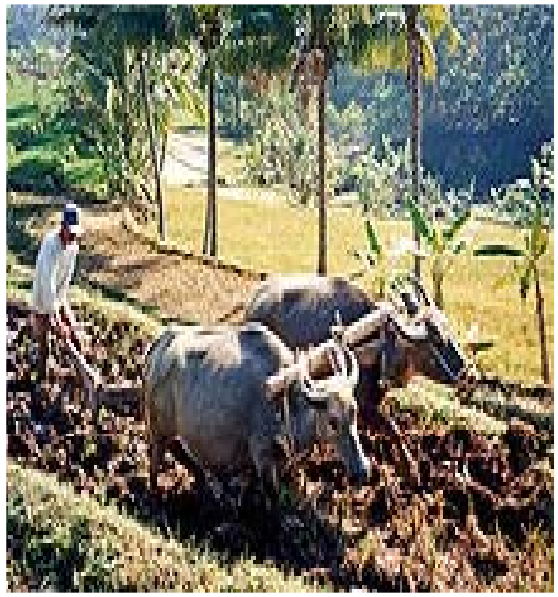
3. The Industrial Revolution in 18-19th centuries.
- Advances in farm technology, transportation, farm machinery

4. Scientific advances in the 20th century
- Refrigeration, chemical fertilizers, pesticides, antibiotics, growth regulators, genetically modified organisms.

Primitive agriculture, traditional agriculture, modern agriculture

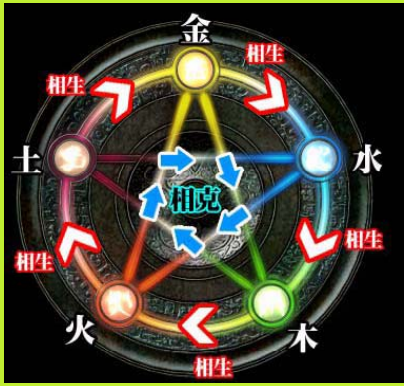
Traditional agriculture (subsistence agriculture)

- Farmers with direct experience of traditional and indigenous technology
- Use of hand-made wooden or iron agricultural tools
- Labor-intensive
- Low agricultural productivity
- Basically self-sufficiency
- Preserve biodiversity and natural resources



Ancient ecological concepts and practices

- The ancient Chinese philosophy of "yin" (earth) and "yang" (heaven)



- "The five elements" theory: metal, wood, water, fire and earth.
- "The three adaptive" principles:
  - *adaptive to location*
  - *adaptive to season*
  - *adaptive to thing*
- The "harmony among heaven, earth and humans" concept
- Innovative agricultural practices:
  - *inter-cropping, relay cropping , integrated cropping and livestock production*
  - *grain–livestock–mulberry –fish integrated production system*
  - *rice- fish, rice-duck systems*
  - *"food chain" to raise sheep and fish*

Conventional agriculture (petroleum-based agriculture)

"Capital-intensive, large-scale, highly mechanized agriculture with monocultures of crops and extensive use of artificial fertilizers, herbicides and pesticides, with intensive animal husbandry" (*Knorr and Watkins, 1984*).

Alternative agriculture

Methods-based

- Organic farming
- Biodynamic agriculture
- Biological agriculture
- Nature farming
- Agroecology
- Ecoagriculture

Conceptually oriented

- Regenerative agriculture
- Permaculture
- Low input agriculture, Low input sustainable agriculture (LEISA) , Low external input and sustainable agriculture (LEISA)
- Sustainable agriculture

Common features:

✓Emphasis on organic or near-organic practices.

✓Favor significantly reduced use of synthetic farm chemicals.

✓Advocate smaller farm units and technology, reduced energy use, greater farm and regional self-sufficiency, minimally processed foodstuffs, conservation of finite resources, and more direct sales to consumers.

