

# DEVELOPMENT STRATEGY OF AGRICULTURAL MACHINERY BASED ON ENERGY-SAVING IN CHINA

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## ABSTRACT

Although the agricultural mechanization program in China has been greatly accelerated in recent years, its level of overall development is still relatively low. It often relies on extensive consumption of resources, resulting in some serious problems, including high energy consumption and high costs. In this paper, the development of agricultural machinery industry in China is described. The energy consumption data of farm machinery is then analysed. The reasons for high energy consumption of agricultural machinery are also discussed. Future development strategies for reducing energy consumption of agricultural machinery in China are also suggested.

**Keywords:** agricultural machinery, energy-saving, mechanization, China

## PRESENT STATE AND TREND OF AGRICULTURAL MACHINERY IN CHINA

### Present state of agricultural machinery in China

Agricultural machinery is one of the important carriers for modern agriculture, a tool for improving agricultural productivity and liberating agricultural labour. Since the 1950s, especially since the start of reform and open-door policies in 1978, agricultural engineering has made tremendous achievements in China (Zhou et al., 2003). In recent years, along with the rapid growth of national economy, the agricultural mechanization program in China enters into the fast track lane and has become an important component of the world agricultural mechanization development (Li, 2005). But the agricultural mechanization level is still relatively low in China. The quantity, types and technique of agricultural machinery and equipments are yet to be improved.

#### *(1) Shortage of agricultural machinery*

The Chinese population is very large, with 1.3b people. Among them agricultural population is 58.7 percent in 2006 (World Bank, 2008). Because of small average farmland and labour surplus phenomenon, it is difficult to promote the use of agricultural machinery and raise the level of agricultural productivity. This leads to high cost of agricultural machinery and agricultural production, and poor investment returns. In comparison with other countries, agricultural and cultural traditions of Japan and South Korea may be similar to the Chinese (Group of Agriculture Ministry, 2008). However, from the comparison of the tractor number in Table 1, it is evident that the ownership of agricultural machinery is far less sufficient in China. This leads to the relatively low labour productivity.

**Table 1 China and Japan, South Korea tractor number comparison**

Country	Year	Rural farmland per capita (hm <sup>2</sup> /farmer)	Tractor number (Unit/hundred hm <sup>2</sup> )	Labour productivity ( industrial added value of agricultural labour /U.S)
China	2004	0.11	65	373
Japan	2004	0.03	4588	26557
Korea	2004	0.03	1239	9996

*(2) Low level of technology development*

As in other developing countries, the purchasing power of Chinese peasants is limited, leading to a low level of machinery usage. There are also too many manufacturers of small tractors, small harvester and farm vehicles. This causes serious waste of limited resources in the country. At present, only a small number of farm machinery has reached the international standard in China. The level of mechanized production of agricultural products except wheat is still very low.

*(3) Equipment structure can not meet the needs of agricultural production*

It is important to realize that different regions and crops need to use different machinery and equipments. However, many agricultural productions lack the suitable mechanized equipments, particularly in the areas of vegetables, fruits, and soybean production. It has also been found that the sugarcane production machinery imported from abroad to China is not suitable for local conditions and therefore difficult to expand the market.

**Investments by the Chinese Government and Farmers**

Agricultural mechanization is one of the major features of agricultural modernization. Improving the quantity and quality of agricultural machinery is an important way to promote agricultural modernization. China's national economy as a whole has entered in a new period of accelerated development of industrialization since 2000. Chinese government has now been paying more attention to the development of agricultural mechanization to speed up the development of modern agriculture.

