



International Seminar on Restructuring and Strengthening
Research and Development of Agricultural Engineering

Restructuring R & D of Agricultural Engineering in China

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International Seminar on Restructuring and Strengthening Research and Development of Agricultural Engineering

Outlines

1

Introduction

2

**Review of Agricultural Engineering
R & D in China**

3

**The R & D System on Agricultural
Engineering**

4

**New Challenges and Opportunities for
Agricultural Engineering R & D in
2006-2010**

5

Conclusions





1. INTRODUCTION

Great Success of China's Agriculture in the Past Half of Century

- Population has increased from 450 million to 1.3 billion
- Arable farmland per capita has decreased from 0.18 ha. to less than 0.1 ha.
- To feed the 21% of the world's population with only 7% of the world's arable farmland





Achieve Self-sufficiency in most Products

- **China is a major producer of grain, cotton, oil plants, fruits, meat, eggs, aquatic products and vegetables in the world.**
- **In 2005, grain output per capita was 371 kg.**
- **The per capita figures for meat (pork, beef, and mutton), milk, egg and aquatic products were above the world average, reaching 59.2 kg, 21.9 kg, 22 kg and 39 kg in 2005, respectively.**



Figures of China's Rural and Agricultural Development

Fig1-A Total Population

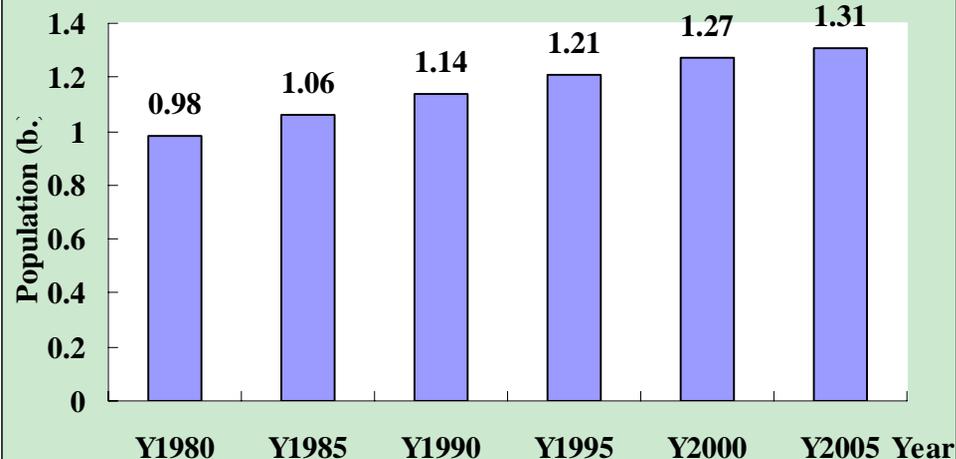


Fig1-B Contribution of agricultural output value to GDP(%)

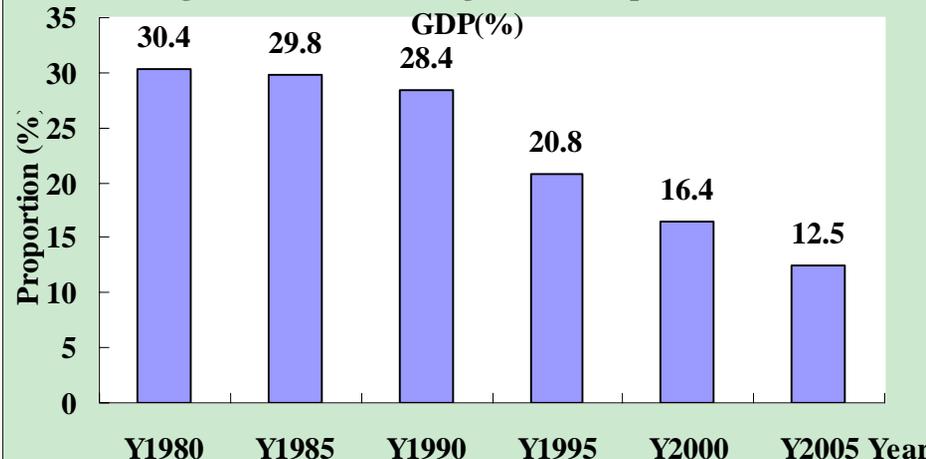


Fig1-C Sown areas to grain crops (million hectares)