Alternative agriculture

Key elements of the competing agricultural paradigms (*Beus & Dunlap, 1990*)

Conventional agriculture	Alternative agriculture
Centralization ● National/international production, processing, and marketing ● Concentrated populations; fewer farmers ● Concentrated control of land, resources and capital	**Decentralization** ● More local/regional production, processing, and marketing ● Dispersed population; more farmers ● Dispersed control of land, resources and capital
Dependence ● Large, capital-intensive production units and technology ● Heavy reliance on external sources of energy, inputs, and credits ● Consumerism and dependence on the market ● Primary emphasis on science, specialists and experts	**Independence** ● Smaller, low-capital production units and technology ● Reduced reliance on external sources of energy, inputs, and credits ● More personal and community self-sufficiency ● Primary emphasis on personal knowledge, skills, and local wisdom
Competition ● Lack of cooperation; self-interest ● Farm traditions and rural culture outdated ● Small rural communities not necessary to agriculture ● Farm work a drudgery; labor an input to be minimized ● Farming is a business only ● Primary emphasis on speed, quantity, and profit	**Community** ● Increased cooperation ● Preservation of farm traditions and rural culture ● Small rural communities essential to agriculture ● Farm work rewarding; labor as essential to be made meaningful ● Farming is a way of life as well as a business ● Primary emphasis on permanence, quality, and beauty

Alternative agriculture

(continued)

Domination of nature	Harmony with nature
● Humans are separate from and superior to nature ● Nature consists primarily of resources to be used ● Life-cycle incomplete; decay(recycling wastes) neglected ● Human-made systems imposed on nature ● Production maintained by agricultural chemicals ● Highly processed, nutrient-fortified food	● Humans are part of and subject to nature ● Nature is valued primarily for its own sake ● Life-cycle complete; growth and decay balanced ● Natural ecosystems are imitated ● Production maintained by development of healthy soil ● Minimally processed, naturally nutritious food
Specialization	**Diversity**
● Narrow genetic base ● Most plants grown in monocultures ● Single-cropping in succession ● Separation of crops and livestock ● Standardized production systems ● Highly specialized, reductionistic science and technology	● Broad genetic base ● More plants grown in polycultures ● Multiple crops in complementary rotations ● Integration of crops and livestock ● Locally adapted production systems ● Interdisciplinary, systems-oriented science and technology
Exploitation	**Restraint**
● External costs often ignored ● Short-term benefits outweigh long-term consequences ● Based on heavy use of nonrenewable resource ● Great confidence in science and technology ● High consumption to maintain economic growth ● Financial success; busy lifestyles; materialism	● All external costs must be considered ● Short-term and long-term outcomes equally important ● Based on renewable resources; nonrenewable resource conserved ● Consumption restrained to benefit future generations ● Self-discovery; simpler lifestyle; nonmaterialism

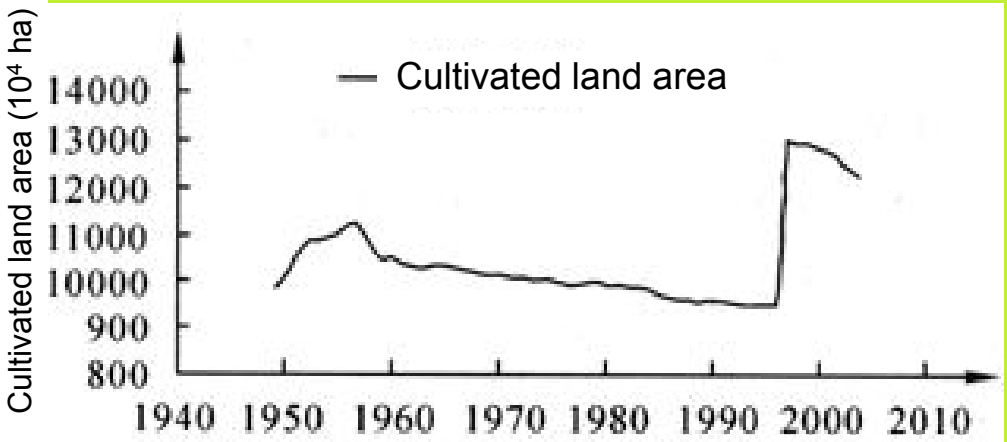
Chinese Ecological Agriculture

The ecological problems in modern China

- *Cultivated land reduction*

Reduction
0.15-0.25 million ha/year

0.11 ha per capita, being 33.3% of the world average. 0.05 ha per capita in costal provinces

