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Current situation and future prospects of sustainable agriculture in China

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Presentation outlines



- **Introduction**
- **Chinese Ecological Agriculture (CEA)**
 - ✓ *The concepts and practices of ecological agriculture in ancient China*
 - ✓ *The ecological problems encountered in agricultural development in modern China*
 - ✓ *The emergence and development of CEA in modern China*
 - ✓ *The concept, connotation and underlying principles of CEA*
 - ✓ *The process and practical principles in organizing CEA*
 - ✓ *Diversified CEA patterns adapted to various areas*
- **Sustainable rural tourism - ecotourism**
- **Precision agriculture**
- **A new countryside construction initiative**
- **Conclusions**

Introduction



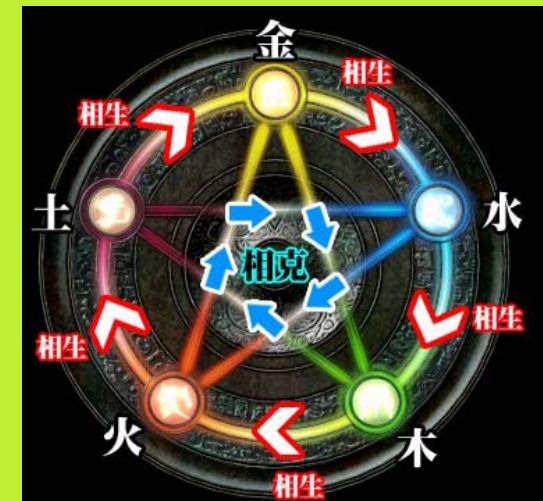
- China has a long history of agricultural production.
 - Rice (*Oryza sativa* L.) planting and livestock raising in China dates back 7000 years (Wang, 1999).
- Land degradation due to increased application of modern agrochemicals to enhance land productivity to feed the population (7% world's cultivated land feeds 22% world's population, Ye et al., 1997; Zhou, 1999)
- A boom in rural industries, resulting in sharp reduction of arable land and a wide range of agro-environmental problems.
- A new mode of agricultural production and rural development, called Chinese ecological agriculture (CEA), emerged in China's rural areas.

Chinese Ecological Agriculture



The concepts and practices
of ecological agriculture in ancient China

- The ancient Chinese philosophy of “yin” (earth) and “yang” (heaven)
- “The five elements” theory: metal, wood, water, fire and earth.



Chinese Ecological Agriculture



- “The three adaptive” principles are central to the principles of ancient Chinese agricultural production.
 - *adaptive to location,*
 - *adaptive to season,*
 - *and adaptive to thing*
- The concept of the “harmony among heaven, earth and humans” (The Chinese classical works “Zhou Li” (Rites of Zhou Dynasty, 3000 years ago))

Chinese Ecological Agriculture



- Innovative agricultural practices:
 - *inter-cropping and relay cropping as well as integrated cropping and livestock production*
 - *grain–livestock–mulberry (Morus L.)–fish integrated production system*
 - *rice- fish, rice-duck systems*
 - *“food chain” to raise sheep and fish*

Chinese Ecological Agriculture



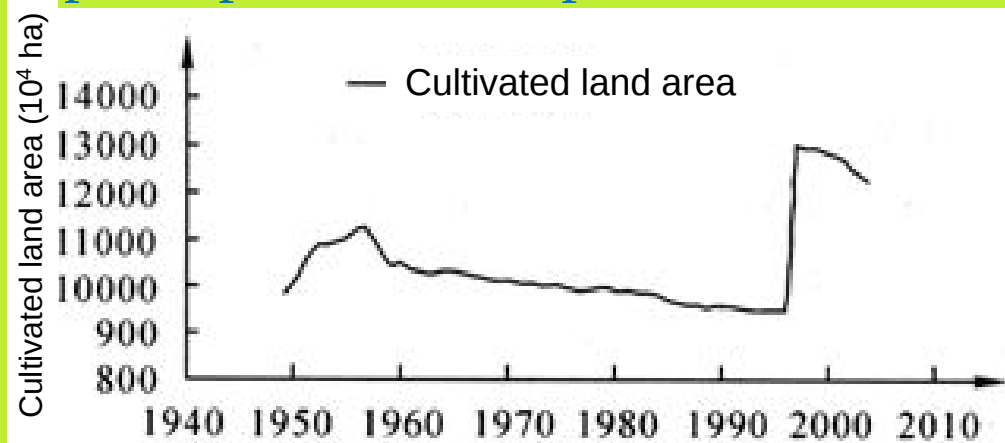
The ecological problems encountered
in agricultural development in modern China

- *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 coastal provinces

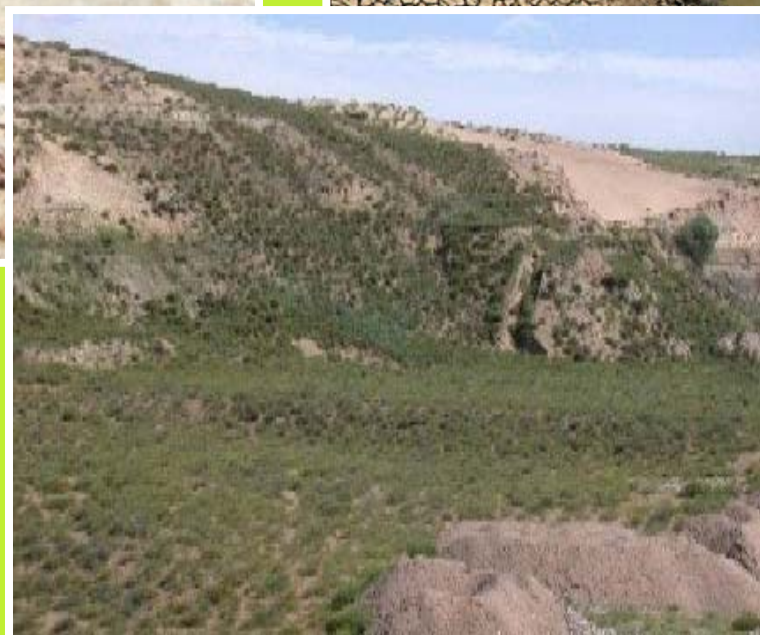
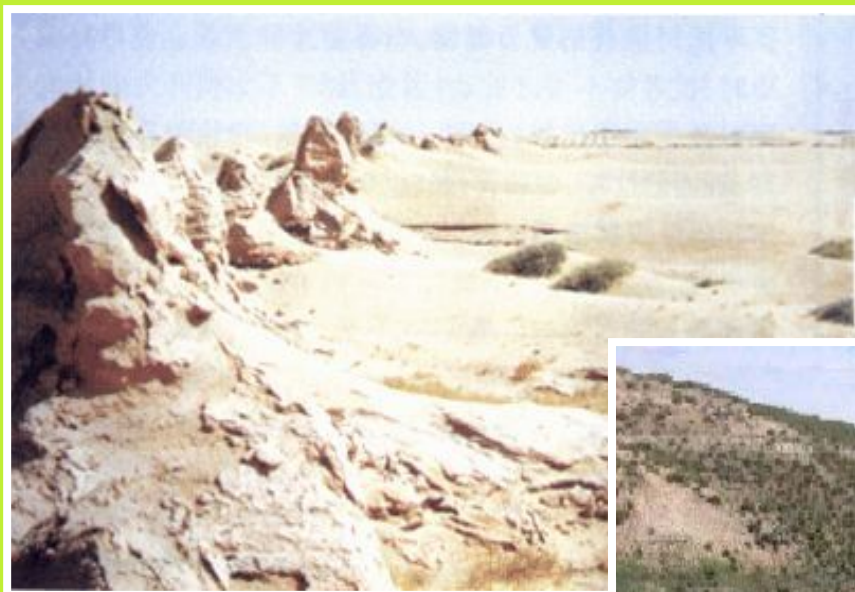


