



## China Agricultural Mechanization Development Experience for Developing Countries

**Kehinde Adedeji Adekola**

Department of Agricultural Engineering,  
Jilin University, Changchun, China  
Email: profkola@sina.com

**Babatope Albert Alabandan**

Department of Agricultural &  
Bioresources Engineering,  
Federal University, Oye-Ekiti, Nigeria

**Taiwo Adekemi Akinyemi**

Dept. of Home and Rural Economics,  
Oyo State College of Agriculture and  
Technology, Igbo-Ora, Nigeria

**Abstract** – The Chinese government initiatives on mechanization of agricultural activities and its indispensable role in agricultural engineering research and development can not be over-emphasized. This dates back to as early as 1949. The continued government supports contributes immensely to the modernization of Chinese agriculture which is able to ensure food security for the over 1.3 billion population. The positive role of Agricultural Engineering in the advancement of agricultural production in China is directly linked to the advancement of Agricultural Engineering education and practices. This paper showed that the effects of the development of Agricultural Engineering to China national economy can be seen in terms of more advanced mechanized agriculture, increased quality and quantity of agricultural products, improved extension services and trainings for farmers and agricultural workers, optimum use of resources, encouragement of farmers cooperatives, competitiveness of agricultural products on global market, better ecological and environmental protection and promotion of cottage industries to create local jobs and enrich the farmers among others. This work pointed specific areas in which the Chinese experience can be readily adapted to developing countries of Africa and Asia situations because of the similarities of prevailing conditions in Africa and some parts of China.

**Keywords** – Agriculture, Developing Countries, Policies, Mechanization.

### I. INTRODUCTION

Early historical review of agricultural mechanization reveals that the long 5, 000 years history of China makes it to have the longest history of tools innovation and development for agriculture and the handicraft industry in the world (Mao, 1959). However, China became backward between the Qing Dynasty (1644 – 1912A.D) and 1940s. This was due mainly to the long feudal agriculture, political instability and negligence.

During the first Chinese dynasty, Qin dynasty (255-206B.C), a renowned politician was the first to propose the establishment of a special administrative unit responsible for agricultural tools. Important tools such as seeders and harrows were developed and the principles are still in use. China then started cattle-driven agriculture. During Wei and Jin dynasties (220A.D.-589A.D.) the world's first agricultural engineering book "Fundamentals for Humans" (QIMIN YAOSU in Chinese pronunciation) was written by Jia Sixie. In the great Tang dynasty, the coulter for seeders and harrows was improved, designed and manufactured Lu Guimeng, the first farm machinery specialist in the world. The first agricultural engineering handbook, "Illustrated Handbook for Agricultural Tools

and Equipment" was completed by Wang Zhen in the early YUAN Dynasty (1280 A.D.-1368 A.D.), describing harvesting tools (Zhou, Xingxiang et al, 2003).

In late Qing dynasty, overseas advanced agricultural technologies and knowledge were introduced. The agricultural science societies were organized beginning in 1897 and the School of Agriculture was established in the Capital University in 1905.

Since then, there have been developments in every sections of farm mechanization through the introduction of improved production power, machinery and facilities. The contributions of Agricultural Engineering profession indeed revolutionized the food production system in China which this paper intends to highlight.

### II. AGRICULTURAL MECHANIZATION AND CROP PRODUCTION

#### A. First Stage 1949-1957

After the creation of new China in 1949, agricultural mechanization continues to receive incentives and supports. During the launching stage of agricultural mechanization in China (1949 – 1957), the first agricultural tools and equipment exhibition was held by the central government in 1950 and in the same year, the then leader of China, Mao Tsetung set up the first tractor service station in north China. During this stage, the focus of mechanization was on repair of agricultural tools and development of higher efficiency new tools (mostly animal-driven).

Irrigation and drainage equipment received a boost and the power increased from 72MW in 1949 to over 400MW in 1957. In addition, as at 1957, 132 tractor service stations had been set up, 12000 tractors tilled 1.7 million ha of land and 59 millions tools were repaired.

#### B. Second Stage 1958-1965

The second stage spanned between 1958 and 1965. During this period, some adjustments were made to the policy direction of the government. Many agricultural tool and equipment factories and tractor service stations expanded and some were merged to make them more effective. Over 200 million tools were redesigned and manufactured. Impliedly, agricultural machines repairs and maintenance service stations increased.