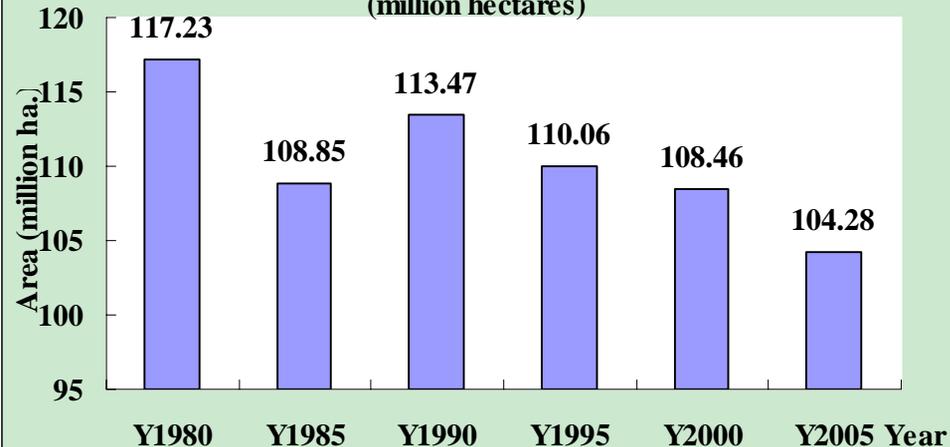


Fig1-D Total grain output (million ton)





Figures of China's Rural and Agricultural Development

Fig1-E Annual per capita amount of grain (kg/capita)

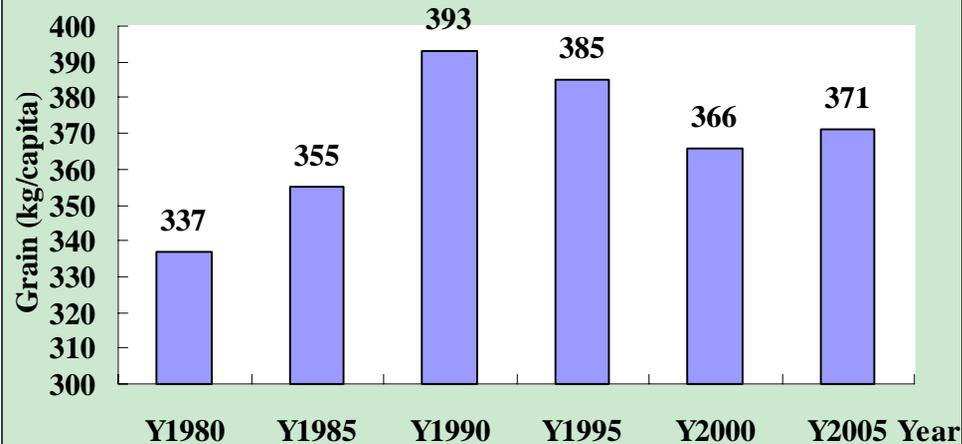


Fig1-F Irrigated areas (million hectares)

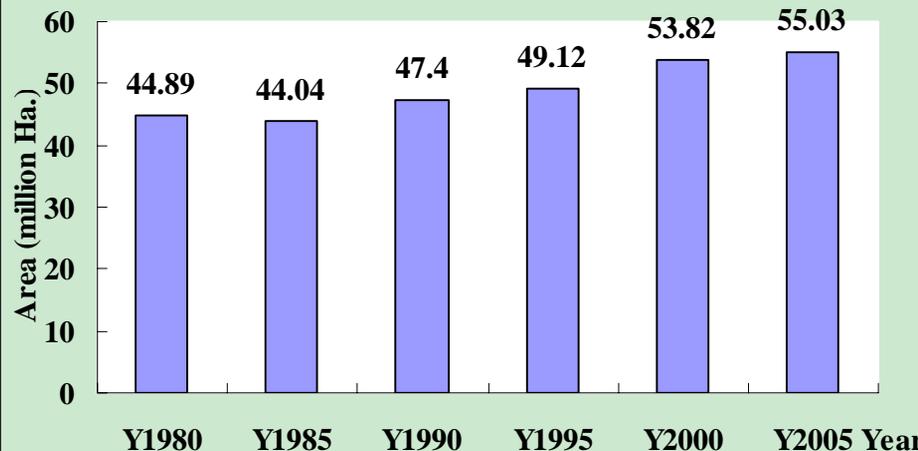


Fig1-G Rural electricity consumed (million kW)