Change trend of cultivated land statistical data
from 1949-2004 in China

Chinese Ecological Agriculture



Land degradation



Chinese Ecological Agriculture



Drought monitoring at national level



<http://www.hudong.com/wiki/>

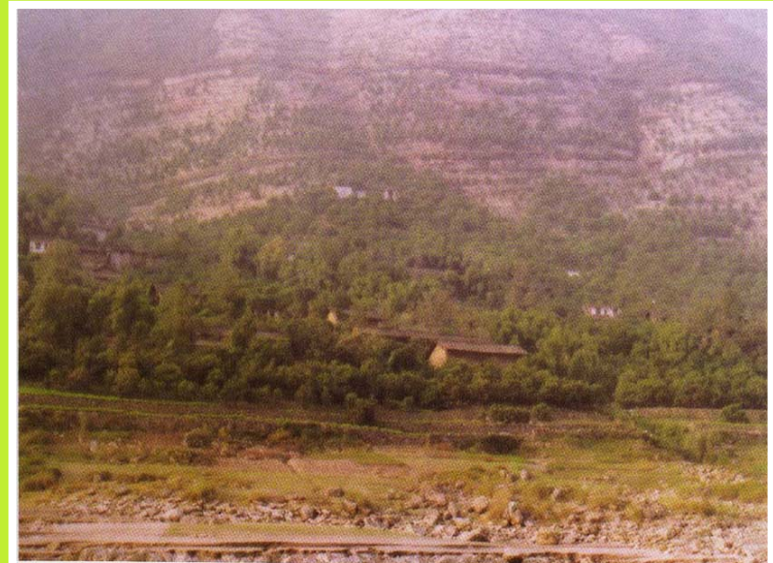
Types of soil degradation	Development speed (10 ³ ha/year)
Land occupation	150
Soil stripping	100
Soil erosion	300-400
Soil desertification	4,900
Grassland degradation	1,300

Chinese Ecological Agriculture



Soil erosion

66% of the territorial area of China. Particularly, in the mountainous and hilly area. The eroded area in China reaches 3.67 million km², being 38.2% of the territory. The soil loss volume amounts to 2.3 million ha of fertile surface soils annually (Yu et al., 1987; Zhou, 1999).



Chinese Ecological Agriculture



Soil erosion

resulted in land degradation and even natural disasters (1998 Yangtze River flood disaster).



Chinese Ecological Agriculture



Desertification

3.3 million km² of land are suffering from desertification in China, which occupies 35% of the total territory. More than 0.4 billion people live under the environmental conditions of desertification. Desertification is still expanding at a rate of 2460 km² annually from north to south, particularly in northwest China (Zhou, 1999).



Chinese Ecological Agriculture



Desertification approached to the village.
The village was abandoned.



Chinese Ecological Agriculture



Sand storms

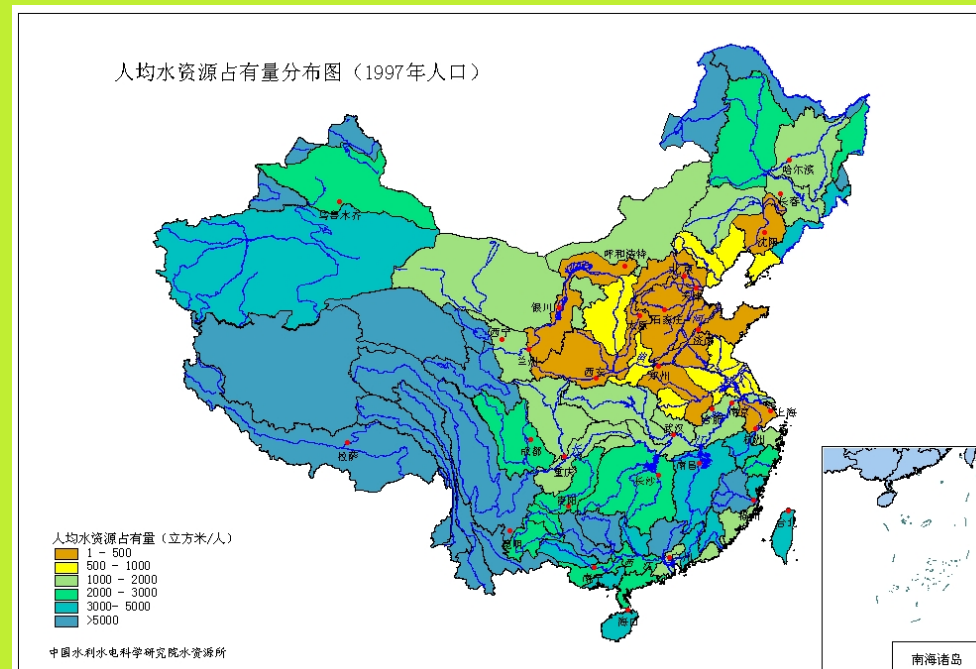


Chinese Ecological Agriculture



Water shortage and pollution

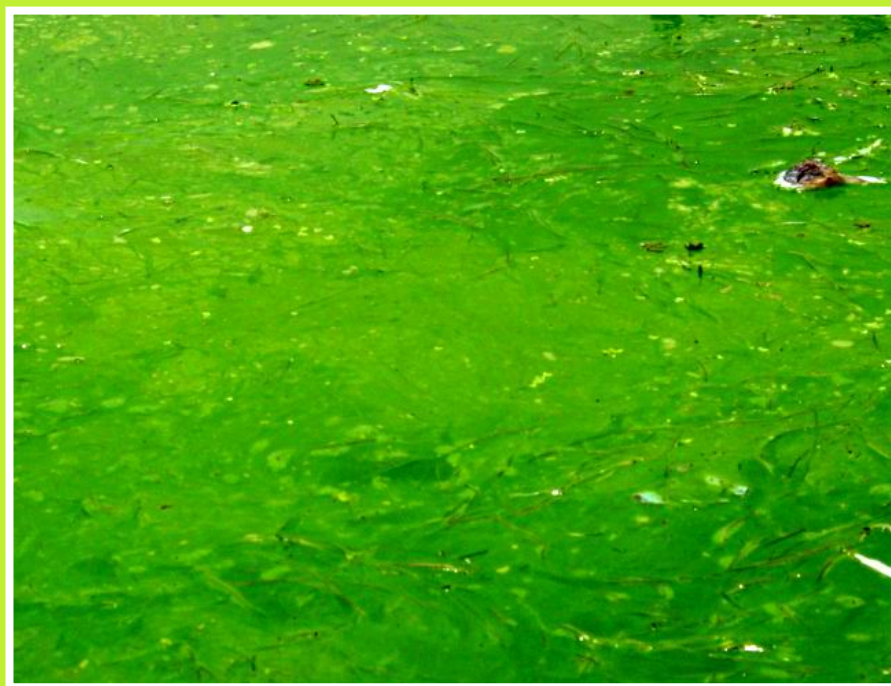
Annually, 2231m³ of water is available per capita in China, which is only 33% of the water resource per capita in the world (Zhang, 1999). The current total water consumption of the country is 450 billion m³ per year, of which 400 billion m³ is used for agriculture. Due to stress on water resources, the annual deficit of water for agriculture is as much as 30 billion m³.



Chinese Ecological Agriculture

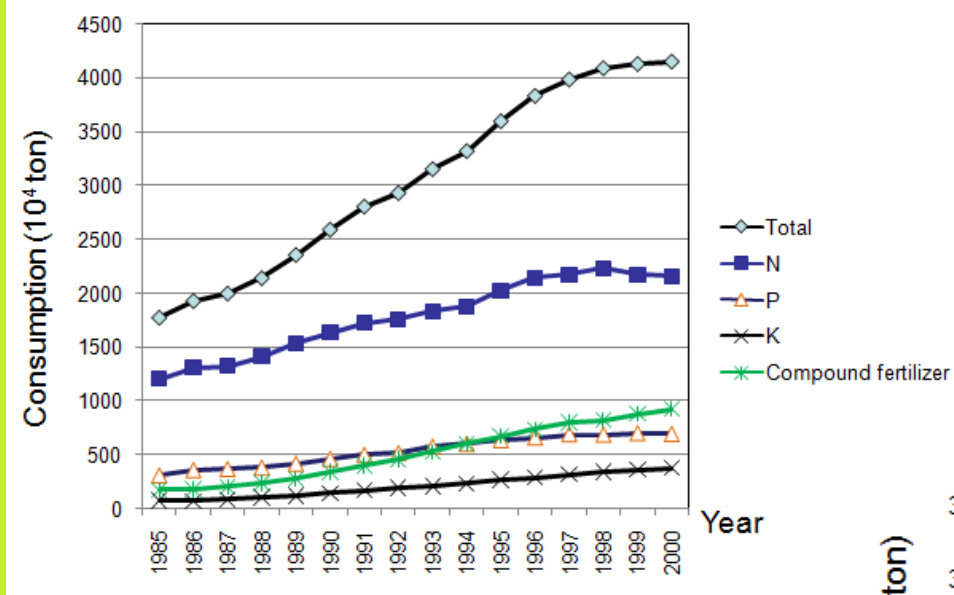


Water pollution

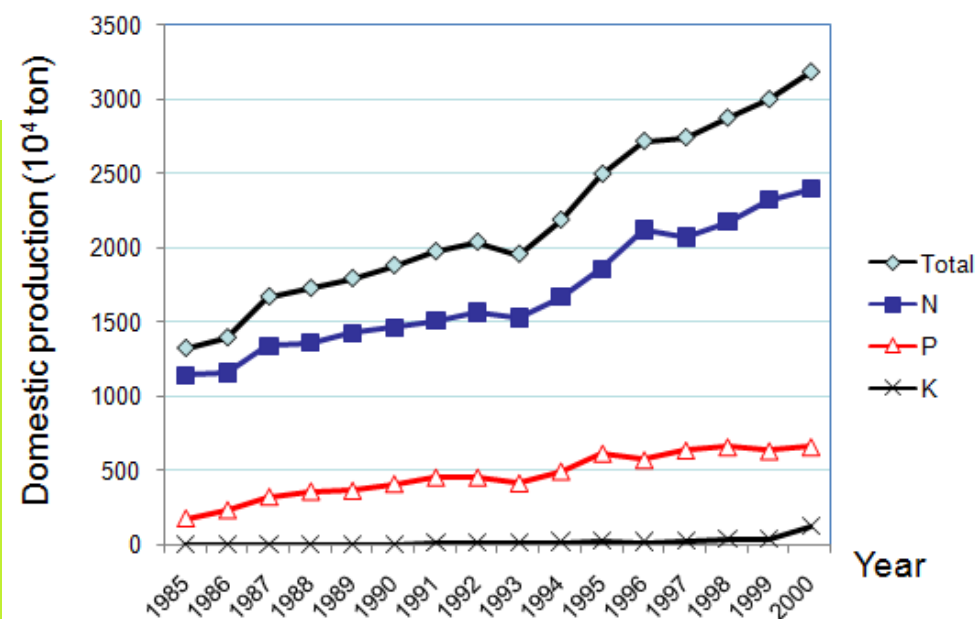


滇池(Dianchi)

Chinese Ecological Agriculture



Chemical fertilizers



Chinese Ecological Agriculture



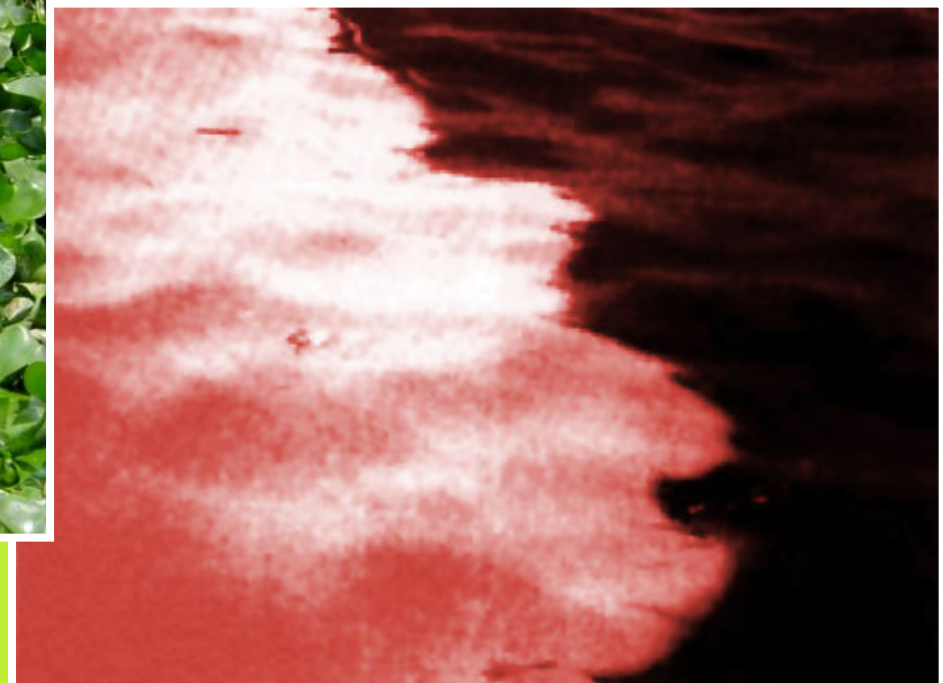
Chemical pollution

Eutrophication



Water hyacinth

Harmful Algal Blooms



Chinese Ecological Agriculture

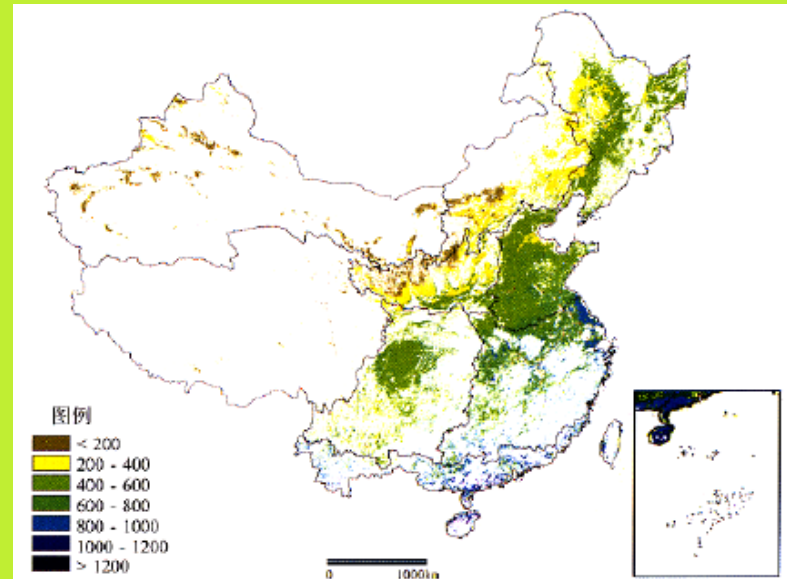


图 1 中国农田生产力分布格局 (单位: $\text{gCm}^{-2}\text{a}^{-1}$)
Fig. 1 Spatial Patterns of Chinese Agricultural Net Primary Productivity (unit: $\text{gCm}^{-2}\text{a}^{-1}$)

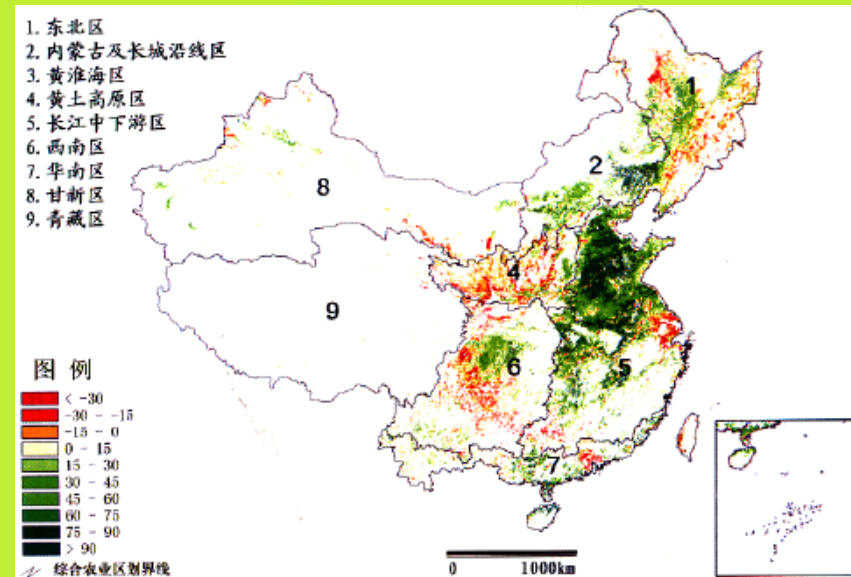


图 4 20 世纪 80 年代到 90 年代中国农田生产力变化空间格局 (单位: $\text{gCm}^{-2}\text{a}^{-1}$)
Fig. 4 Map of agricultural productivity variation in China from the 1980s to 1990s (unit: $\text{gCm}^{-2}\text{a}^{-1}$)