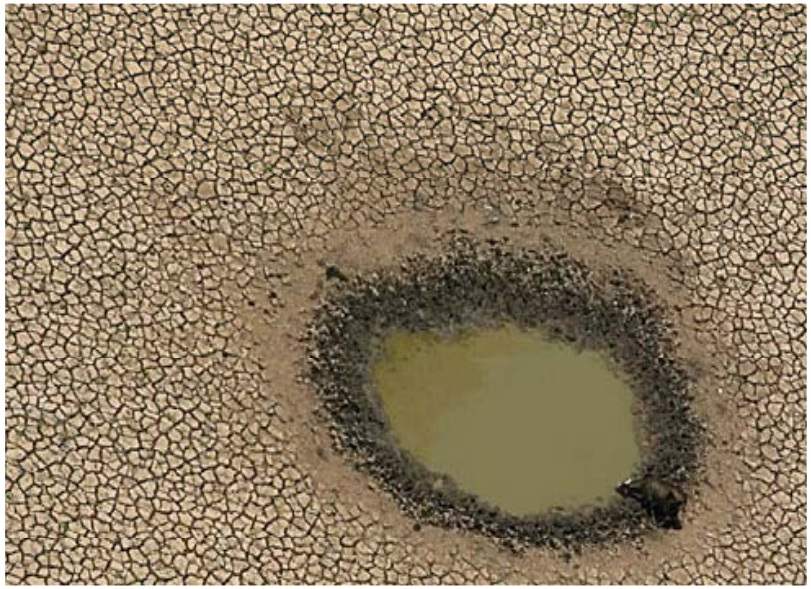


Change trend of cultivated land statistical data from 1949-2004 in China

Chinese Ecological Agriculture

- *Land degradation*

Types of soil degradation	Development speed (10^3 ha/year)
Land occupation	150
Soil stripping	100
Soil erosion	300-400
Soil desertification	4,900
Grassland degradation	1,300



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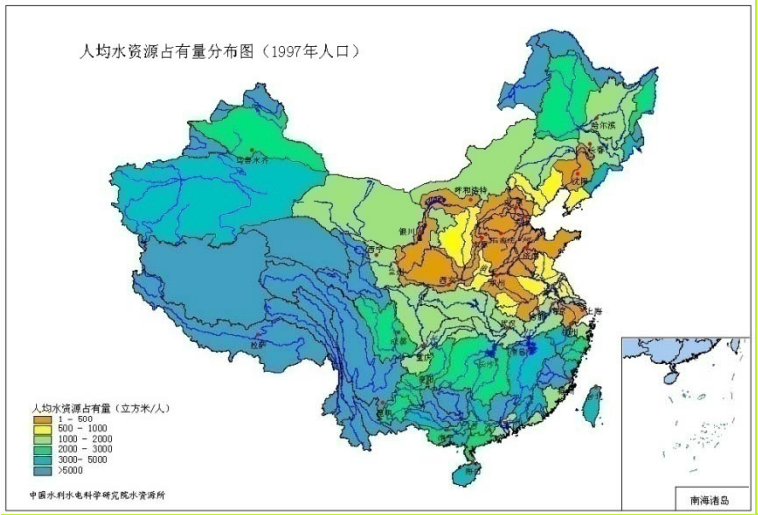
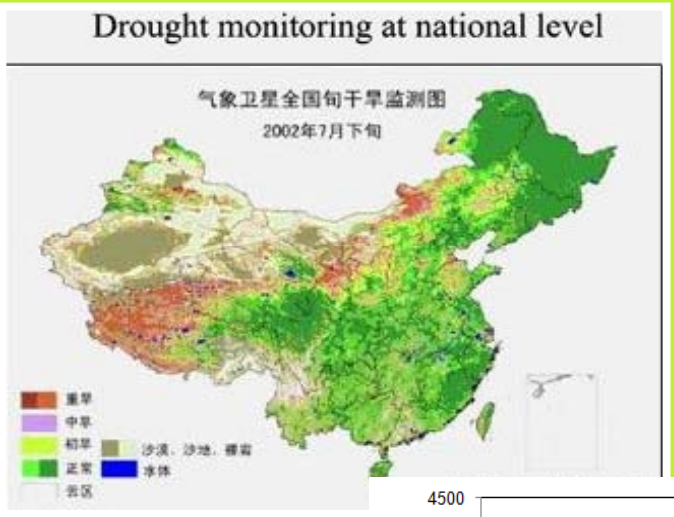
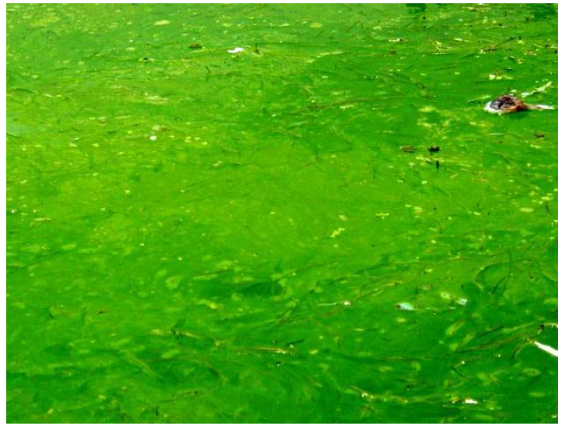
- *Water shortage and pollution*