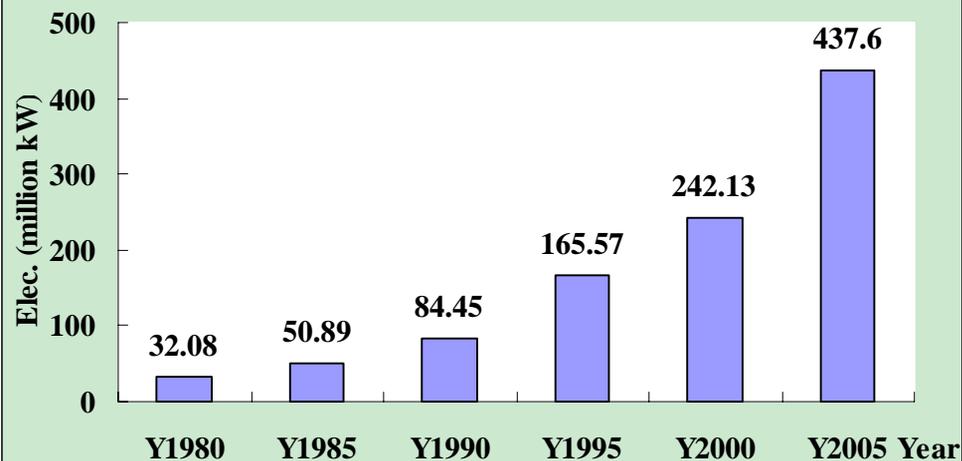


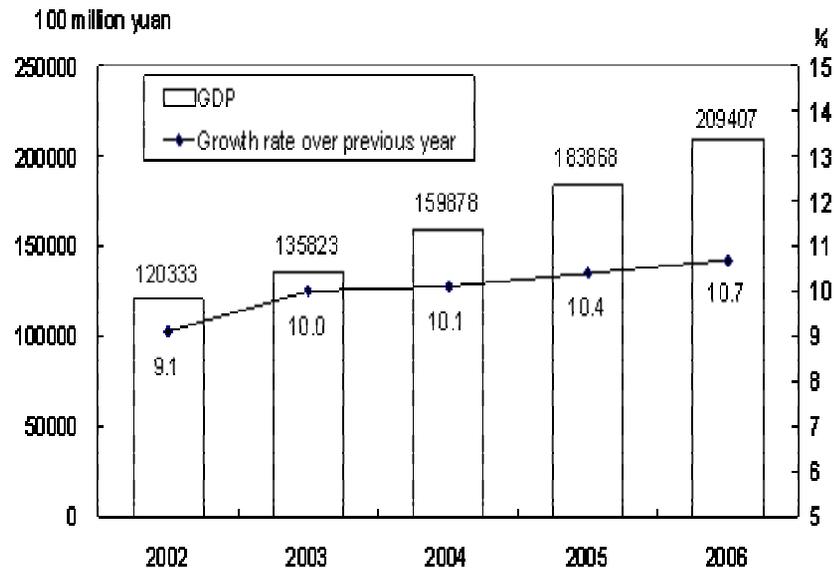
Fig1-H Total farm power (million kW)





THE NATIONAL ECONOMY HAS BEEN ADVANCED CONTINUOUSLY IN THE PAST 28 YEARS

- The annual average GDP increase in the past 28 years was over 9 %
- Per capita GDP (USD): 1978- 224; 2005 – 1702; 2006- 2050
- In recent 4 years *GDP had double-digit growth rates*



CHINA TARGETS TO REALIZE NATIONAL BASIC INDUSTRIALIZATION AND PRELIMINARY ECONOMIC MODERNIZATION BY 2020



Major Measures of the Reform in the 1980's

- 1) The household contract / responsibility system, which restored farmers the right to use land, arrange farm work, and keep their output after meeting the quota;**
- 2) Lift of the monopoly on agricultural products and price control over most agricultural and ancillary products by the central government,; and**
- 3) Abolishing many restrictive policies and allowing farmers to develop diversified businesses and set up township enterprises to encourage production.**