Agricultural
productivity
(Yan, et al., 2007)

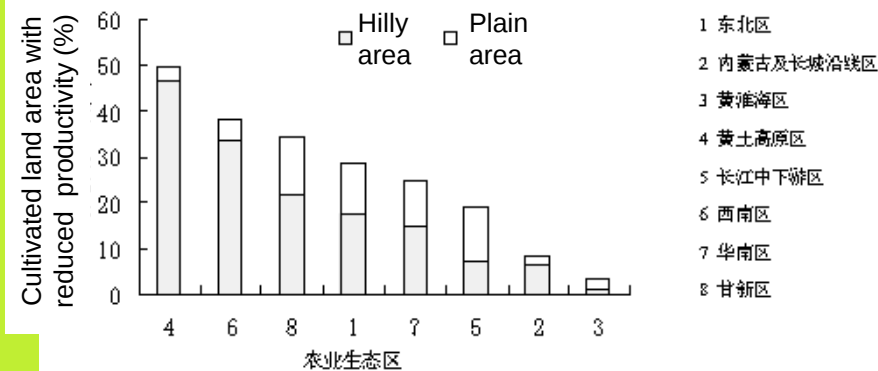


图 3 中国不同地形条件下各农业区农田生产力下降耕地面积比例
Fig. 3 Proportion of cropland area with decrease of NPP under different topographic conditions

55%: mountainous and hilly, accounts for 71% cultivated land area with reduced productivity..

15%: plain area productivity reduced, yet hilly area doubled.

Soil erosion.

Chinese Ecological Agriculture



The emergence and development of CEA in modern China

- In attempting to resolve the conflicts between ever-intensifying agricultural production and the resulting agro-environmental problems, in the 1980s a new mode of agricultural production and rural development, commonly referred to as CEA, emerged in rural areas.
- CEA ensures a sustainable development of agriculture with optimized ecological, economic and social benefits.
- CEA is characterized by adaptation to local conditions, recycling of resources, high efficiency, sustained development and improved environment.
- A large number of CEA projects with various development patterns and models that are suited to various natural and socioeconomic conditions have been developed and successfully replicated.

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).

Chinese Ecological Agriculture



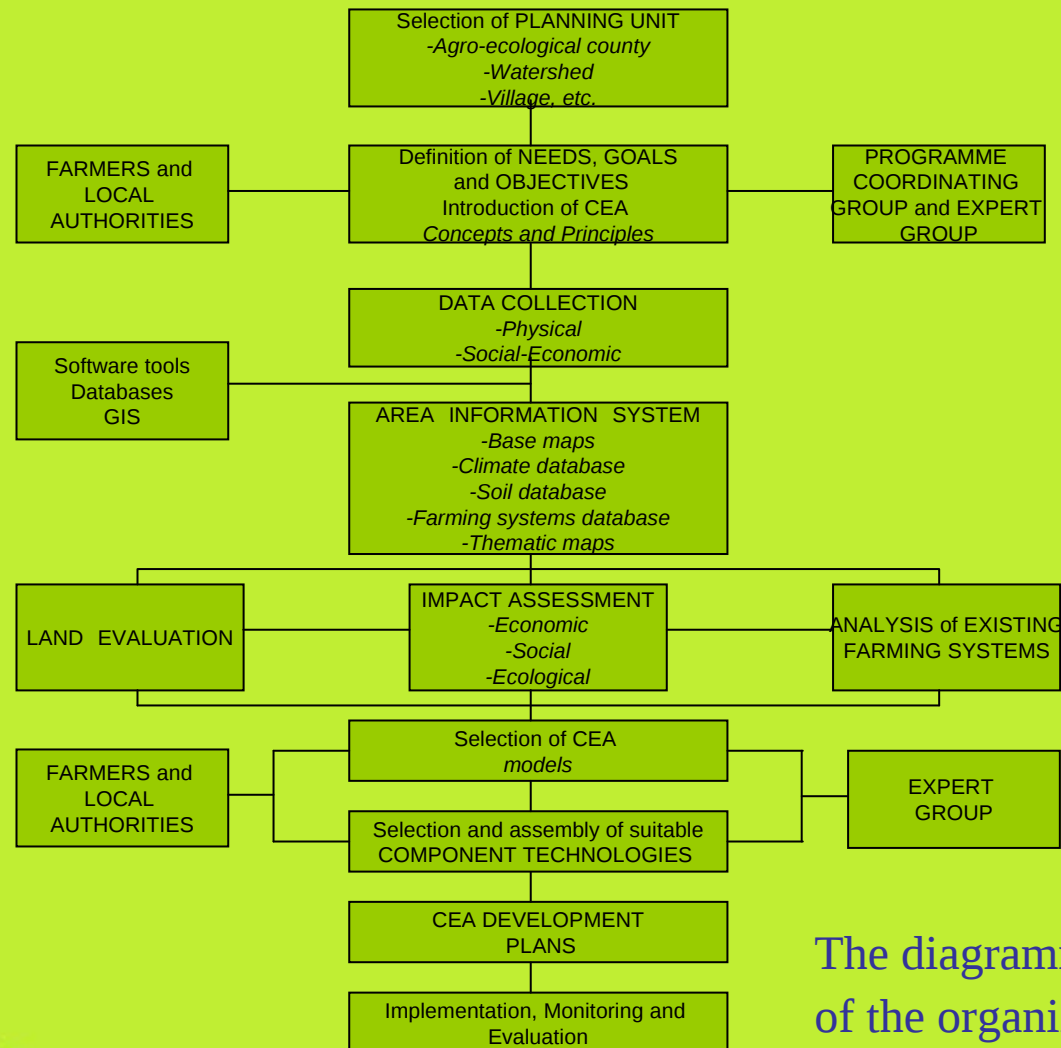
The underlying principles of CEA

- sustainability;
- holistic harmonization;
- system structural orderliness;
- rational energy transformation and material cycling;
- integrating resource utilization and economic development with environmental protection;
- integrating quantity, efficiency and advantages;
- integrating short-term interests with long-term interests;
- integration among the ecological, economic and social effects;
- regional differentiation and adapting measures to local conditions;
- development in accordance with different development stages.

Chinese Ecological Agriculture



The organization process of CEA



The diagrammatic presentation
of the organization process of CEA.

Chinese Ecological Agriculture



- While organizing CEA development projects, some practical principles need to be taken into consideration.

*Briefly, the essence of CEA ideology is to start initiatives with **systems thinking** and carry out activities without neglecting the **system's overall harmonization** so as to ensure the attainment of the overall benefits.*

Chinese Ecological Agriculture



Diversified CEA patterns

- Integration of sectors (enterprises or subsystems)
- Diversified planting and husbandry
- Time series pattern
- Vertical utilization
- Complementary benefits
- Symbiosis
- Agroforestry
- Ecotone utilization
- Food chains

Chinese Ecological Agriculture



Diversified CEA patterns

Integration of sectors (enterprises or subsystems)

This pattern refers to the system consisting of two or more sectors (enterprises or subsystems) that are integrated in terms of economic and/or ecological linkages. **Integration of crop and animal production**, in some cases, together with addition of the processing industry, is the most basic model.



Fruit-aquaculture system

Chinese Ecological Agriculture



Diversified CEA patterns

Integration of sectors



Forest-rubber-tea system



Forest-duck-fish system

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Diversified planting and husbandry

Diversified planting and husbandry is based on the integration between organisms and environment and the application of ecological niche theory.

A more complex biodiversity is beneficial to a system's ecological balance, and a multiplicity of agro-products helps reduce economic risks due to varying marketing prices of some agro-products.