Chinese government began to implement “Agricultural Mechanization Promotion Law” in 2004. The law established the status and role of agricultural mechanization in agriculture and rural economic development. Under the impetus of the National Policy, almost all provinces in China established various forms of local supporting policies, regulations and Agricultural Management Ordinance to provide a strong legal and institutional base for the development of agricultural mechanization. In particular, since 2004, a significant amount of government fund started to subsidize farmers to purchase agricultural machinery. As shown in Figure 1, from 2004 to 2008, the central government has allocated 69.7 billion of CNY (1 Chinese Yuan is about 0.18 Australian dollars at today's exchange rate) to subsidize farmers to purchase agricultural machinery. This has driven farmers input 373 billion CNY and pulled the industrial sales of farm machinery to the value of 443 billion CNY. In 2009, the central government will again be spending some 100 billion CNY at farmer subsidies (Wang, 2008), which will directly drive farmers input to near 540 billion CNY.

Driven by the policy of national farm machinery purchase subsidies, the development of agricultural mechanization has greatly been enhanced. The role of mechanization has now been recognized by the majority of farmers. The interest of purchasing and using agricultural machinery has also greatly increased, which makes the total power of agricultural machinery of the country continue to rise (Agricultural Mechanization Management Division in Ministry of Agriculture, etc., 2006). As shown in Figures 2 and 3, the total available power of agricultural machinery in China reached 800 million kilowatts in 2008. Among them, the number of large-medium sized tractors, small sized tractors and combine harvesters possessed is respectively 2,400,000, 16,600,000 and 710,000 Units. This is in comparison with the year of 1978, when the gross industrial output value of agricultural machinery in China was just over 50 billion CNY, which was equivalent to about 1800 billion CNY in 2008. This number has increased by 30 times in the past 30 years. In fact, China has now become the world's second agricultural machinery manufacturing country which is only behind the United States (Wang, 2008).

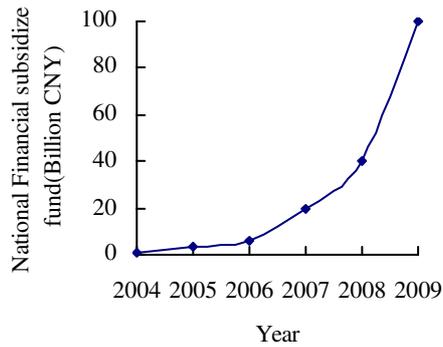


Figure 1 National financial subsidies fund

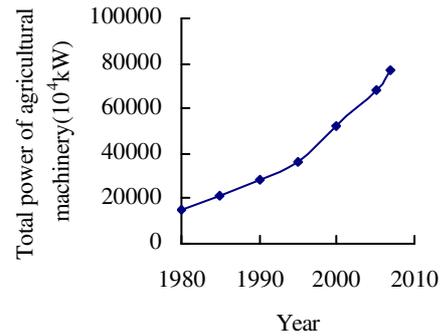


Figure 2 Total power of agricultural machinery

As shown in Figure 4, the greatly increased machinery power has significantly raised the mechanization level of major crops operations in China.

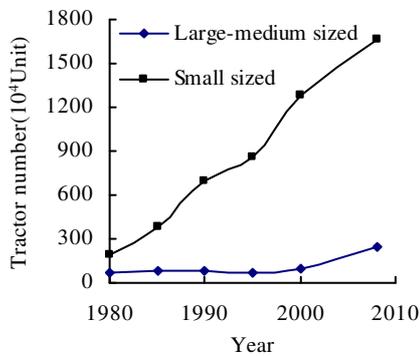


Figure 3 Tractor numbers in China

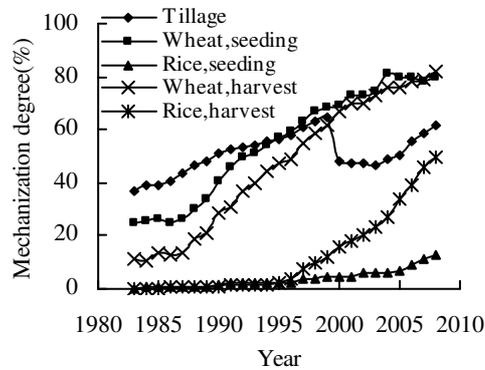
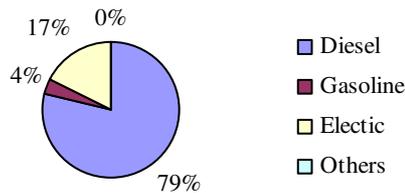