Driven Forces for the rural Development

Township Enterprises

- **Developed Since the Early 1980s**
- **2005:**
 - **22.5 million township enterprises with 142.72 million employees generated output value of 5053.4 billion RMB**
 - **The added-value output was 20.9 percent increase than previous year.**
 - **Created job opportunities for about 30 percent of the rural laborers**



Industrialized Management of Agriculture

- Agro-Industrialized management for agriculture has been fast developed to lead individual farmers to meet the needs of marketing requirement
- In 2004, about 82 million USD has collected to invest the 35 agro-industrial enterprises development programs.

The ratio of investors are:

Central gov. / local gov. / private enterprises and farmers:

4.4 % : 7.4 % : 88.2 %





The Recent Agricultural Research & Development System in China

Agric. research institutions: 1,541

researchers and staff: 130,000

Agric. universities and colleges : 50

faculty members: 17,000





The Reform of Agricultural R & D System (Including AE R&D)

The reform in the past 20 years has proceeded in 3 stages:

- Decentralization (1986-1992);
- Readjustment Period (1992-2000); and
- Classification of R&D institutes (2000-2006)





The Reform of Agricultural R & D System (Including AE R & D)

The emphasis of the recent reform is on:

- Strengthening support to R&D institutes for public welfare
- Encouraging the transformation of applied research institutes to enterprises,
- Enhancing academic discipline development and research platform construction
- Improvement of internal management.





The Reform of Agricultural R & D System **(Including AE R & D)**

The national programs play significant roles in raising public awareness of sci-tech knowledge and disseminating advanced sci-tech achievements to the countryside

- **the Spark Program,**
- **the Promotion of Achievements Extension Plan**
 - **the Bumper Harvest Plan**
 - **the Prairie Fire Program**





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2. Review of Agricultural Engineering R & D in China





2. Review of Agricultural Engineering R & D in China

■ 1949--2005:

- machinery power: nearly zero to 684 million kw
- rural electricity: 438 billion kwh
- Reclaimed arable lands: > 20 million hectare
- irrigated farming areas: increased by a third
- Reservoirs: 80,000 with water storage capacity:
480 billion m³.





2. Review of Agricultural Engineering R & D in China

■ Four Stages of AE R & D Development:

- 1950–1980
- 1981–1994
- 1995–2003
- Since 2004





■ **1950-1980: Preliminary Stage of AE Development**

- **Farming machinery and equipments as well as operation technology were imported or supported by the former Soviet Union.**
- **The infrastructure and technology development were under strict control of the state's planned economy system**
- **The state promoted the farm machinery production and industry development,**



The Main Fields of Engineering Services for Agriculture:

- **Agricultural mechanization,**
- **Rural electrification,**
- **Field water conservancy**
- **Others**



- **Key aspects of agricultural mechanization technology**
 - **New and improved farm tools application and small engines or electrically powered irrigation equipment developed;**
 - **State-owned farms and specialized colleges and professional training schools established;**
 - **State-owned tractor stations to provide mechanized tillage services;**
 - **Establishment of an agricultural machinery industry**
 - **Agricultural mechanization institute and departments set up.**





- 1959, “*The Future of Agriculture Lies in Mechanization*” - Mao Zedong
- 1966, “*Basically complete national agricultural mechanization by 1980*”. The government heavily invested and provided subsidies and preferential loans to pursue the goal
- By the end of 1980: **low-level mechanization.** mechanization level of tillage reached 42.4 % in 1980.