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Time series pattern

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

Heritage from traditional Chinese farming techniques:

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



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Time series pattern



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Vertical utilization

Vertical utilization includes the comprehensive planning, management and 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.



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Vertical utilization



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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.



Rhizobium (nitrogen-fixing bacteria)

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

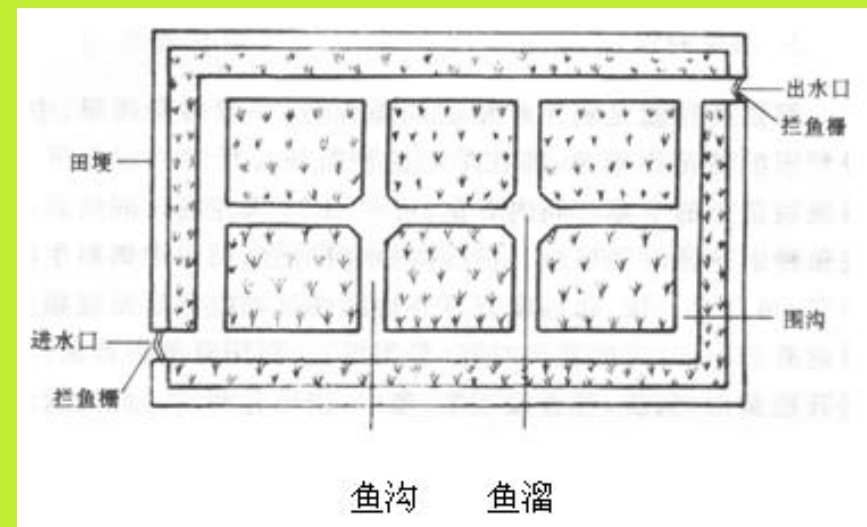
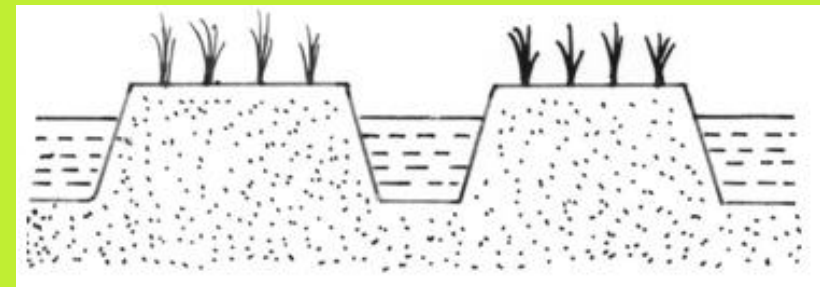
Chinese Ecological Agriculture



Symbiosis

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

Rice and fish system is an important model of symbiosis.



Chinese Ecological Agriculture



Agroforestry

In northern China, agroforestry systems mainly take the forms of crops planted between rows or within a network of tree windbreaks.



In southern China, a wide variety of woody plants such as arbors, fruit trees, mulberry trees, tea, and bamboo, are integrated with crops to produce diverse agroforestry systems with ecological and economic linkages.



Chinese Ecological Agriculture



Ecotone utilization

Ecotones are referred to the 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 to regulate the relationships of material exchange, transformation and complement at each trophic level within food chains could enhance the ecological efficiency and achieve a high economic efficiency in the marginal areas.

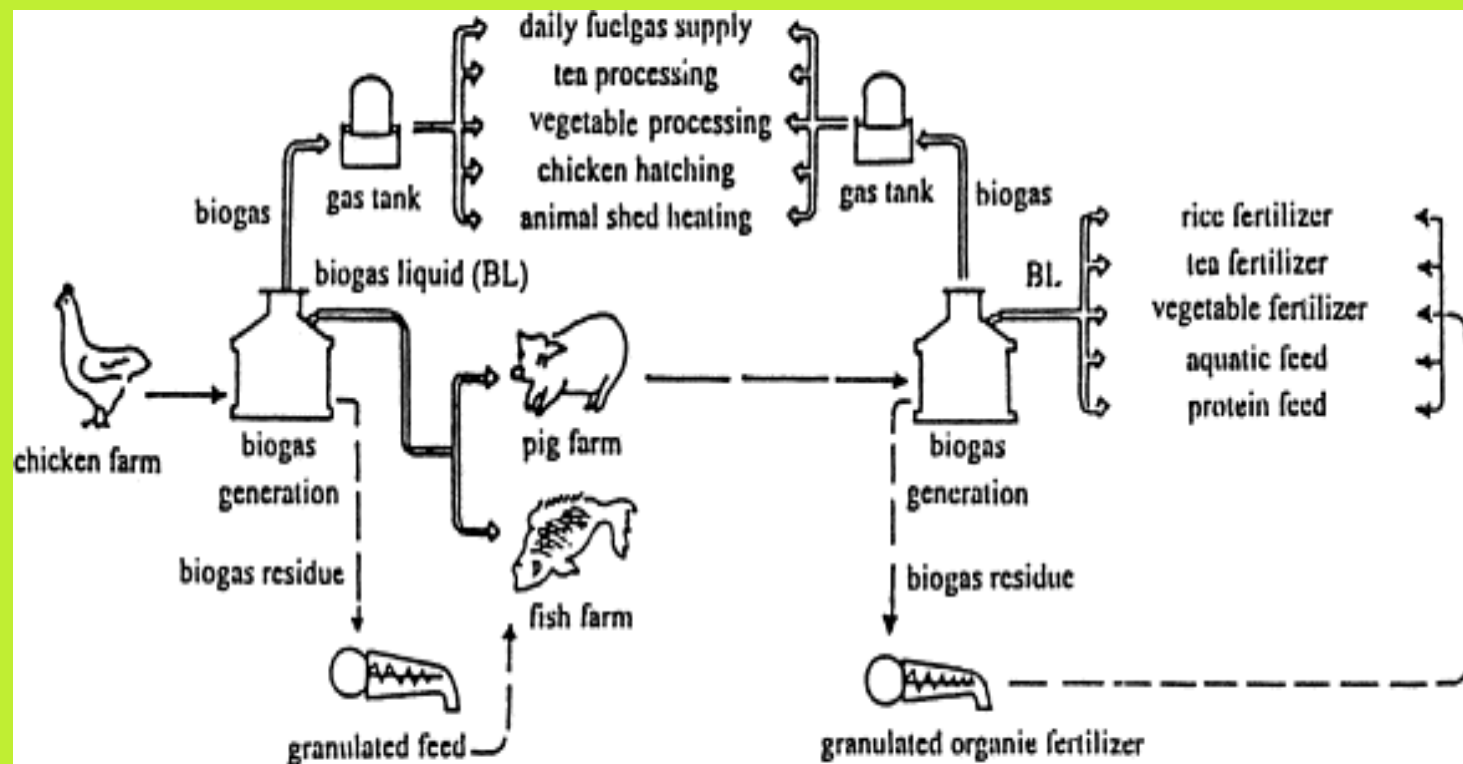


Chinese Ecological Agriculture



Food Chains

According to the food chain principle, populations of organisms at different trophic levels are organized into a food chain system to carry out production.