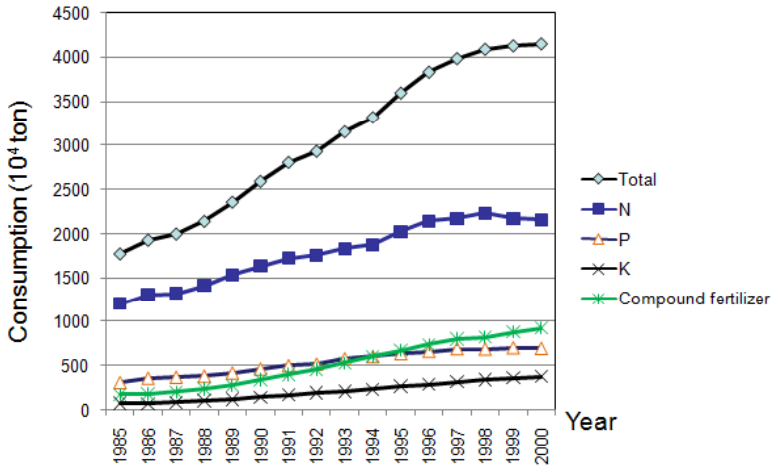
1/3of the water resource per capita in the world (Zhang, 1999).

More 80% is used for agriculture. Water deficit.









Chinese Ecological Agriculture

The concept and connotation of CEA

CEA is defined as “an integrated agricultural technological system, which is constructed by organizing rational agricultural structure according to local resource conditions, and assembling the suitable component technology packages, in the light of the combined principles of ecology and economics and the methodology of system engineering, to achieve the overall economic, ecological and social benefits of the whole system ”(*Sun and Zhang, 1993; Wang, 1999*).

- A derivative of sustainable agriculture
- Ecological agriculture with Chinese characteristics

Diversified CEA patterns

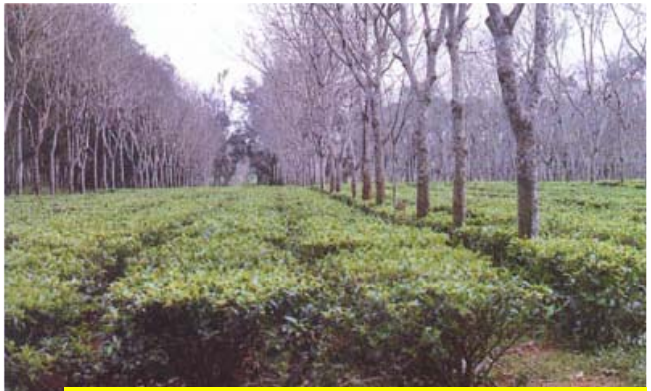
Integration of sectors (enterprises or subsystems)

In terms of economic and/or ecological linkages.

Crop-livestock integration

Forest-duck-fish system

Fruit-aquaculture system



Forest-rubber-tea system

Diversified planting and husbandry

Application of ecological niche theory

Beneficial to a system's ecological balance, reduce economic risks.

Diversified CEA patterns

Polycultures and time series pattern

This pattern is the production practice of several crops in sequence.

Heritage from traditional farming techniques:

Inter-cropping;
Relay-cropping;
Mixed cropping;
Rotational cropping
(paddy and upland rotation).

Diversified CEA patterns

Vertical utilization

Utilization of three-dimensional construction of mountains, rivers, farmlands, forests, and roads in accordance with the characteristics of topography, geomorphology, micro-climate, and soil adaptability, and the distribution of fields, residential area of villages, roads, canals, and ditches.

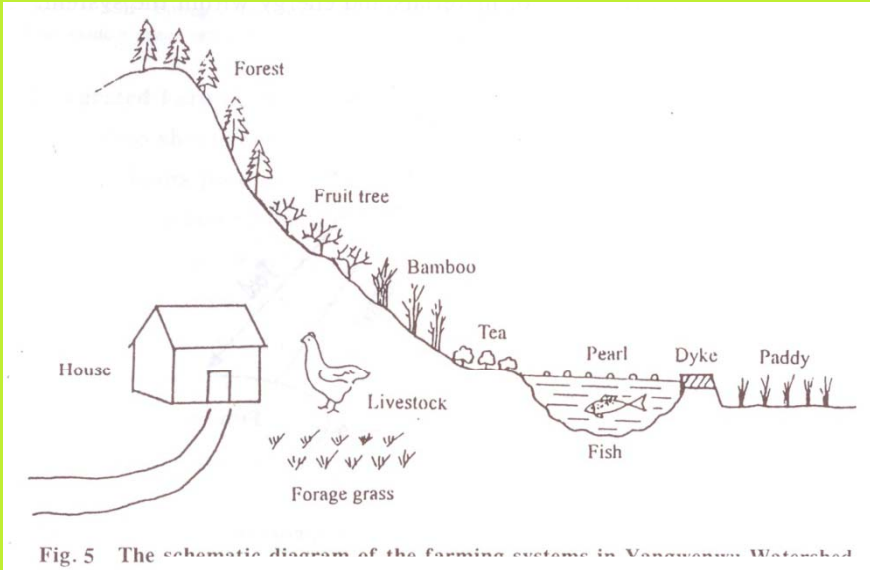


Fig. 5 The schematic diagram of the farming systems in Yangwenxu Watershed

Chinese Ecological Agriculture

Complementary benefits

Mutually beneficial systems can be established either by mimicking the natural ecosystems formed through evolution and succession, or by organizing various inter-cropping and / or multiple cropping patterns through a selection of mutually beneficial crops.

Legumes (clover, astragalus, etc.) + other crops

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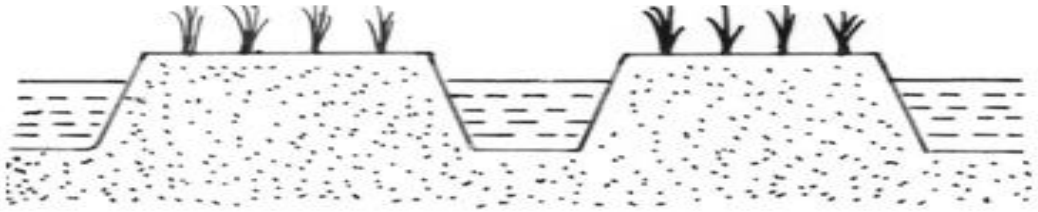
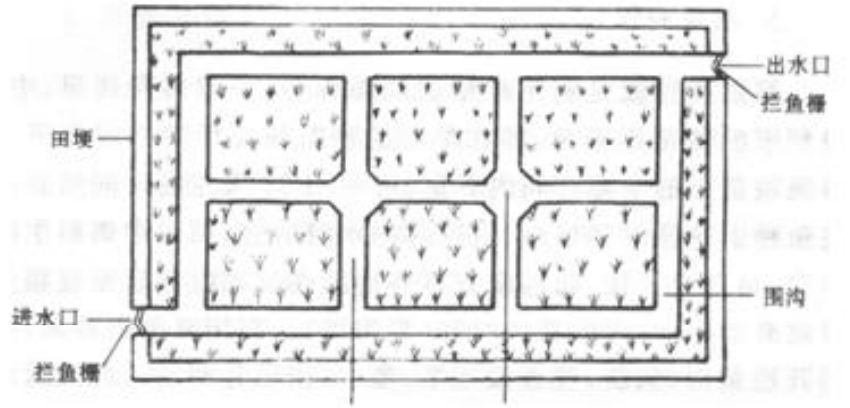
Symbiosis

This pattern takes advantage of the symbiosis relationship between species, organisms, etc.