Goal didn't achieved



■ **1981-1994: Economic Reform Stage**

- **1978:** the people's community system abolished and introduced the farmland household contract responsibility system
- **Early 1980's:** rural industries and village and township enterprises
- **1985:** exclusive state purchasing of farm produce abolished
- sustainable development
of Opening Policy





■ 1981-1994

- The selective farm mechanization development
- Farmers gradually become major investors and owners
- Contract responsibility for collectively owned agricultural machinery
- Combination of planned and marketing-oriented operational system
- Expand to forestry, livestock farming, subsidiary processing, fishery and rural transportation
- Focus on developing small-scale mechanization



■ 1995-2003: Market-oriented Stage

- No longer subsidized diesel for farm uses
- Abolished all preferential policies to support agricultural mechanization
- Increase competitiveness of products by improving quality and lowering the cost
- Set distribution networks and improve after-sale services
- R&D should meet the needs of farmers and transfer scientific research results to farming practices





- agricultural machinery and cost efficient mechanization technologies for key areas, important farming periods, main crops.
- three major areas: Crop harvesting, paddy field mechanization, and arid farming technologies
- The administrative management functions of government organizations were replaced by macroeconomic guidelines, and policies and regulations were formulated to promote agricultural mechanization.
- agricultural engineering R&D has extended to horticultural engineering facility, intensive livestock and aquatic production, value-added agro-product processing, etc
- More attention has been paid to ecological and environment-friendly technologies



Since 2004

- To balance urban and rural development : problems of agriculture, rural areas and farmers has **become a top priority** of the National Social & Economic Development Program
- Measures (2004) :
 - Reducing farmers' burden: US \$36 billion
 - Subsidy policies: US \$18 billion for grain production, seeds and farm machinery





■ **State and local governments have greatly enhanced financial subsidies for farmers to buy machinery:**

★ **Subsidies for buying farm machinery:**

(Central Gov. / Local Gov. / farmers' input)

2004: 8.4 mil. / 49.4 mil. / 360 mil (1 : 5.9 : 43)

2005: 36 mil. / 96 mil. / 1.8 bil. (1 : 2.7 : 50)

2006: 75 mil. / 126 mil. / 6.3 bil. (1 : 1.7 : 84)

2007: 150 mil.

★ **Completely rescinded the agricultural tax of 126.5 billion RMB throughout the country from 2006. Exemption of fee to passing through the public road for trans-regional harvesting and rice planting machinery services.**

★ **Some other subsidies policies to promote agricultural mechanization are coming**

THE NEW STAGE TO PROMOTE AGRICULTURAL MECHANIZATION

A STATE LAW ON *"PROMOTION OF AGRICULTURAL MECHANIZATION"* was effective as of 1st Nov,2004

■ **The State Law** targets to promote development of agricultural mechanization and provide an aid to support producers and rural service organizations with advanced and appropriate machinery.

“鼓励、扶持农民和农业生产经营组织使用先进适用的农业机械，促进农业机械化，建设现代农业”²⁸

- **The State Law** requires that all government bodies above county level should add **the promotion of agricultural mechanization** into the national and social development plans and smooth an **increase of financial support** to promote AM development.

“县级以上人民政府应当把推进农业机械化纳入国民经济和社会发展规划，采取财政支持和实施国家规定的税收优惠政策以及金融扶持等措施，逐步提高对农业机械化的资金投入，...，按照因地制宜、经济有效、保障安全、保护环境的原则，促进农业机械化的发展”。



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3 The R & D System on Agricultural Engineering





3.1 The Development of AE Discipline

- **1932:** “Farming Tools and Agronomy” and “Machine and Power” provided by Mr. C. H. Riggs in Jinling University —A Milestone of China’s Agricultural Engineering Development
- **1948-1949:** Departments of Agricultural Engineering were set up at the Central University & Jinling University
- **1952:** Both the Departments were Renamed as Departments of Agricultural Mechanization.



■ Chairman Maozedong (Later 1950s):

“The Fundamental Way Out for Agriculture Lies in Mechanization”

“Irrigation is the Lifeblood of Agriculture “

■ Soviet Union experiences:

- **Agricultural Mechanization,**
- **Field Water Conservancy**
- **Rural Electrification**

Established in Agricultural Universities



■ 1978:

- **Fang Yi (Vice-Premier of the State Council): put stress on research and application of agricultural engineering technology at the national scientific congress**
- **Draft for developing agricultural engineering was proposed at a symposium in Beijing.**
- **An Agricultural Engineering Discipline Group under the State Science and Technology Commission (SSTC), current Ministry of Science and Technology was set up to supervise Agricultural Engineering Science and Technology Development.**



The Development of AE Discipline

■ 1979:

- The Chinese Society of Agricultural Engineering (CSAE)
- The Chinese Academy of Agricultural Engineering (CAAE)