#### C. Third Stage 1966-1980

The period between 1966 and 1980 witnessed unusual expanding development. In 1966, China policy shifted towards full agricultural mechanization. In 1980, policies for investment, interest-free loans and price controls were introduced. The purpose is to encourage the farmers'

collective organizations to purchase agricultural equipments and machines. This great boost to the development of agricultural engineering development, led to rapid development nationally of agricultural machine factories and maintenance service system expanded throughout the counties and towns in China.

Many kinds of machines were produced. By 1980, records show that annual manufacturing capacities were 138,000 units of various models of agricultural tractors and 600,000 units of grain combine harvesters.

#### *D. Fourth Stage 1981-1994*

With the opening door policy of Deng Xiaoping government in the 1980s, the central government issued five annual No. 1 documents successively from 1982-1986. The documents optimized the household contract responsibility system a basic rural economy stipulating at least 15-year lease of land by farmers and removed farm produce unified purchasing system that had been in existence for over 30 years under planned economy (Zhang, 2004). Government initiatives and policy are highly important in China polity so as in Chinese agriculture. In mid 80's, to solve the problem of vegetable shortage, the government implemented the Vegetable Basket Program. With government inputs and farmers participation, a tremendous increase in vegetable production was recorded.

During the policy reforming period (1981-1994), the farmers are allowed to buy small tractors and machines and own large machines which are hitherto impossible (CCCP, 1983). By 1994, the private sector possessed 79% of agricultural machine asset value and small tractors volume increased by about 340%. This not only made mechanization widely practiced for large farms but also made inroads into other sectors of aquaculture and livestock production.

#### *E. Fifth Stage 1995-2003*

As the former President Jiang Zemin once said in September 1996 that to solve the agriculture and food problem by Chinese themselves, then emphasis should be on new revolution in Agricultural technology. During this period, agricultural mechanization contributes greatly to the social development in China and it is mostly driven by the market. In 1996, agricultural mechanization constitutes 58% of the total tillage area, 21.38% of the total seedling area and about 12% of the total harvesting area.

Mechanized farming equipment and technologies made great contributions to agricultural development in China. The farm machinery manufacturing industry in China developed into a complete system subdivided into: tractors, internal-combustion engines, tillage implements, combined and integrated precision seedling unit, fertilizer applicators and sprayers, pest and weed control equipment, harvesters, irrigation and drainage machines, transport machinery, livestock farming equipment, post-harvest processing machinery, post-harvest storage facilities, feed processing machines, semi-mechanized implements and tractor spare parts. The Seed Project, implemented by the government in mid 90's ensured good quality seed production, application and higher agricultural

productivity. It also effectively promoted agro-processing equipment development.

Since 1996, large agricultural machines have been increasing since 1996. By 1999, the total power in China reached 489 million kW, which is 2700 times higher than that in 1952. From 1975 till 2000, the total area of powered tillage and harvest operations has increased by 31.75% and 14.8% respectively.

The Chinese government placed top priority on the issue of agriculture, rural areas development and farmers' welfare calling for coordinated economical and social developments of both urban and rural China, thereby building an overall well-off society, creating a new countryside and modernizing agriculture (Jiang, Zemin, 2002).

#### *F. Sixth Stage 2004- 2007*

In the new century, in order to address the problems of limited resource availability, farmers low income increase, widening gap between the urban and rural population, restriction of traditional farming system and increased market demand for agricultural products, the central government issued four annual No. 2 decrees successively from 2004 – 2007.

These policies were intended to stimulate income growth for farmers and remove decades old agricultural tax. Other intentions include proposals to improve comprehensive agricultural productivity by consolidating agricultural infrastructures, speeding up scientific and technological research process and for urgent higher productivity subsidizing grain production and purchase of quality seeds and machinery and calling for building a new socialist countryside (Zhu Ming, 2006).

The 2004 promulgation of P.R. China Agricultural Machinery Promotion Law enabled the promotion of machine operations for major crops such as wheat and enhanced the role of agricultural engineering and agricultural machinery application in agriculture and rural economic development. To facilitate the implementation of this law, the central government released 70 million yuan of subsidy and the local government input was 600 million yuan. In 2005 and 2006, the central government subsidy was 300 million and 1.2 billion yuan respectively while the local government subsidy for the same period was 1 billion yuan and 1.8 billion yuan respectively (10). These figures are expected to increase drastically in the coming years.

An opinion poll conducted on January 29, 2007 by central government about modernizing agriculture and steadily advancing new socialist countryside development revealed that modernized agriculture is the top priority for the new socialist countryside.

### **III. FARM MECHANIZATION SUBSIDIARIES**

#### *A. Animal Production*

Livestock production development in China between 1949 and 1976 was very slow when compared with crop production. According to Chinese statistical yearbook, total output of meat in 1949 was 2.2 million tons and increased to 7.8 million tons in 1976. From the 1950's to

the mid 1970's, the development of animal production machinery is focused on cutting, raking and pulverizing. Since 1975, processing and fodder machines have been developed. Thereafter, followed by vast grassland engineering, forage harvest, storage and processing, advanced feed processing, transport and supplying technologies. However, with the shift from planned economy to market economy in 1978, livestock production increased drastically.

The concept of "Eco-greenhouse" which is the integration of small scale livestock production with greenhouse technologies was introduced in 1984. It provides common space for domestic animals, vegetables and waste treatment reactors within a unit resulting to resources recycling and conservation (Dong, 1998).

In recent years, traditional livestock production is developing into large scale and intensive model resulting in increase in animal-farming capacity. By the end of the 1990's, there were 750,000 laying hens and 30 million chickens for annual sale (Lu, 1998). Poultry farming and production of cattle, swine goats and sheep takes greater share of the meat production.

As a result of the government policy, advanced technologies were developed livestock production. From the engineering viewpoint, development were made in the area of livestock building in terms of ventilation, heating, automatic environment, inside air quality management and waste management.

### *B. Soil and Water Engineering*

In the past ten years, the Chinese government greatly increased investments in scientific research in the field of agricultural engineering. In the area of soil and water engineering, the government in the "tenth five year plan" technological system of modern water-saving agriculture was listed among major projects for the national 863 plan. (Zhu, 2005)

The key objective of research in soil and water engineering is to mainly focus on the efficient use and conservation of limited water resources in order to protect environment and increase farmers' income. Measures such as tillage operations, chemical treatments, the rainwater storing and supplemental irrigation agriculture have been introduced for forestry irrigation.

### *C. Rural Energy*

The term "rural energy" refers to other forms of energy being used in the rural areas besides coal, petroleum and electricity. In China, rural energy began with marsh gas technology in 1950 with further research in 1960's. In 1979, when Chinese Society of Agricultural Engineering was established, researches in rural energy received a boost. By 1980, the government established a policy of "Encouragement of in-situ production of supplemental energy and Utilization" for rural energy development. With this favorable government policy, researches were intensified with well over 100 national research units established by 1988. Between 1990 and 1995, constructions of rural energy facilities in 100 counties were completed.

In 2001 in order to improve rural working and living conditions, protect eco-environment and increase farmers'

income, the Chinese government initiated the Eco-land and Enriching Farmers program. The program was to build on rural bio-gas application, tap resource potential with eco-farming and renewable energy technology and promote efficient planting and animal farming to enrich farmers. As the needs arise, solar energy, wind power and micro-hydro power renewable energy were constructed to make full use of land, solar energy and biomass.

The central government invested 3.4 billion yuan for rural biogas application between 2001 and 2005 and beneficiary households increased by 11.12 million (10). According to statistics, by the end of 2005, national biogas digesters was 18.07 million household, animal farm biogas projects was 3556 locations, municipal sewage biogas purification digesters was 140,000 locations, solar energy ovens 6.856 billion, solar energy power generators 86200, micro-hydro power generators 81,200, small wind power systems 105,600 (CAY, 2006).

The development of agricultural bio-energy industry is of great significance to the expansion of scope of agricultural activities and for the guarantee of national energy security. This area will continue to receive more funding with more awareness about the need for cleaner rural environment as highlighted in the 8<sup>th</sup> five year plan.

### *D. Agricultural Information Technology*

At the beginning of the 21<sup>st</sup> century, the development of agricultural and information technology is revolutionizing agricultural science and technology. With the expansive nature of China landscape, complicated crop structure and small scale nature of family farms, large scale agricultural information is important for vast land management.

Research into and application of instrumentation and control, micro-nutrients and information technology is developing towards intelligent and electromechanical integration. Government funding is readily available for research in "precision farming" in some special institutes in China Universities. Technologies such as greenhouse environmental control technology, grafting robots, fruit sorting and "electronic nose (sensor) are listed as science and technology key projects in the national 10<sup>th</sup> five -year plan.

Emphasis is now on information technology on regional and national crop monitoring technology for agricultural management, early prediction and estimation of grain production, disaster (flooding, drought, disease outbreak etc) prediction and farmland area monitoring.

### *E. Protected Agriculture*

Protected agriculture has the potential to solve the problem of annual fluctuation of vegetable supply. In 1950's, wind breaks and improved cold frames were the main protected agricultural facilities for plant growing. In 1996, the first large plastic tunnel with bamboos and timber structure was constructed in Changchun, a northeastern city. Up to 1978, the area of national protected horticulture was 15,940 ha. This area increased to 139,250 ha in 1980 and 569,550 ha in 1995 (Pan, 1996).

As a result of government initiatives and farmers' participation, protected agriculture developed rapidly, greenhouses boomed and the area increased to 2.5 million ha ranking the first in the world in 2006. Currently, the

current production is expanding from vegetables to horticulture, fruits, saplings, edible fungi and herbal medicines.

Soilless culture usage in China dates back to the Song Dynasty when people steeped bean sprouts for human consumption (Pan, 2001). Commercial soilless culture began in 1941. The need for green food, easy management of soilless culture and the large area needed for greenhouse are making soilless culture getting popular in China (Jiang, 2001). Shandong Agricultural University started to produce soilless vegetables in gravel in a small area in 1976.

The soilless culture technology in China is still at its infancy however with the policy of the central government making it a national key project, progress is being made. In 1985, soilless culture area was 0.1 ha, by 1990, it was 7 ha, 50 ha in 1995 and increased to 315 in 2003 with the potential of increase in subsequent years.

#### *F. Agricultural Engineering Education and Research in China*

The evolution and development of agricultural engineering education in China is closely linked with the policies and support of the central government. The need for China to feed her population gingered the government to formulate policies to promote agricultural mechanization through the training of required personnel. According to Mao Zedong, the future of agriculture lies in mechanization and irrigation is the lifeblood of agriculture (Mao, 1959). In 1966, it was the government policy to basically complete agricultural mechanization by 1980. To achieve this goal, the central government heavily invested and provided subsidies and preferential loans. By 1980, China was able to record level of tillage mechanization of 42.4%.

Agricultural Engineering education was launched in 1930 in China but evolved slowly. In 1948, departments of Agricultural Engineering were set up at the Central University and Jinling University and the department was renamed as departments of Agricultural Mechanization in 1952. In 1978, Fang Yi (Vice-Premier) emphasized on the importance of research and application of agricultural engineering. Draft for developing Agricultural Engineering was proposed and an agricultural engineering discipline group under the central government was set up to supervise agricultural engineering science and technology development. In 1979, the Chinese Society of Agricultural Engineering (CSAE) and Chinese Academy of Agricultural Engineering (CAAE) were set up with the assistance of the government. In 1980, approval was granted for the award of PhD and master degrees for agricultural engineering.

Agricultural Engineering education systems are divided into: specialized post-primary schools, technical and vocational colleges and Universities/ Research and Development Institutes (70 for bachelor degrees, 38 for master degree and 11 for PhD degrees). In China, the main areas of research in agricultural engineering are in the following areas: Agricultural mechanization engineering, Agricultural soil and water engineering, Agricultural Bio-environmental engineering, Agricultural energy

engineering, Agricultural Electrification and Automation, Agricultural products processing engineering, Land Use Engineering, Agricultural System Engineering (Zhu, 2007).

In order to promote research and development in Agricultural Engineering, the government increased funding and established research institutes, agricultural engineering institutions, technology extension service and R&D divisions of manufacturing enterprises. In the period between 2001 and 2005, funding for agricultural mechanization national key project investment was \$40 million, five fold increase over 1996-2000 (Wang and Qiao, 2007).

#### **IV. CONCLUSION**

Agricultural Engineering profession and practice in China is greatly supported by the central government policies and support. The support is in the area of adequate funding for research and development, training and extension. In the last twenty years, the central government at the beginning of every year issues policies documents and working plan related to agriculture, rural areas and farmers issue. The attendant results is the contribution of agricultural engineering to ensuring adequate food supply and enhancing the income of the farmers (Adekola, 2011). Agricultural engineering development in China has promoted mechanization and industrialization of agricultural production, development of cooperative organizations of farmers, advanced research in new techniques, competitiveness of agricultural products and environmental protection and ecological development.

Many Africa countries are still faced with the inadequate supply of food to feed their population. The attendant results are hunger, malnutrition, and sometimes political instability. The model of China experience can be adapted to revolutionize the Africa agriculture. Government heavy investment in all aspects of agriculture is highly needed, researches into new and improved mechanization agricultural system is urgently needed. Farmers need incentives and increased income to avoid urban migration thereby depleting rural labor. Rural transportation needs to be overhauled and post-harvest technology needs great improvement. Appropriate government deliberate supportive policies are required and I believe Africa countries governments can learn from Chinese experience. A lot of Africa countries have the required resources and experts to develop agriculture and make Africa self-sufficient in food production (Adekola, 2010). However, government efforts, investment and favorable policies are still inadequate in most Africa countries. Huge food importation being employed by Nigeria and some governments to supplement local production will not augur well for sustainable efforts to be self-dependent in food production. Instead local investment should be made to encourage local investors in agricultural sector (Adekola, 2010).

With the double challenges of shortage of primary resources and increasing population, coupled with the increasing demand for quality and safe agro-products,

agricultural engineering in China is facing new challenges to increase the quality and quantity of agricultural products. However, if the central government continues to outline and adopt appropriate and effective measures and initiatives, research and development in agricultural engineering will be able to continue to cope with the emerging challenges.

### REFERENCES

- [1] Adekola, K.A. (2010). Problems and prospects of agriculture in Africa- Nigeria as a case study. Proceeding on Solutions to Food Scarcity in Africa Through Sino-Africa Bilateral Cooperation, Jilin University, Changchun, China. Pp. 25-34.
- [2] Adekola, K.A. (2011). Agricultural engineering research and China self- sufficiency in food production. Proceeding on Agricultural Education and Food Security, Jilin Agricultural University, Changchun, China. Pp. 44-50.
- [3] Central Committee of Communist Party of China , CCCP. (1983). Some issues of current rural economic policies.
- [4] China Agricultural Yearbook, CAY (2006). China Agricultural Press, Beijing.
- [5] Dong, R.J. (1998). The study on eco-greenhouse environment. PhD. Thesis. Pp. 102-125.
- [6] Jiang, W.J. (2001). Development of soilless culture in mainland of China. Transaction of Chinese Society of Agricultural Engineering, (1), Pp. 10-15.
- [7] Jiang, Z.M. (2002). Building all-round well-off society and creating a new situation in building socialism with Chinese characteristics. The Report at the 16<sup>th</sup> National Congress of the Communist Party of China (CPC).
- [8] Lu, Z.X. (1998). Foresight of poultry industry and equipment in China. Poultry Industry Science and Technology:14 (4), Pp. 1-4.
- [9] Mao, Z.D. (1959). The China's revolution and the Communist Party of China.
- [10] Pan, J.Q. (1996). Development of sunlight greenhouses in China. Journal of Shihezi University : 3, Pp. 1-4.
- [11] Pan, W.W. (2001). The current situation and the future of greenhouse industry development. North Horticulture : 3, Pp. 4-5.
- [12] Wang, M.H. and Qian, J. (2007). Restructuring R&D of agricultural engineering in China. International Seminar on Restructuring and Strengthening Research and Development of Agricultural Engineering, Beijing, April 27.
- [13] Zhang, B.W. (2004). Development of agricultural engineering in China. Proceedings of the 2004 CIGR International Conferences, Beijing, Oct. 11-14.
- [14] Zhou, X.X., Dong, R.J., Li, S.J., Peng, G.J., Zhang, L.F., Hou, J.C., Xiao, J.H., and Zhu, B.H. (2003). Agricultural engineering in China. Agricultural Engineering International: CIGR Journal of Scientific Research and Development. Invited Overview Paper.
- [15] Zhu, M. (2005). New developments of agricultural engineering in China. Transactions of the Chinese Society of Agricultural Engineering (CSAE): 21(12), Pp. 1-11.
- [16] Zhu, M. (2006). Promoting the innovation of agricultural engineering science and technology for building new socialist countryside of China. Transaction of the Chinese Society of Agricultural Engineering (CSAE): 22(6), Pp. 192-196.
- [17] Zhu, M. (2007). Experience of agricultural engineering development in China. Transaction of Chinese Society of Agricultural Engineering (CSAE): 9, Pp. 269-275.

### AUTHOR'S PROFILE



#### **Kehinde Adedeji Adekola, Ph.D.**

is a Nigerian and he has been involved in teaching, research and consultancy at University level for about 25 years. He got his Ph.D. degree in Agricultural Engineering (Emphasis in Agricultural Products Storage and Processing Engineering) from Jilin University, Changchun, P.R. China in 1999. Presently, he is a Senior Research Fellow/Associate Professor at the Jilin University. He has written and presented many academic articles in reputable journals, conferences and meetings. He is also a reviewer for some reputable academic journals. His research interests include: Food Engineering, Computer Applications in Agriculture, Process Engineering, Agricultural Products Packaging and Transportation, Agricultural Production Systems and Policy, Appropriate Technology and Energy Utilization. He is a member of professional and social organizations such as Nigerian Society of Engineers, