

# Agricultural Engineering in China

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## Abstract:

China has a longest history of tools innovation and development for agriculture on the world but became backward between the Qing Dynasty and 1940s. Since the 1950s especially since the reform and opening policies started in 1978, agricultural engineering has made tremendous achievements in China. Agricultural engineering was referred to as agricultural mechanization before 1978. Agricultural engineering has been gradually understood and agricultural mechanization, agricultural water and soil engineering, agricultural bio-environment and energy engineering, and agricultural electrification and automation engineering have been developed and have contributed to the overall agricultural achievement.

Agricultural engineering is entering the age of bio-systems engineering in 21<sup>st</sup> century. The future needs from the agriculture and the development of agricultural engineering are briefly described.

**Key words:** *agricultural engineering, China*

Agriculture has made tremendous achievements in China in the past 50 years, especially since the reform and opening policies started in 1978. In the report “*China 2020*”, the World Bank gave high praise to the agricultural development in China—“China, with a population more than the total of Africa, spent only a generation of time to make the achievement which have taken several centuries for other countries. This is the most significant development nowadays.” Chinese agriculture is now moving into a completely new stage:

***Agricultural production can now meet, and sometimes exceed, the overall need for food, feed and other materials.*** During the ninth Five-Year Plan from 1996 to 2000, the yearly total grain output was about 500 million tons; the annual grain supply per capita was kept at about or even more than 400 kg; for most kinds of products, supply often exceeds demands in some regions.

***Rural industry helps the rural labor transfer.*** The proportion of non-agriculture industries in the rural economy keeps growing. The increased value in township business was about 64% of that in the total rural economy in 2000, 9.2% higher than in 1995. Employees in the secondary industries were 175 million at the end of 2000, 11 million more than 1995.

***The average net income per capita keeps increasing.*** In the ninth Five-Year-Plan, it increased by 4.7% annually. The population in poverty decreased from 65 million in 1995 to 30 million at the end of 2000. About 150 million farmers now live comparatively well-off with the average annual income of 3000 Chinese Yuan (about \$360 US) per person. The Engel Index in rural areas decreased from 58.6% in 1995 to 50.1% in 2000.

The agricultural development and achievements benefited from the engineering applications. Without agricultural engineering the farmers could not have been liberated from the heavy work, the agricultural production could not have reached such high efficiency and become so specialized, and China could not have produced enough food.

## I. Agricultural Mechanization-the First Stage of Engineering Application in Agriculture

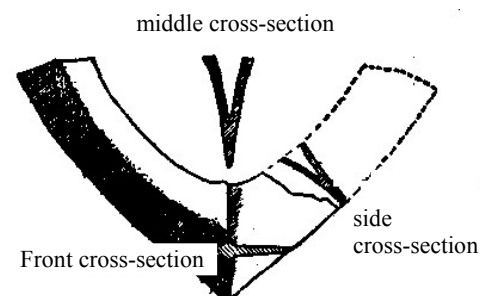
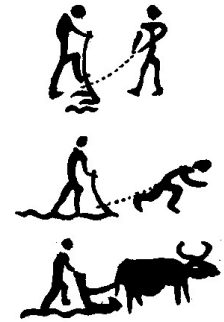


Fig 1. The coulters before QIN Dynasty

China has a long history of tools innovation and development for agriculture and the handicraft industry (MAO Tsetung). After about 30 thousand years exploration, the ancient Chinese people used “perfect” stoneware (hoes, oxes, etc.) for primitive agricultural cultivation 5000 to 7000 years ago (ZHOU Xin). From 1800 to 1100 B.C.-when China entered the Bronze Age, many kinds of agricultural tools were made of bronze, followed by the Iron Age although even then most of the tools were made from wood and stone. During the first Chinese dynasty, QIN Dynasty (255 B.C.-206 B.C.), a famous politician GUAN Zhong first proposed to set up a special administrative unit responsible for agricultural tools. Most important tools like seeders and harrows were developed and the principles are still used today. China then began cattle-driven agriculture. During WEI and JIN Dynasties (220A.D.-589A.D.) the world’s first agricultural engineering book was written by Mr. JIA Sixie named “Fundamentals for Humans” (*QIMIN YAOSU* in Chinese pronunciation). In the Great TANG Dynasty, the coulter was improved and a special thesis for coulter design and manufacture was implemented by Mr LU Guimeng, the first machinery specialist in the world. The first agricultural engineering handbook, “Illustrated Handbook for Agricultural Tools and Equipment”, was completed by Mr WANG Zhen in the early YUAN Dynasty (1280 A.D.-1368 A.D.), describing harvesting tools. About 400 years ago late in the MING Dynasty (1368 A.D.-1644A.D.) and continuing throughout the whole QING Dynasty (1644A.D.-1912A.D.) as well as the following 50 years of the Republic of China, the long historical feudal agriculture finally caused China to be lost during the crucial industrial revolution. Chinese agricultural tools and equipment innovation and application entered a behindhand age on the modern world.

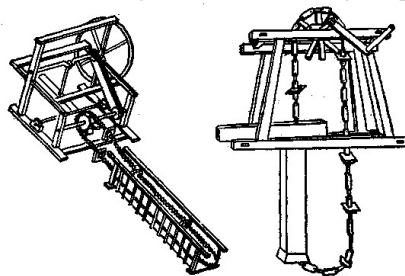


**Fig 2. The plow improvement stages**

The pioneers in late QING Dynasty began to introduce the overseas advanced agricultural technologies and knowledge. The agricultural science societies were organized beginning in 1897 and the Agricultural School of Capital University was set up in 1905.

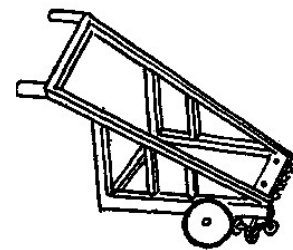
### 1.1 Launching Step of Agricultural Mechanization (1949-1957)

Agricultural mechanization continued to develop after the setup of the new China in 1949. The first agricultural tools and equipment exhibition was held in the place of the Central Government as suggested by Chairman MAO Tsetung in 1950, the first Tractor Service Station was set up in North China in the same year. From 1949 to 1957, the main work for agricultural mechanization was to repair the agricultural *tools* and to develop higher-efficiency new *tools* (most were animal-driven), e.g., 59 million tools were repaired in 1953 (ZHOU Xin). The irrigation and drainage equipment was the first priority and the power increased from



**Fig 3. Water lifter: foot push (left) and hand crank**

These are improved types in early 1950s. The forebear of this type was innovated more than 1800 years ago (ZHOU Xin, 1980).



**Fig 4. The innovated handy wheat “combine” in 1950s**

72MW in 1949 to over 400 MW at the end of 1957. Tractor application started with a set of tractor stations through the country. Up to 1957, 132 tractor service stations had been set up, 12000 tractors tilled 1.7M hectares of land.

### 1.2 Exploring and Adjustment (1958-1965)

The Chinese *First Tractor Company* was established in 1956 and the first Chinese crawler tractor was assembled in 1958, with engine power of 45kW. *Dongfanghong* (orient sunrise) has become a world famous brand in the tractor family.

In 1958 agricultural mechanization entered into and a period of adjustment. Agricultural tool and equipment factories and tractor stations underwent a fluctuation of rapid expansion and contraction from 1958 to 1965. Two hundred and ten million tools were redesigned and manufactured. The agricultural machine maintenance

service system was then increasing.

### 1.3 Unusual Expanding Development (1966-1980)

In 1966 China decided to move toward full agricultural mechanization. In 1980, policies for investment, interest-free loans and price controls were published to encourage the rural collective organizations to purchase machines. This led to a rapid development period. By 1978, the national self-sufficient agricultural machine factories and maintenance service system expanded throughout the counties and towns in China. Almost all kinds of machines were produced in China. As a result, the annual manufacturing capacities for agricultural tractors, handy tractors and combines were 138 thousand, 350 thousand, and 6000, respectively in 1980. Because of the fluctuation in the Chinese economy, full mechanization was not realized as expected



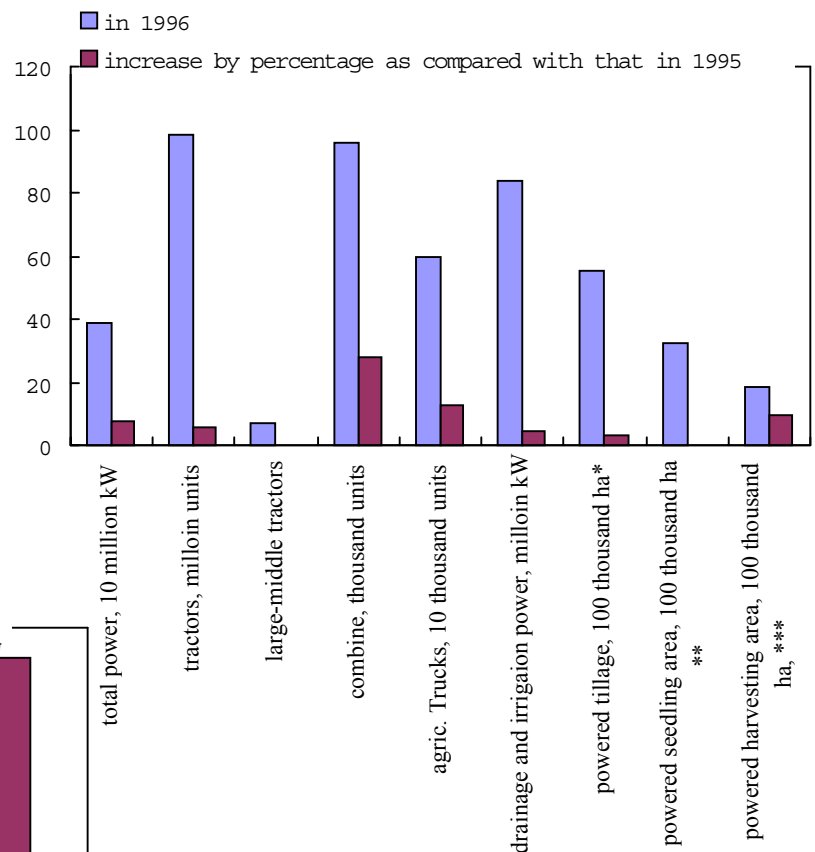
**Fig 5. Farmers bought small tractors in a county-owned company in 1980s**

### 1.4 Policy Reforming Stage (1978-1994)

The agricultural economic structural reform covered each sector. The central government began to permit farmers to buy small tractors and machines and did not prohibit the possession of large machines (Central Committee of Communist Party of China, 1983). Up to 1994, the private sector possessed 79% of agricultural machine asset value. Large machines decreased a little and the small equipment leaped dramatically; for example, the total amount of large tractors in 1994 dropped by 7.2% as compared to that in 1980, but the small tractors increased by about 340%. The implantation of market changed the pattern in rural area. Agricultural mechanization not only served for large farms, but extended its influence into other sectors of agricultural production such as livestock production and aquaculture.

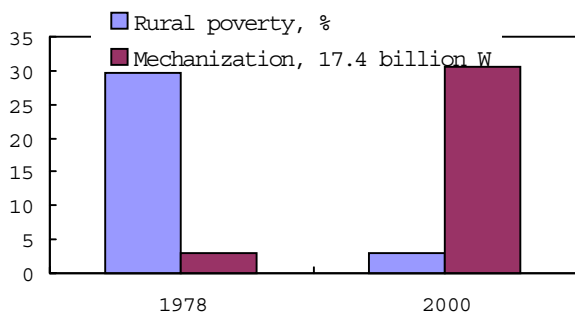
### 1.5 Market Driven Developing Stage (after 1994)

Mechanization is playing a leading role in the agricultural production of China. It has progressed from partial mechanization in some key operations to complete mechanization of the whole production process. After the middle 1990s, the farm machinery manufacturing industry in China developed into a complete system consisting of 16 sub-industries including tractors,



**Fig 6. Agricultural mechanization in 1996**

\* it is about 58% of the total tillage area  
 \*\* it is about 21.38% of the total seedling area  
 \*\*\* it is about 12% of the total harvesting area



**Fig 7. Agricultural mechanization contributes greatly to the social development**

internal-combustion engines, tillage implements, pest & weeds control equipment, harvesters, irrigation and drainage machines, transport machinery, animal farming equipment, post harvest processing equipment, feed processing machines, semi-mechanized implements and tractor spare parts.

By the end of 1990s, the total farm power in China reached 489 million kW, which is 2700 times higher than that in 1952; and large agricultural machines have becoming increasing since 1996. From 1975 up to 2000, the total area of powered tillage and harvest operations has increased by 31.7% and 14.8% respectively.

Mechanized farming equipment and technologies have made great contributions to agricultural development in China. They may include mechanized deep tillage & subsoiling with plow or subsoiler; shallow tillage plow-seeder; non-tillage or minimum tillage with no-till direct seeders; combined or integrated precision seeding unit to finish tillage, seedbed preparation, precision seeding, fertilizer application and spraying in a single operation; and spraying or seeding with agricultural planes.

## II. Agricultural Engineering-Full-developed Engineering in Agriculture

As the former President JIANG Zeming mentioned in September 1996, to solve the agriculture and food problem by Chinese people ourselves, a forward leap or a new revolution must be carried out in agricultural technology. Although the history of Agricultural Engineering is not so long in China, it still played an important role in the modernization of agriculture all these years. With the further reformation or modification of agricultural production structure, agricultural engineering will continue a significant role in the revolutionary process of agricultural science and technology in China.

### 2.1 Fast Development of Protected Agriculture

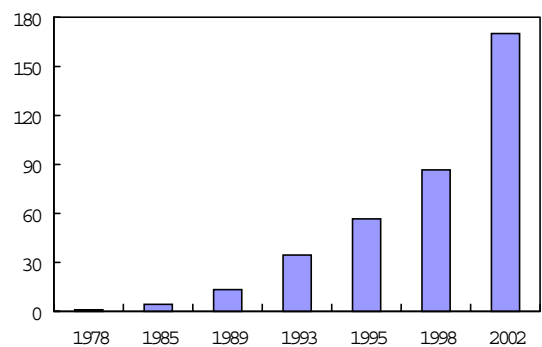
#### 2.1.1 Protected Plant Growing

As far back to the great TANG Dynasty (A.D. 618-907), natural hot spring water was used to produce the melons.

In 1950s, wind breaks and improved cold frames were the main protected agricultural facilities for plant growing. Small plastic tunnels and medium-sized plastic tunnels appeared at the beginning of 1960s. In 1966, the first large plastic tunnel with bamboo and timber structure was constructed in Changchun, a north China city. Up to 1978, the area of national protected horticulture was 15,940 ha, in which the area of medium and little plastic tunnels was 10,670 ha. In 1980s, the protected horticulture experienced rapid development. The area came up to 139,250 ha, in which the area of medium and small plastic arc tunnels was 85,970 ha, the area of large plastic tunnel was 27,990 ha, and the rest is sunlight greenhouse area (Pan Jinquan). The total protected area increased to 569,550 ha in 1995,



**Fig 9. The Solar greenhouse: The rural farmer's (left) and the peri-urban farmer's (lower right)**



**Fig 8. The development of protected horticulture in China, (10 thousand ha)**



**Fig 10. Soilless vegetable production**



**Fig 11. Giant tomato plant**

in which the area of medium and small plastic arc tunnels was 310,610 ha, that of large plastic tunnels and greenhouses was 116,880 ha and 142,060 ha respectively (Feng Guanghe).

In the period from 1975 to 1984, China introduced 21 ha modern greenhouses from Holland, Japan, and US, which promoted the modern greenhouse technologies development. The area of large-scale greenhouses reached 590 ha in 2000, including the imported greenhouse area of 185 ha (Chen Diankui).

Soilless culture in China traces back to the SONG Dynasty when people steeped bean sprouts for human consumption (Pan Wenwei). Commercial soilless culture in China began in 1941. A farm of soilless vegetable production was built in Shanghai but was soon bankrupt because of high operating cost. Shandong Agricultural University started to produce soilless vegetables in gravel in a small area in 1976. Since 1996 the soilless culture has become a national key project, which resulted in very rapid development. The soilless culture area in China was around 0.1ha in 1985. By 1990 China had developed 7 ha of different types of soilless culture systems, the area became 50ha 5 years later and about 315 ha at present. The need for green food, the easy control of soilless culture and the large area of greenhouse are stimulating the soilless culture in China (Jiang Weijie).

With the development of agricultural environmental engineering, protected agriculture has greatly improved, evolving from large numbers of separated family scale smallholders to large-scaled intensively managed farms. The so-called *solar greenhouse* technology which is very special for the Chinese situation, has been extensively applied between 38<sup>o</sup>~42<sup>o</sup> North Latitude in China, reducing the regional or climatic difference effects on vegetable production. The on-going research of the high-yield-and-quality "giant tomato plant" has reached the level of producing 13000 tomatoes on a single plant. The main structure and part of the internal facilities for the large modernized greenhouse can now be made domestically. Research on greenhouse environmental control has been listed as one the national science and technology key projects.

### 2.1.2 Protected Animal Growing

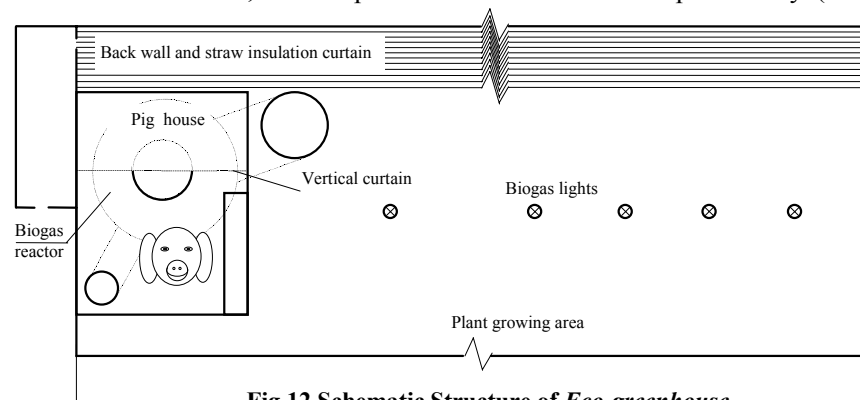
It was recorded that the wild animals had been domesticated since the Neolithic Age in China, and domestication seemed to fulfill an important need for animals about 7000 years ago. In the period of "the Lord of the East (Huang Di)" that is 5000 years ago, the domestic draught animals appeared (Tao Dinglai).

**Table 1. Development of the animal production in China before 1976**(Source: *Chinese statistical yearbook*)

year	total output of meat ( 10000 tons)	meat production per capita (kg)	The proportion of animal production benefit in agriculture (%)
1949	220	5.94	
1952	339	0.07	11.2
1957	399	6.33	12.2
1961	194	2.85	10.9
1965	551	7.60	13.4
1976	780	8.47	14.2

As ancient in the Ming Dynasty, over 5700 bulls, sheep and pigs and 16000 domestic birds were grown in the suburb of Beijing (Tao Dinglai). From 1949 to 1976, animal production in China developed slowly (Sun Dongsheng).

Livestock production increased dramatically since 1978, generating 70 billion US dollars GDP in 1981 (Du Lixin). Greenhouse technologies were integrated with small scale livestock production, providing a warm environment for animals in the cold seasons and saving energy. The concept of "Eco-greenhouse" was proposed and applied then in 1984, creating a



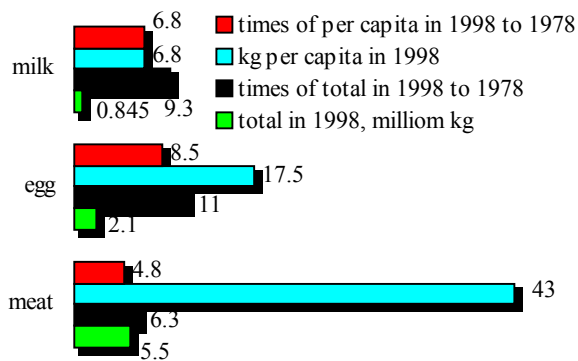
**Fig 12 Schematic Structure of Eco-greenhouse**

common space for domestic animals, vegetables, and waste treatment reactors in a unit greenhouse, leading to the resource recycling and conservation (Dong Renjie).

The first large-scale modern livestock organization, Beijing Red Star Farm for poultry production, was built in 1978 near the current urban area of Beijing (Tao Dinglai). Thereafter in recent years, large-and-middle-scale mechanized poultry houses developed very fast. By the end of the 1990s, there were 750,000 laying hens and 30 million chickens for annual sale (Lv Zhongxiao).

**Table 2. Animal production and the rank on the world in 1997 (\*rank in the world) (Du Lixin)**

Livestock (10000 heads)	pig	ox	sheep	goat	chicken
Whole World	93688.6	133362.0	106417.0	70338.8	1341300.0
China	46805.5(1)*	1164.0(2)	13269.1(1)	17099.3(1)	301100.0(1)



**Fig 13. The animal production in 1988 vs 1978 in Mainland of China (Wang Dongsheng)**

animal production machinery focused on cutting, raking and pulverizing. Processing and fodder machines have been developed since 1975, followed by the vast grassland engineering and forage harvest, storage, processing and advanced feed processing, transport and supplying technologies. Livestock production machine manufacturing has become a new industry. There were 55 main companies for livestock machines in 1988, employing 18000 workers (Yang Wenda).

Generally the most advanced technologies for livestock production from the engineering viewpoint are:

**Buildings**-most effective in energy (electricity) saving. Solar energy and sunlight utilization is taken in the consideration in building design and management. Buildings suitable for local ambient environment like plastic tunnel-type solar house, passive solar animal house, assembly house with heat insulation, and light materials have been developed.

**Ventilation**-special fans. The low pressure high flow rate axial fan was developed in 1988, replacing formerly used industrial fans and reducing the noise and energy consumption. Longitudinal ventilation technology was then applied.

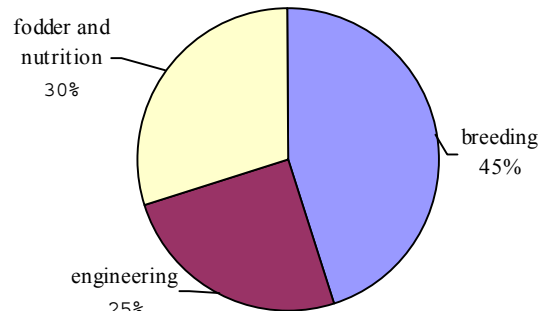
**Evaporation technology**-The wet-pad evaporation system was developed in 1993 and popularized with the longitudinal ventilation technology.

**Heating**-Warm air heating system has been used with solar heating design. Water heating system is rare in China.

**Automatic environment control**-A series of auto-technologies have been develop for the environmental

In recent years, large scale industrialized production developed rapidly China (Fig 13). Technology and facilities for raising chicken, such as cage raising technology of laying hens as well as circular fence and confined raising of pigs have developed and become popular(Li Baoming). In 1998, the proportion of large scale production contributed 50%, 40% and 15% of the total output of chicken, laying hens and pig respectively. The contribution of modern environmental engineering to the livestock production is shown in Fig 14 (Du Lixin).

From the 1950s to the mid-1970s, the development of



**Fig 14. Engineering contribution to livestock production**

control. An animal-age-based technology is developed for the inside temperature, humidity and light control.

**Inside air quality and waste management**-Animal welfare is an increasing concern of the consumers, but the waste impact on pollution of air, water and soil has been the main issue in China. Several institutions have been studying and introducing types of technologies although there have not been standards.

## 2.2 Soil and Water Engineering

Research of soil and water engineering mainly focuses on how to use the limited water resources to ensure the increasing of farmer's income, meanwhile to protect environment as well. The key objective is to supply or develop a system of technologies, which can maintain the environment, avoid overexploitation and destruction of resources, and thus ensure the sustainable development of agriculture. Some engineering measures, tillage operations, chemical treatments, and the rainwater storing and supplemental irrigation agriculture have been introduced for the irrigated forestry.



Fig 15. Dripping system

## 2.3 Success in Rural Energy

Energy consumed in rural areas is becoming much more commercialized, and especially rural energy technology has developed rapidly in recent years. "Rural energy" is a special term in China. It means in most cases that all the energy except commercial energy like coal, petroleum, and electricity used in the rural area. Rural energy capability began with popularizing marsh gas technology in 1950s with additional the research in the 1960s. In 1979, China established the Chinese Society of Agricultural Engineering (CSAE) and started the preparation of Rural Energy Professional Committee within the structure of CSAE. At the beginning of the 1980s, China established the famous policy of "local condition-suitable, energy multi-supplemental, utilization-integrated, benefit-preferable" for rural energy development. Rural Energy Service Agencies at different administrative levels have been set up since then.

There were nearly 5000 agencies with 20,000 staff members, 100 national research units, and 14,000 technicians for biogas plant construction by 1988. The country completed the construction of rural energy facilities in 100 counties by 1990-1995. Biogas technology is probably the leading level in the world. There are also some manufacturers or enterprises who produce high quality hydraulic power generators.

Bio-waste treatment is a also a recent development. More than 1000 large pig farms are located around Beijing, causing pollution danger to the underground water. Since the 8<sup>th</sup> Five Year Plan the organic waste water and solid

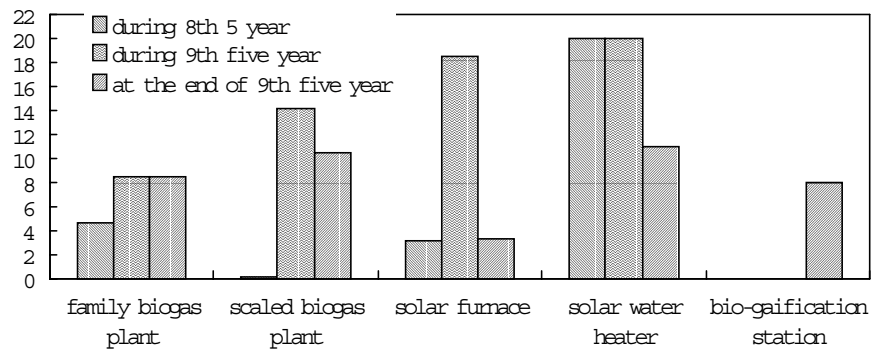


Fig 16. Rural energy development and utilization

The annual increase rate during the 8<sup>th</sup> and 9<sup>th</sup> five-year, %;

The absolute number at the end of the 9<sup>th</sup> five year:

Family biogas plant: 8.48 million; Scaled biogas plant: 1042; Solar furnace: 332 thousand;  
Solar water heater: 11 million m<sup>2</sup>; Bio-gasification: 79.4 thousand families benefited



Fig 17. Pig farms wastewater treatment

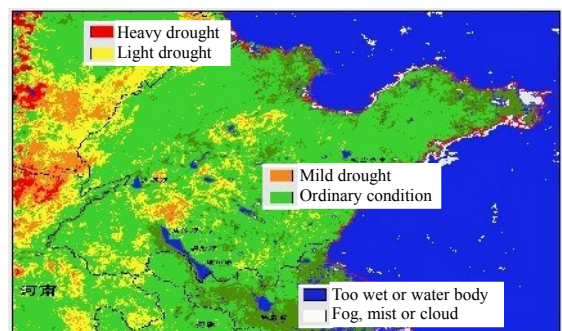


Fig 18. Drought monitoring by satellite, Sent 30. 1998

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waste treatment have been given more and more serious consideration. With the future 2008 Beijing Olympics, urban waste treatment also is being given more attention.

## 2.4 Information Technology in Agriculture

Research and application of micro-electronics, instrumentation & control, and information technology on farm machinery is now developing along the way for intelligentization and electromechanical integration. "Precision Farming", which is based on information and knowledge to manage farming system precisely, has already started. A special research institute has been set up in some universities like China Agricultural University.

China is a large country with various landscapes, complicated crop structure and numerous small scale family farms. Large-scale agricultural information is important for vast land management.

Crop monitoring on a regional or national scale is a principal technology for agricultural management, early prediction and estimation of grain production, farm land area monitoring, and disasters like heavy flooding and drought.

Greenhouse environmental control technology has been listed as one of the Science and technology key projects in the national 10<sup>th</sup> Five Year Plan. Grafting robots were introduced into China and successfully re-developed according to the local situation. Other technologies like machine vision in fruit sorting and "electronic nose (sensor)" were used recently.

## 5. Advanced Mechanization

The agricultural engineering has evolved from agricultural mechanization. Agricultural mechanization itself is still developing and maturing according to the Chinese situation, which is different from the western agricultural mechanization in some special cases.

### 5.1 Tide Mechanization Through Out the Main Grain-producing Regions

Ordinarily agricultural mechanization is



Fig 19. Combines transfers from south region to the near north region- an example of *tide* mechanization

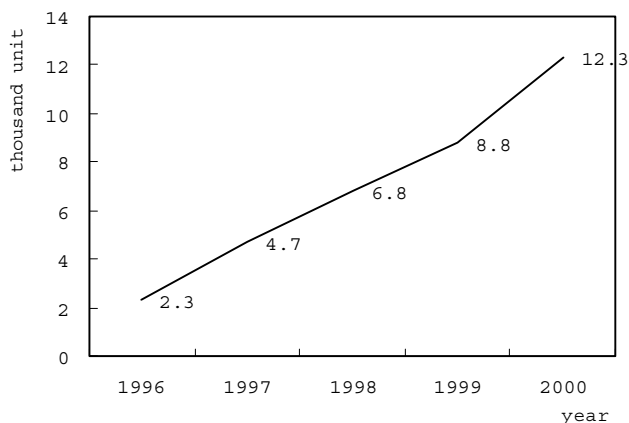


Fig 20. Combines number in the *tide* mechanization

mechanization services: about 40 US dollars for 1 ha harvesting of wheat or rice, and similar payment for tillage. There is a large market if one thinks of the 800 million farmers in China. The market attracted the investment and small to middle sized combines were purchased by the richer farmers. At the beginning, they just served for their home region. Since 1999, the Ministry of Agriculture cooperated with the Police Bureau to guarantee the safe transfer of combines from one region to the neighbor through the national transportation networks (Fig 20).

considered to be suitable for large-scale farming. In China, however, the family-based rural economic system guarantees each small family with 3 to 5 people have parcels of land for their food and life. It is difficult to adopt mechanization on such small and crowded pieces of land. About 20 years ago while the family-based rural economy system was just developing, no one knew clearly what was a suitable mechanization scheme for China. No one could imagine the creation of such a new and special way of mechanization for small pieces of land, but it becomes true. Each family cannot afford to own all machines for the annual periodic agricultural activities of only a few days. But more and more families can buy the

Has China's agriculture achieved mechanization for the most activities? Yes. Is the mechanization realized on all the large-scale farms? No. This is a special difference from many other areas of the world.

### **5.2 Middle-sized Machines for Vast-land Mechanization**

It would not be possible to achieve mechanization on the vast land of China with only small or middle sized machines. Almost each of the machines belongs to a single farmer. His small machines could cover less than one ha per day for wheat or rice harvesting. However, farmers who need mechanization services, are satisfied with such a machine. One day is enough for the small machine to harvest one farmer's grain. On the other hand, small machines reduce damages such grain loss for example.

The government plays a key role in organizing the *tide* mechanization. Many small or middle machines are utilized. In most cases a team leader is selected or assigned to handle farmers requests for service. The mechanized activity is carried out on a vast piece of land with each small machine operating on a small piece of this vast land.

**5.3 Western Large-scale Mechanization** is adopted on large farms where and contributes greatly to the national commercial grain production.

## **6. Agricultural Engineering Education in China**

Agricultural Engineering is listed as the Level One Specialty in the educational system. It consists of four Level Two Specialties including Agricultural Mechanization, Agricultural Water and Soil Engineering, Agricultural Bio-environment and Energy Engineering, and Agricultural Electrification and Automation Engineering. Bachelor degrees in agricultural engineering are authorized for Agricultural Mechanization and Automation, Agricultural Electrification and Automation, Agricultural Building Environment and Energy Engineering, and Water Conservancy Engineering (Zhao Yibo and Ying Wenbin).

Agricultural engineering education was launched in 1930s but evolved slowly. Since 1949, China strengthened the education of agricultural mechanization (Geng Chengxin). Huabei Agricultural Machinery Institute and Agricultural Machinery Department of Beijing Agricultural University were set up in 1949. A Tractor Ploughing School was organized by the Ministry of Agriculture in 1950. The Pingyuan Agricultural Mechanization College was set up in 1951. One year later in 1952, all the agricultural mechanization-related institutes and schools were collected and reorganized to form the Beijing Agricultural Machinery College, which offered programs in education, research and distribution of agricultural mechanization.

With the development of biology, computer science and information technology, new energy and new material technology, and the social economy moving towards sustainability, agricultural engineering development stepped into a brand-new stage. In 1984 Prof. Zhang Jigao, the founder of new China's agricultural engineering program, introduced the modern concept of agricultural engineering in his book entitled Agricultural Engineering Introduction. Twenty seven institutions in more than 70 institutions with agricultural engineering department have set up masters and doctoral degrees in agriculture engineering (Jin Juanqin and Zhao Wenbo). By 1994, there were 8 major of colleges of agricultural engineering and 11500 students in agricultural colleges of China.

By the end of the 20th century, a group of comprehensive universities were formed by combining special colleges, institutes and universities. This has opened a new opportunity for agricultural engineering development in the new millennium.

### **III. Bright Future for Engineering in Bio-systems (Cui Yin'an)**

Generally speaking, Agricultural Engineering in China still has a long way to go compared with other countries. Here are some areas of emphasis for the future.

1. Agricultural Mechanization: (1) Mechanization technology and standard equipment for main crops; (2) Mechanization for Agricultural Sustainability and Precision Farming; (3) Mechanization for protected agriculture.
2. Protected Agriculture: (1) Energy-saving solar greenhouse and Economical multi-span greenhouse; (2) Greenhouse production and environment control; (3) Industrialized seedling technology and equipment; (4) Information and Networking technology; (5) Standardization.
3. Livestock Farming: (1) Environmental control and feeding equipment; (2) Information technologies

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integration; (3) Standardization.

4. Rural Energy: (1) Integrated recycling concept and action to form ecological agriculture; (2) Waste treatment; (3) Global warming control from the view of agriculture; (4) Standardization.

5. Soil and Water Engineering: (1) Water saving and soil and water resources protection; (2) High-efficiency irrigation technologies, improving average irrigation water utilization efficiency up to 0.65~0.7; (3) Greenhouse irrigation.

6. Post Harvest Engineering: (1) Equipment and facilities for storage and transportation; (2) Rapid quality tests; (3) Bio-materials extraction; (4) Traditional food industrialization; (5) Extend the agricultural production chain to enhance value-added processing technology & equipment innovation; (6) Standard and quality control system.

7. Information Technology (Meng Fanqi; Zhang Beizeng): (1) Farm machinery and equipment featuring Intelligentization and electromechanical integration; (2) Automatic and intelligent environment control for Modern Protected horticulture; (3) Virtual agriculture and biosensor technology; (4) Machine vision and Image information processing technology; (5) Bio-robot technology; (6) Horticulture cropping management Intelligent Expert System and Decision Support System; (7) Computer simulation model for soil-plant-water system, and soil & water erosion; application of 3S and intelligent technology in soil and water environment monitoring; Intelligent irrigation system; (8) “precision processing” management Decision Support System based on information and knowledge technology; (9) Precision Agriculture.

8. Engineering Extension and Services: (1) Establish the extension network; (2) Innovate the effective extension mechanism.

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