■ Rename (1985) :

- Beijing Institute of Agricultural Mechanization-- Beijing Agricultural Engineering University (BAEU)
- Agricultural Mechanization Departments ---Agricultural Engineering Departments

Agricultural Engineering R&D Started a New Development Phase



The Development of AE Discipline

- **1980:** State Academic Degree (PhD and master) for agricultural engineering academic fields(Under the engineering category):
 - (1) Agricultural Mechanization
 - (2) Power & Machinery
 - (3) Soil & Water Engineering
 - (4) Agricultural Electrification & Automation
 - (5) Agro-product Processing Engineering
 - (6) Rural Energy Exploitation & Utilization
 - (7) Bio-Environmental Engineering, and
 - (8)Agricultural System & Management Engineering.



3.1 The Development of AE Discipline

- **1997 – AE discipline structure was further improved into:**
 - (1) **Agricultural Mechanization Engineering,**
 - (2) **Agricultural Soil & Water Engineering,**
 - (3) **Agro-biological Environmental & Energy Engineering,**
 - (4) **Agricultural Electrification and Automation**



3.1 The Development of AE Discipline

- **Agricultural Engineering Education Systems:**
 - specialized middle schools,
 - technical colleges,
 - undergraduate and graduate courses.

- **Universities and the R&D Institutes Grand Degrees:**
 - undergraduate level: 70
 - master degrees: 38
 - PhD degrees: 11



3.1 The Development of AE Discipline

- **Agricultural R&D Laboratories:**
 - **National level: one key laboratory and five national engineering research centers**
 - **Ministry level:**
 - **The Ministry of Education: 3 key laboratories and 1 engineering research center**
 - **The Ministry of Agriculture: 6 key laboratories and 3 research centers**
 - **A number key provincial level laboratories and research centers**



3.1 The Development of AE Discipline

- **The main fundamental and applied research in the following areas:**
 - **Agricultural Mechanization Engineering**
 - **Agricultural Soil & Water Engineering**
 - **Agricultural Bio-environmental Engineering**
 - **Rural Energy Engineering**
 - **Agricultural Electrification and Automation**
 - **Engineering of Post-harvesting Processing**
 - **Land Utilization Engineering**



3.2 AE R&D Development

- **The Agricultural Engineering R & D System**
 - **research institutes,**
 - **agricultural engineering schools in universities,**
 - **technology extension service**
 - **R&D divisions of manufacturing enterprises.**



3.2 AE R&D Development

- **The Advancement of AE**
 - **Agricultural Mechanization(1995-2000):**
 - **paddy rice seedling nursery technology in greenhouses and rice planting machinery**
 - **high-performance rice combine harvesters**
 - **rice dryers**
 - **nursery and planting machinery for inter-tilled crops**
 - **tillage machinery.**



3.2 AE R&D Development

- **Agricultural Mechanization(2001-2005):**
 - the national key R&D project investment:280 million RMB, a 5.6-fold increase over that between 1996 and 2000
 - The "bottle neck" technologies of high-performance rice combine harvesters and transplanting machinery had made breakthroughs and were applied in production.
 - Corn harvesting machinery considered to be matured,
 - potato planting, fertilizing machinery and combine harvesters were introduced in main growing areas
 - R&D on rapeseed and sugarcane harvesting technology and forage seed harvesting and processing equipment were also promoted



3.2 AE R&D Development

■ Facility Horticulture Industry

- **Planting areas: over 2.5 million hm²**
- **Total annual vegetable output: over 100 million tons and the per capita vegetable possession reached more than 70 kg per year**
- **R&D for facility horticulture is one of the priorities for agricultural engineering R&D in the new millennium.**





3.2 AE R&D Development

Achievement also in:

- **Intensive Livestock and Aquatic Farming**
- **Post-harvesting processing**
- **Rural renewable energy and biomass utilization**





3.3 Lessons and Problem Analysis

■ New problems

- Lack of understanding on the function and features of most agricultural science and technology research as public welfare good
- national S&T fund allocation is insufficient
- Resources to agricultural should be more reasonable
- Necessary incentives are needed to encourage
- The initiatives of researchers