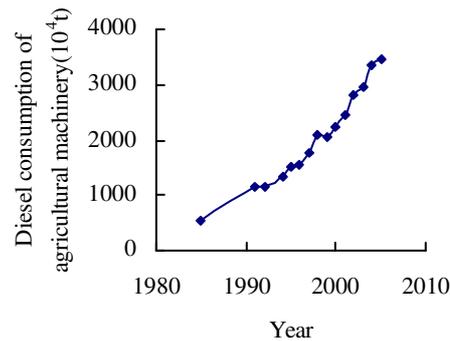
Figure 4 Degree of production mechanization for major crops

## ENERGY CONSUMPTION OF AGRICULTURAL MACHINERY IN CHINA

The problem of higher energy consumption of agricultural machinery in China has not got sufficient attention. With the rapid development of agricultural machinery, energy consumption has increased significantly. As shown in Figure 5, diesel engines now consist of 79% of the total power of agricultural machinery, which is more than 30% of the total consumption in China. Correspondingly, as shown in Figure 6, diesel consumption of agricultural machinery also continues to rapidly increase and reached 34,543,900t in 2005 (Nanjing Agricultural Mechanization Research Institute, 2007). In 2006, it was reported that China's total energy consumption was higher than 15% of global total. Oil consumption reached 346,550,000 t. External dependence reached 47%. In global term, the total energy consumption in China is now only lower than the USA (Yu, 2008) The statistics of China Petroleum & Chemical Association (CPCA) show that China's diesel consumption achieved 138,800,000 t in 2008, an increase of 7.9% over the preceding year.



**Figure 5 Power structure of agricultural machinery in 2005**



**Figure 6 Diesel consumption of agricultural machinery**

On one hand, oil consumption is continuously increasing, on the other hand, according to the forecast, the remaining reserve of exploitable petroleum in China is only 2,300,000,000 t, which is only available for exploration for another 14 years. Therefore, China must promote energy efficiency and develop its renewable energy source. Energy saving of agricultural machinery should also be an important component of this overall strategy. It is identified that the reasons for high energy consumption of agricultural machinery in China are mainly as follows.

*(1) Problems of equipments*

Chinese manufacturing industry of agricultural machinery is underdeveloped and its technology shows considerable disparity with other developed countries. It is estimated that the average fuel consumption of China's diesel engines is about 30% higher than that of the developed countries. Furthermore, from Figure 3, it can be seen that the number of small sized tractors is significantly higher than the large or middle sized tractors in China. The increasing rate of this type of machinery stock is also significantly higher than the latter, which is mainly because the low price of small-sized tractors is fit with the current farmland scale and production form in Chinese rural areas. Generally speaking, small sized tractors have lower efficiency, higher energy consumption and excessive emissions. The operating efficiency of small sized tractor, tricycles and four-wheel agricultural vehicles in China is lower 10 ~ 20% than large-sized high-speed vehicles' (Zhang & Gao, 2007). There is also an issue of the old age of agricultural machinery fleet in service. The lack of retrofitting measures causes a sharp increase in fuel and accessories consumption.

*(2) Problems in operation*

The working scale of the farmland in China is smaller than those of Australia, America and many other countries. The difference in productivity and oil consumption may reach up to 50% between the large number of irregular small land and a small number of smooth regular large land. Moreover, the skills of Chinese agricultural machinery operators were not generally high, which have affected the machinery efficiency, and the working life of equipments.

*(3) Utilization efficiency of available equipment*

The poor matching between the tractors and implements is another reason for high energy consumption. This results in the inefficient utilization (field efficiency) of tractors. For many agricultural machinery in China, the function is unitary, the operational period is short and the utilization ratio is low. For instance, if the wheat seeders and the combine harvesters can work only in the local area, they may only work several to ten days one year, resulting poor capital return. 80% of farmers in China buy machine for themselves (Gao, 2007), considering the conveniences mostly, instead of utilization ratio. In addition, there is no uniform standard for agricultural production, so the crop planter's row spacing and ridge spacing may be inconsistent among different regions, which limits the applicability of available agricultural machinery.

## **STRATEGY FOR REDUCING ENERGY CONSUMPTION OF AGRICULTURAL MACHINERY**

### **Reduce power and energy demand**

It is important to improve and optimize the agricultural technology and system, radically reduce energy demand through the implementation of new technologies such as conservation tillage to reduce the compaction level of farmland, the oil usage, and the agricultural production cost. Past experience has shown that the implementation of conservation tillage in north China can reduce the requirement of agricultural machinery power by 15 ~ 20% and fuel consumption 25 ~ 30% in comparison with the conventional method (Gao, 2007). If a farmer moves from conventional tillage to minimum tillage, there is a potential saving of around 10% of the fuel used on the farm in Australia (Chen & Baillies, 2009). According to the American Council for an Energy Efficient Economy (ACEEE), many more saving methods are available to producers, including reduced tillage, precision farming system and efficient irrigation. The use of these new technology and equipments can not only save fuel, but also fertilizer, seed and water. Rational allocation of machinery use is also important.

### **Improve the quality and reliability of agricultural machinery**

It is also important to continue to increase the national and local financial support, through the implementation of preferential policies such as subsidies of purchasing machinery, to increase the application of advanced and applicable agricultural machinery. The support of agricultural machinery manufacturing industry will also need to be increased, for example, by encouraging the expansion and technology development of internationally-competitive large-scale industrial enterprises.

Through the policy of purchasing subsidies, the government may encourage/guide farmers to purchase the agricultural machinery from large-scale reputable manufacturers. Large-medium sized tractors and machinery are also often more energy efficient than the small ones. The technical standards, maintenance standards of main lines of agricultural machinery such as tractor and combine harvester should be upgraded (Liu & Liu, 2006), in order to enhance the overall quality and safety of agricultural machinery in China.

Research and development efforts of agricultural machinery should also be increased. Research and extension of energy-saving technologies and new agricultural equipments should be accelerated, by focusing on the development of high-performance, multi-purpose, new agricultural machinery and equipments.

### **Improve the operating efficiency of agricultural machinery**

Shaping the farmland and merging the block can provide basic conditions for the efficient operation of agricultural machinery. The development of agricultural mechanization in many countries in the world has proven that merging of small-scale farmlands into large ones is a necessary prerequisite for agricultural mechanization, especially in countries and regions whose per-capita arable land is low. This work is often implemented by the government. It mainly includes shaping the farmland, merging the block, arranging the rules, building road and irrigation infrastructure and so on.

It is a good way of promoting the process of agricultural industrialization to expand the agricultural production scale. The implementation of large-scale production of the agricultural industrial production can significantly reduce the operating cost of agricultural machinery and increase economic efficiency. The agricultural industrial production requires large-scale agricultural machinery. Only in this way can high-performance and energy-saving agricultural machinery and equipments have development space and market.

The training for agricultural machinery operators should be strengthened, by integrating a variety of educational resources. Training opportunities should be provided for agricultural machinery

operators so as to strengthen their operating skills, by all kinds of ways such as professional training, operating demonstrations and network media. In addition, the awareness of energy conservation education of agricultural machinery and equipment should be strengthened.

## CONCLUSION

This paper has reviewed the recent development of agricultural machinery industry in China. It has been shown that the Chinese government has been investing heavily to the development of agricultural mechanization program in China. To achieve the best outcome, it has been shown that the quality of agricultural machinery should be significantly improved. The structure of agricultural machinery industry should also be optimized. The utilization efficiency of agricultural machinery should be improved.

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