Fushan Integrated Ecological Farm

Chinese Ecological Agriculture



Food Chains



The biogas digesters in Fushan Integrated Ecological Farm

Chinese Ecological Agriculture



Food Chains



Biogas Digester
沼气池建造

Sustainable rural tourism - 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

Sustainable rural tourism - Ecotourism

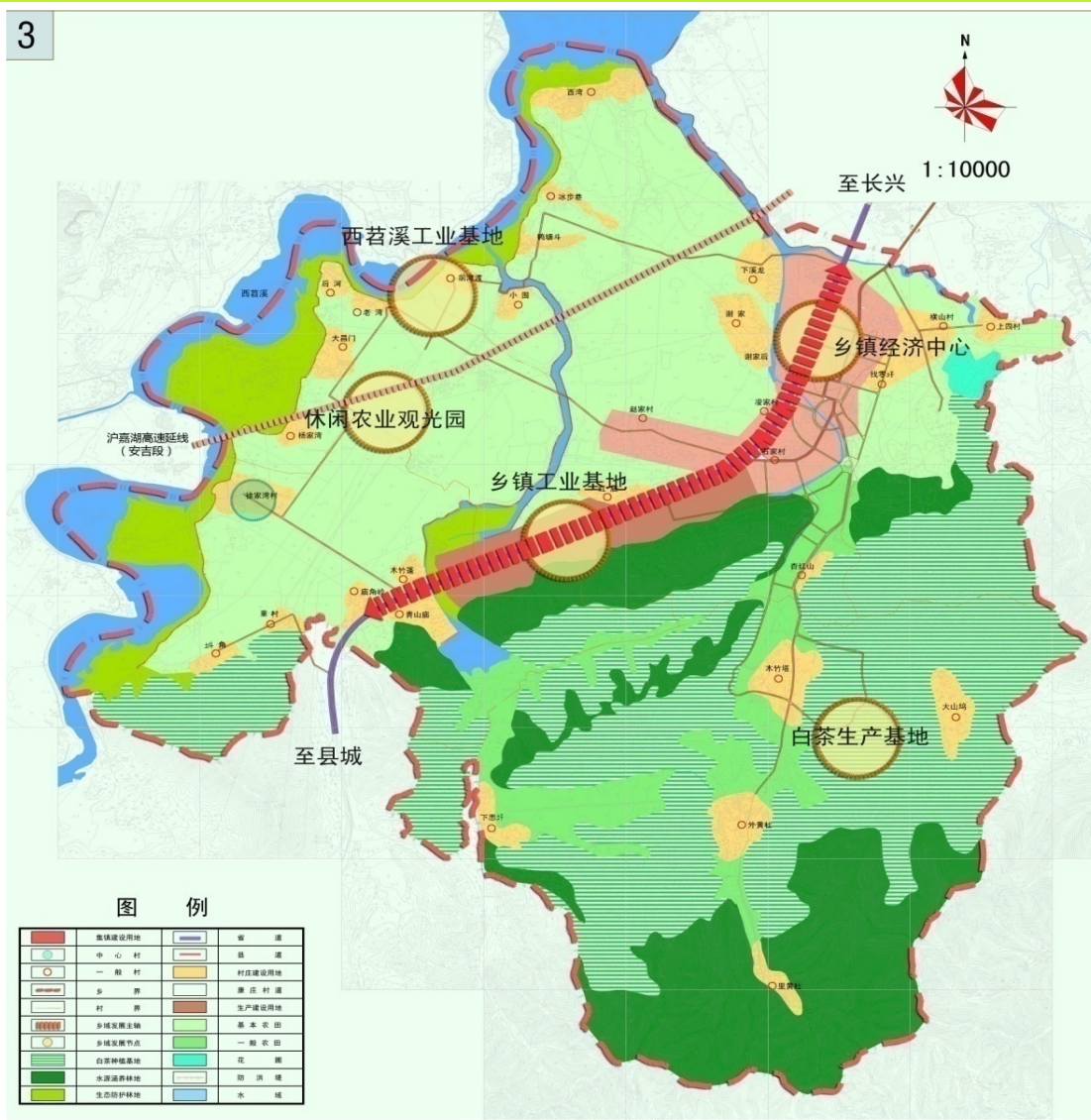


Baicaoyuan, Anji, Zhejiang

Sustainable rural tourism - Ecotourism



Sustainable rural tourism - Ecotourism



Sustainable rural tourism - Ecotourism



Huazhuang Ecological Park, Tongxiang, Zhejiang

Sustainable rural tourism - Ecotourism



Sustainable rural tourism - Ecotourism



Global 500 Roll of Honor (UNDP)

Tengtou Eco-village, Fenghua, Zhejiang

Sustainable rural tourism - Ecotourism



Daqiao Eco-farm, Cixi, Zhejiang

Sustainable rural tourism - Ecotourism



Sustainable rural tourism - Ecotourism



Chuanhua Dadi Hi-tech Green House, Hangzhou, Zhejiang

Sustainable rural tourism - Ecotourism



Sustainable rural tourism - Ecotourism



Sustainable rural tourism - Ecotourism



Sustainable rural tourism - Ecotourism



Sustainable rural tourism - Ecotourism



Sustainable rural tourism - Ecotourism



**Ecological
parks and
restaurants**



Sustainable rural tourism - Ecotourism





浙江桐廬 (Tonglu County, Zhejiang Province)



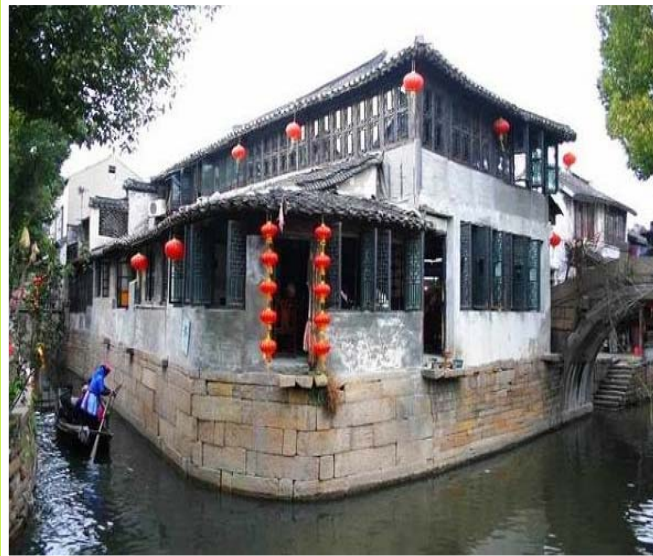
Sustainable rural tourism - Ecotourism



桐廬農家樂 (Nongjiale)
Tonglu, Zhejiang



Sustainable rural tourism - Ecotourism



**Agricultural
museum and
ancient tools**



Sustainable rural tourism - Ecotourism



Principles of sustainable tourism development

The sustainable tourism should:

- (1) make optimal use of **environmental resources** that constitute a key element in tourism development, maintaining essential ecological processes and helping to conserve natural heritage and biodiversity.
- (2) respect the **socio-cultural authenticity** of host communities, conserve their built and living **cultural heritage and traditional values**, contribute to inter-cultural understanding and tolerance.
- (3) ensure **viable, long-term economic operations**, providing socio-economic benefits to all stakeholders that are fairly distributed (*stable employment and income earning opportunities and social services to host communities*), and contributing to poverty alleviation.

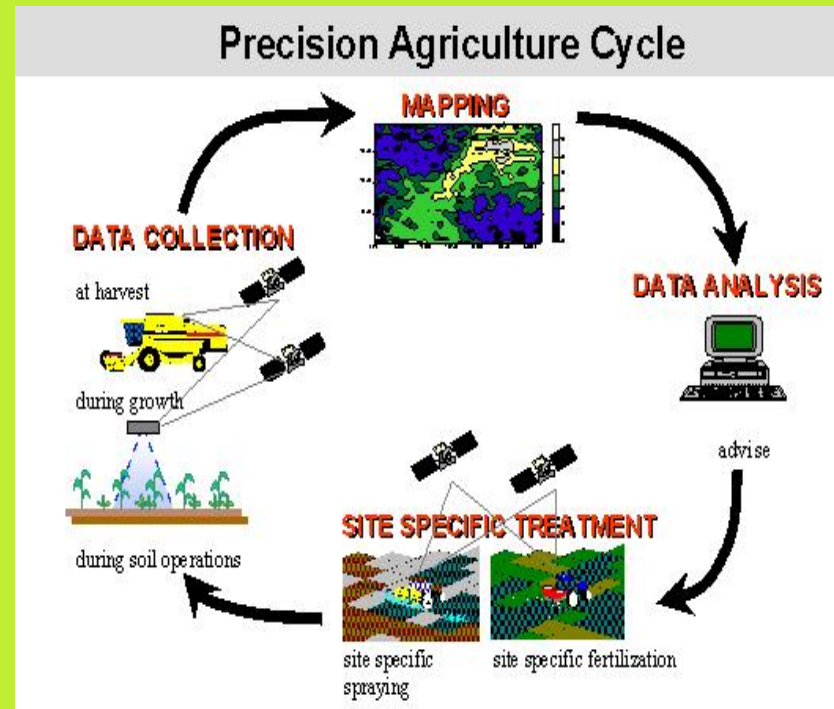
Precision Agriculture



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**.



Integration of technologies in site specific farming.



Precision Agriculture

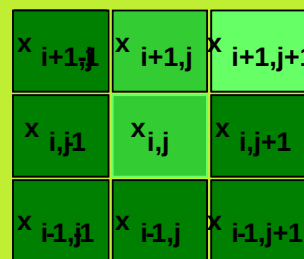


PA: Precision agriculture

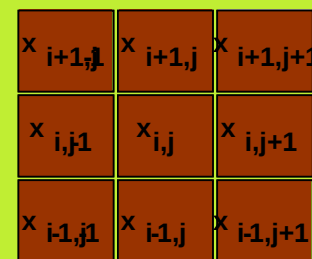
精细农业

VRT: Variable rate technology
变量作业

VRT



VRT



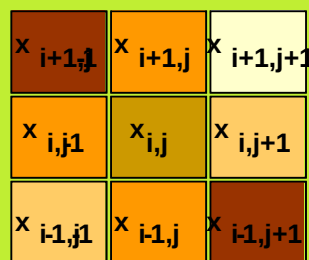
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j

生长

产量

i



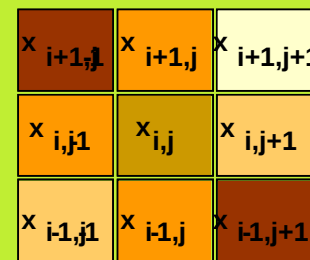
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土壤养分图
产量图

ERT



ERT



j

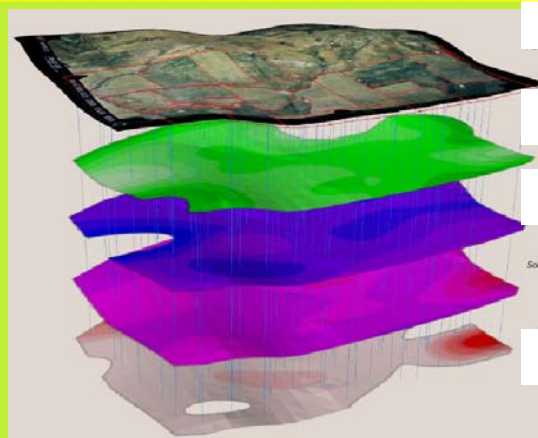
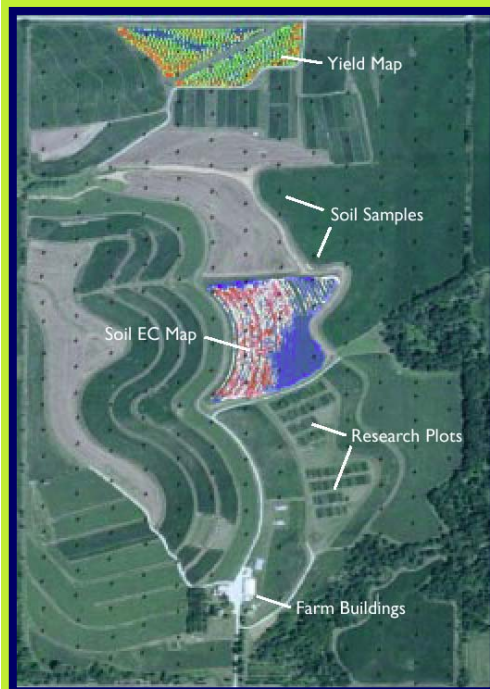
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ERT: Even rate technology
均一作业

CA: Conventional agriculture

常规农业

Precision Agriculture



Aerial Photo

Yield

Soil pH

Slope

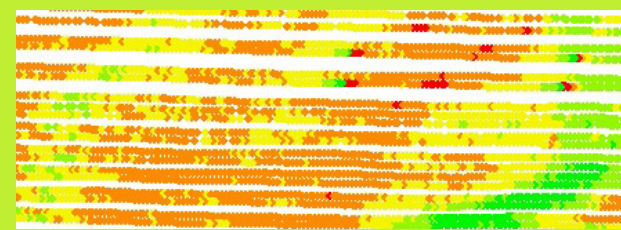


Aerial photo

Yield

Photo + Yield

Management zones





Future prospects of sustainable development in China



Three pillars for China's development

Sustainable Development

Economic growth (↑): $\geq$ World Average Wealth

Social development (↑): $\geq$ World Average HDI

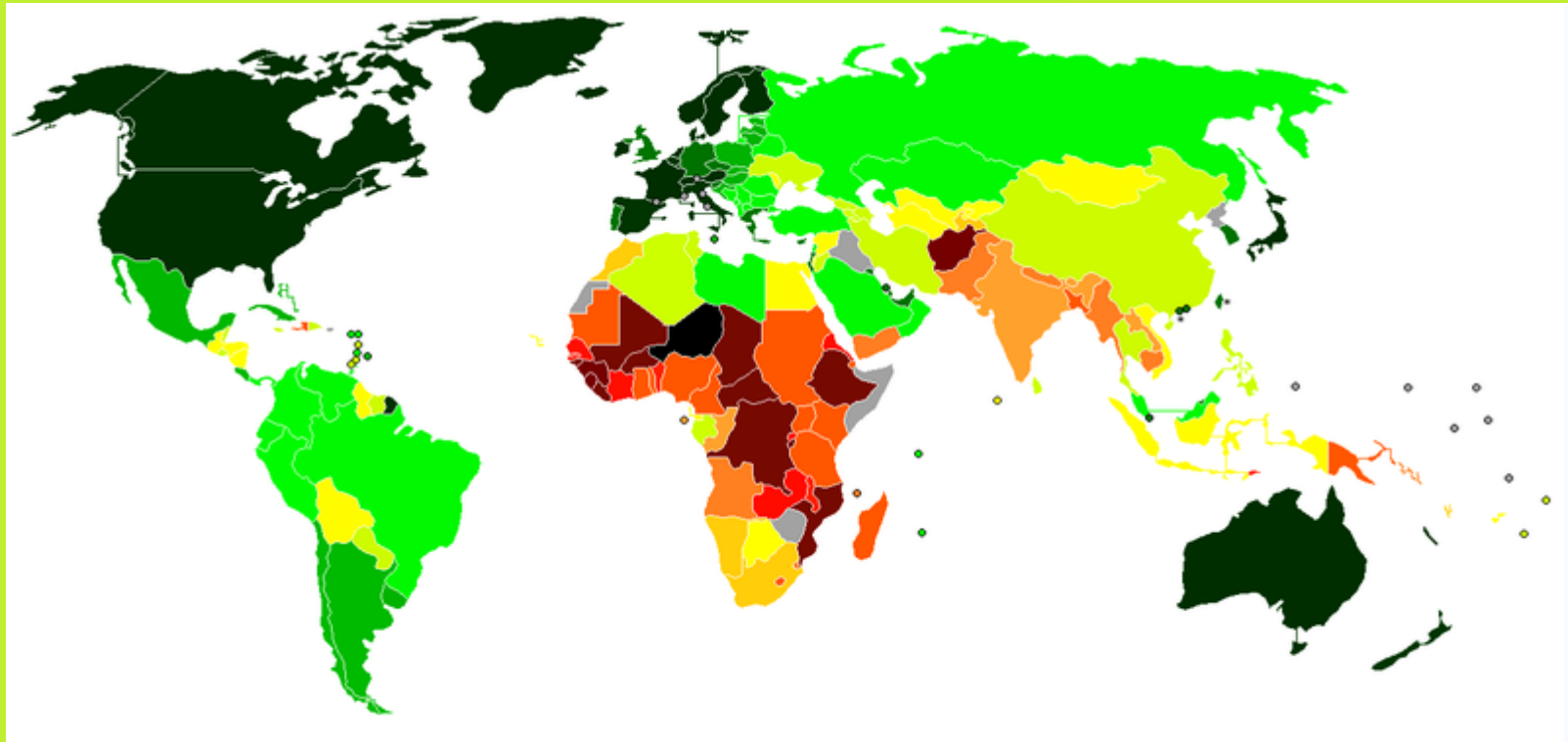
Environmental impact (↓): $\geq$ World Average Impact

China's development goals

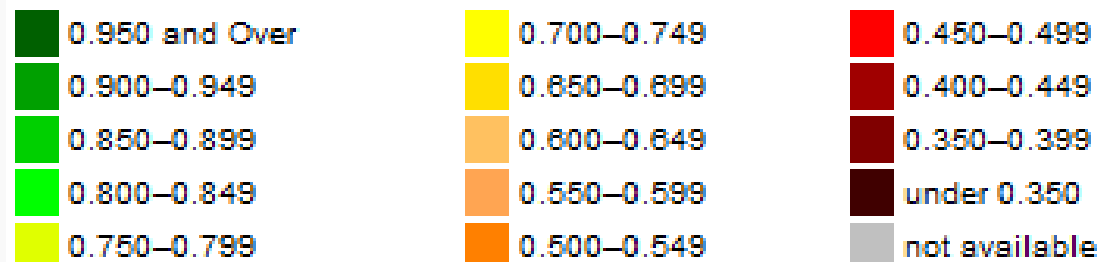


	China's developing phase	Economic growth	Social development	Environmental impact
General well-off	1978-2000	\$800 per capita	Human development index 0.7	Low resource consumption and Environmental Impact
Entire well-off	2001-2020	\$3000 per capita	Human development index 0.8	High increase of Environmental Impact
General modernization	2021-2050	\$10000 per capita	Human development index 0.9	Negative increase of Environmental Impact

World human development index

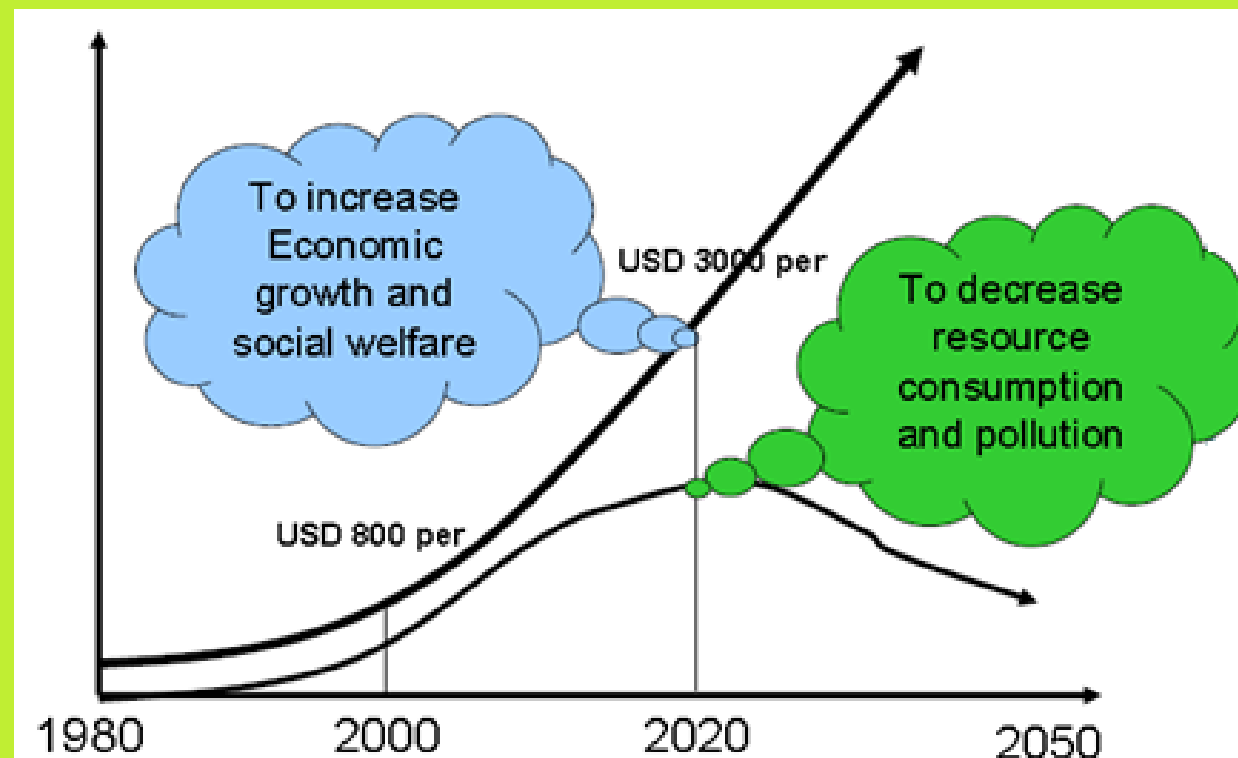


World map indicating the Human Development Index (based on 2007 data, published on October 5, 2009)



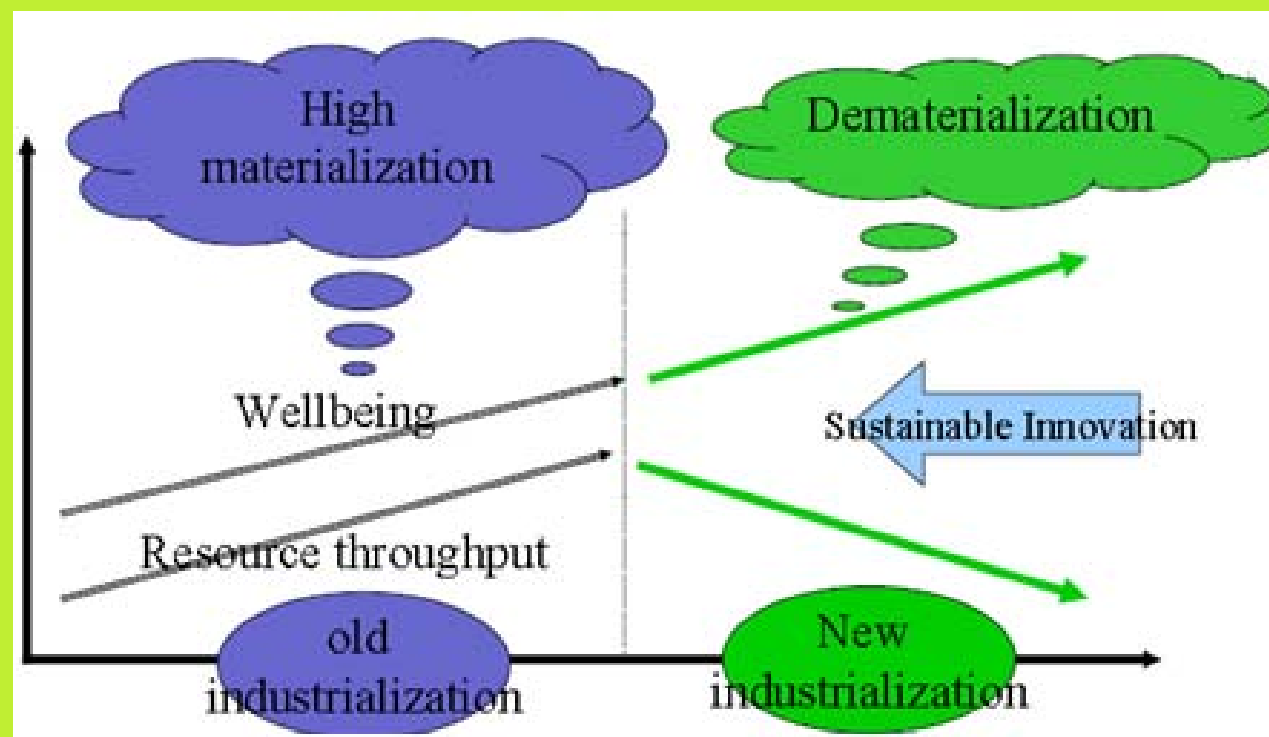


Let economic growth decouple from environmental impact





Change production methods from materialization to dematerialization



Building a new socialist countryside



- It aims to modernize the countryside, which has fallen behind in China's race to expand, and to help the 800 million people living in the countryside catch up economically with people in the cities.
- Measures: More rural investment and agricultural subsidies and improved social services.
- The government promises sustained increases in farmers' incomes, more industrial support for agriculture and faster development of public services.

Building
a new socialist countryside



Harmonious society



New countryside



Sustainable agriculture

Conclusions



- Review of the CEA development
- New trends in agriculture development
- Future prospects of sustainable development of China.

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Thanks for your attention!

ご清聴どうもありがとうございます!

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