Rice-fish system, rice-duck systems.





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Chinese Ecological Agriculture

Agroforestry

In northern China, crops planted between rows or within a network of tree windbreaks

In southern China, a wide variety of woody plants are integrated with crops

Ecotone utilization

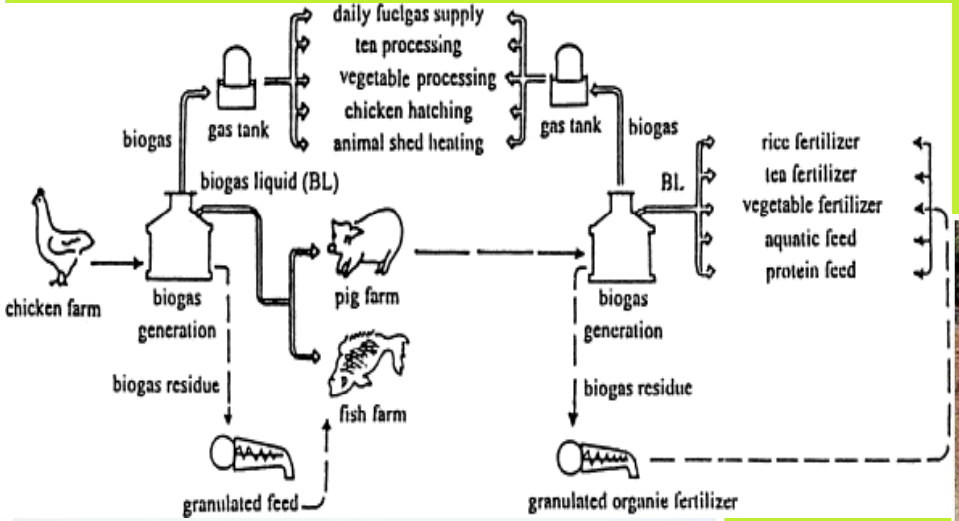
Transitional areas between land and bodies of water, between mountainous land and level ground or plain, and even between desert and farmland

Proper ecological management and technical intervention could enhance the ecological efficiency

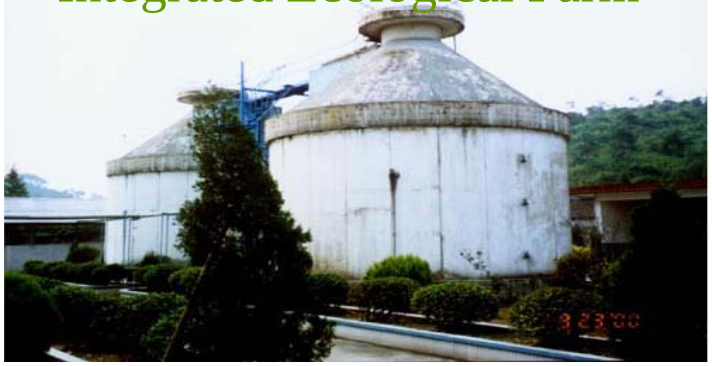
Diversified CEA patterns

Food Chains

Populations of organisms at different trophic levels are organized into a food chain system to carry out production.



Integrated Ecological Farm



Biogas Digester

CEA movement

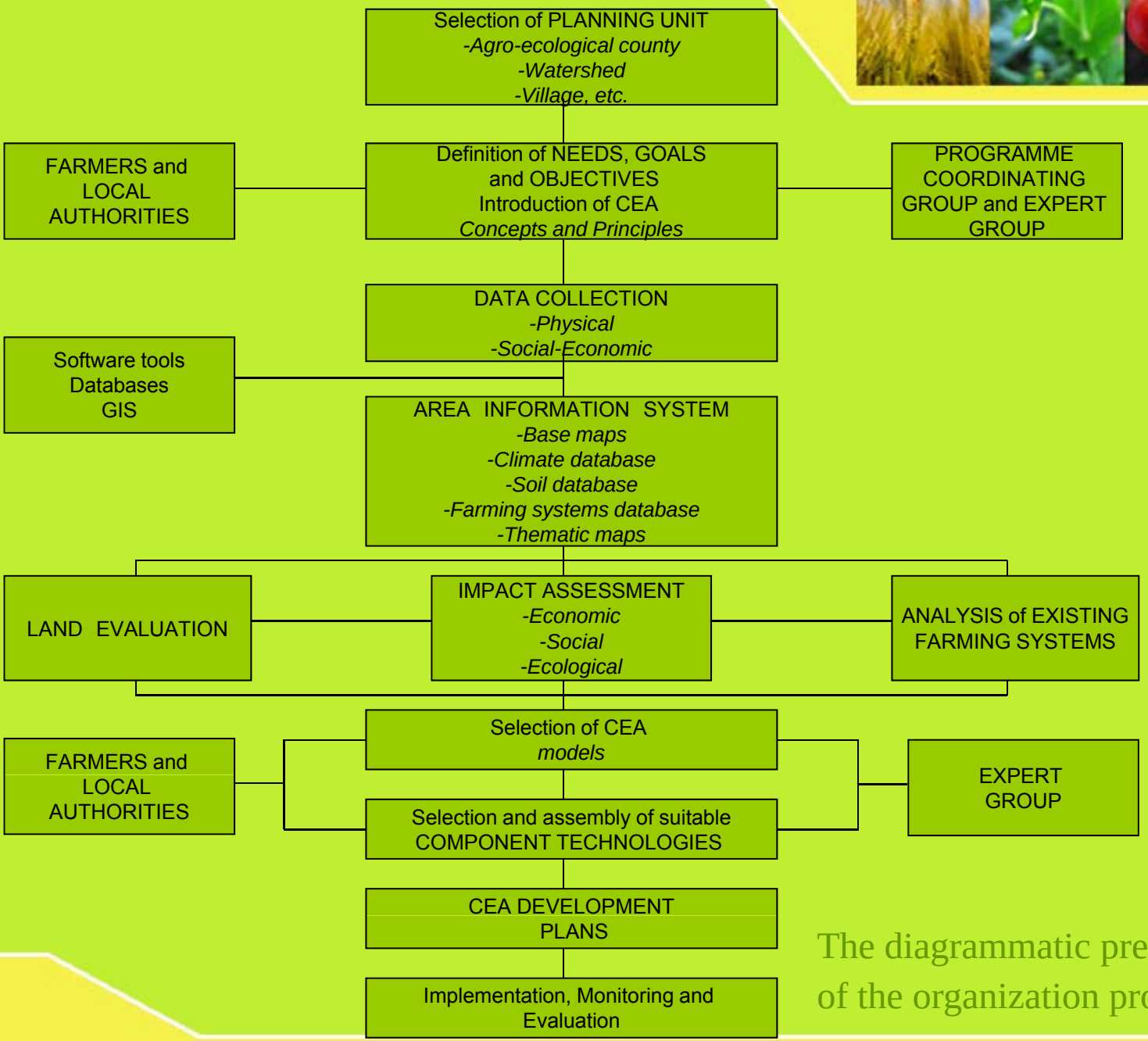
CEA construction programs across China:

- More than 20 million ha of CEA demonstration areas since 1980s.
- National CEA county construction program in since 1990s. 7 ministries organized a leading group. (1st 50 counties selected)
- CEA village, township, county and province construction programs

Role of CEA in agricultural and rural development:

- Challenging the dominant position of conventional agriculture
- Reconciling the conflicts between economic and ecological objectives

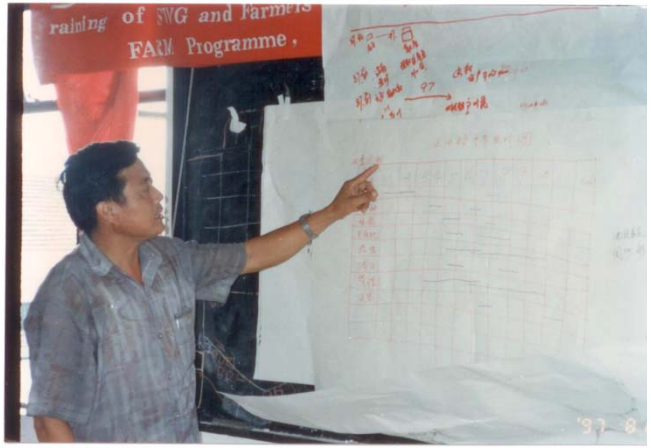
The organization process of CEA



The diagrammatic presentation of the organization process of CEA.

People's participation in CEA planning

People's participation is an interactive social process, motivated by the desire to meet an individual's needs through collective action.



Ecotourism

Agricultural tourism:
Sightseeing, natural scenery

Agricultural education:
agricultural history, ancient and modern agro-technologies

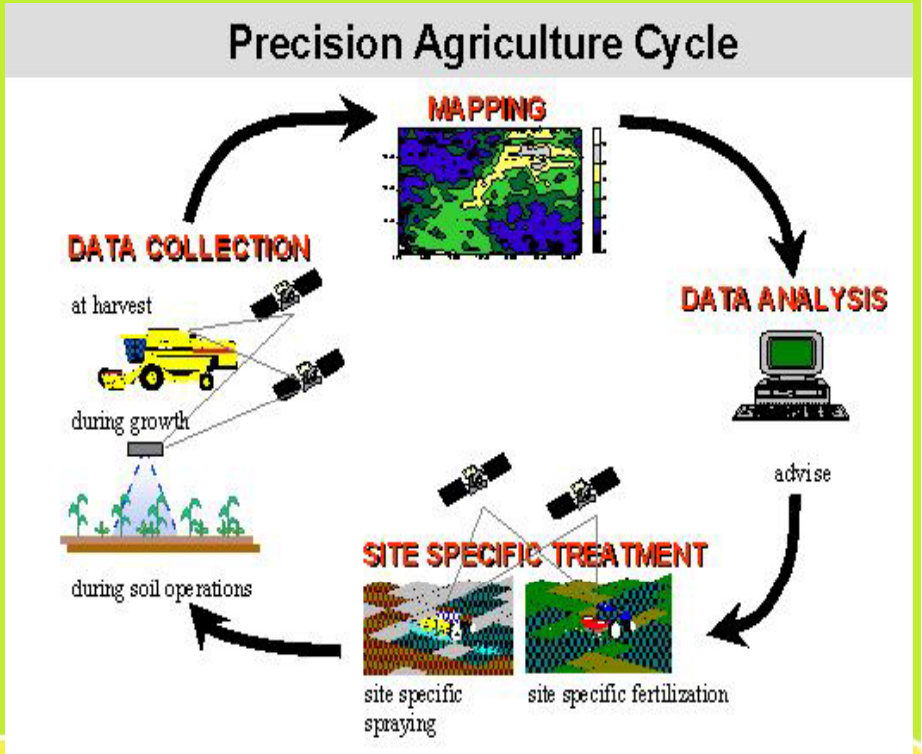
Participatory agricultural activity:
practices of crop planting, harvesting, etc.

Recreation in countryside:
holidays, leisure time

Precision Agriculture

An information and technology based farm management system to identify, analyze and manage variability within fields for optimum profitability, sustainability and protection of the environment.

Figure 15. Integration of technologies in site specific farming.



Future prospects

Three pillars for sustainable development

Sustainable Development

1978-2000: general well-off
2001-2020: entire well-off
2021-2050: general modernization

Economic growth (↑): ≥World Average Wealth

I: $800 per capita
II: $3000 per capita
III: $10000 per capita

Social development (↑): ≥World Average HDI

I: HDI 0.7
II: HDI 0.8
III: HDI 0.9

Environmental impact (↓): ≤World Average Impact

I: Low resource consumption and Environmental Impact
II: High increase of Environmental Impact
III: Negative increase of Environmental Impact

Conclusions

- Review of the agricultural development
- CEA movement and new trends in agriculture development in China
- Future prospects of sustainable development

Thanks for your kind attention!