3.3 Lessons and Problem Analysis

- **New Challenges:**
 - **Facility horticulture**
 - **Intensive Livestock Farming**
 - **Utilization of Biomass**





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4. New Challenges and Opportunities for Agricultural Engineering R&D (2006-----2010)





4. 1 New Trend in Developing Modern Agriculture

- **Basic industrialization and preliminary modernization by 2020 ,Additional rural labor force will transfer in increasing speed into urban and township industries.**
 - By the end of 2005, 57.6 % of the labor force in secondary industry came from rural areas and about 52% of the labor force in tertiary industry was former farmers.
 - agricultural labor less than 30 % by 2020.
 - the seasonal shortage of labor force in agriculture turned into a constant shortage and a great challenge is faced for sustainable agricultural production.



4.1 New Trend in Developing Modern Agriculture

- **Challenge of primary resources shortage and sustained population**
- **Quality and safety of agro-products. Green foods and product traceability has emerged as official requirements.**
- **Increasing competition in the global market. After entering WTO**
- **Urgent to reconstruct the conventional increase mode of agricultural production with modern concepts and technologies**



4.1 New Trend in Developing Modern Agriculture

- **Urgent to reconstruct the conventional increase mode of agricultural production with modern concepts and technologies**
- ***“Industry is to support agriculture and cities are to support the countryside.”***
- ***“Developing Modern Agriculture and Firmly Promoting of a New Countryside”***



4.2 Priorities of Agricultural Engineering R&D in the Next Five Year

■ R&D for Accelerating Agric. Mechanization

- main grain crops production mechanization;
- harvesting technology and new equipment for cotton, reap seed, sugarcane, peanut, crude drugs, forage, glass crops;
- healthy animal raising mechanization
- value-added product processing
- resource conservation and environment friendly equipment;
- recycling biomass and energy
- fertilizer and chemical-saving new machinery development;
- conservation tillage and machinery
- waste treatment equipment



4.2 Priorities of Agricultural Engineering R&D in the Next Five Year

- **Developing Agricultural Water Conservation and Irrigation Technologies**
- **Technologies for Agro-product Processing and Food Safety**
- **Biomass Resources, Energy and Material – Conservation**
- **Information and Communication Technology (ICT) for Agriculture**
- **Enhancing Agricultural Engineering Development Strategy Research**



4.3 Improving Agricultural Engineering Independent Innovation Capacity

■ Technical Innovations:

- Original innovations
- Integration innovations
- Renovations based on digester imported technology

■ Management Innovations:

Leading new ideas, new methods, new organizing patterns to create new efficiency systems

■ Running Mechanism Innovations:

Creation of new operation mechanism
building new systems, etc.



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5 Conclusion





- **Agricultural engineering contributes to economic development. Agricultural engineering is facing challenges and opportunities for development. The world population is increasing especially in Asia where three fourths of the world's farm households are concentrated. The arable land is decreasing. The environment is worsening including water pollution, soil pollution, etc. Food security and safety still remain two thematic issues for agricultural engineering, especially in the developing countries in Asia and the Pacific.**



- **Government policy plays an indispensable role in promoting agricultural engineering R&D. In the last twenty years, at the beginning of each year, the central government issued a No. 1 document which related to agriculture, rural areas and farmer issues. If appropriate and effective measures were outlined and adopted, it would have a positive impact on the advancements of agriculture including R&D of agricultural engineering.**



- **Agricultural mechanization is still an essential component of agricultural engineering in the developing countries in Asia and the Pacific. For example, the mechanization rate of rice harvesting is only 27% in China. In some other Asian countries, there is a large number of farmers holding a very small piece of land, demanding small-scaled tractors. Agricultural engineering will address the needs of rural development.**



- **Agricultural engineering will provide assistance in promoting the development of agro-based small and medium sized enterprises (SMEs)**



- **Agricultural engineering is expanding its scope in research and development along with the advancements of science and technology. In the transition of conventional agriculture to modern agriculture, new disciplines of agricultural engineering will make contributions**



- **Regional cooperation should be enhanced. The agricultural engineers of China are willing to work partners in the member countries of UNAPCAEM to promote regional cooperation. Cooperation will be mutually beneficial speeding up renovation in traditional farming, technology transfer and information dissemination, and market development**



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Thanks!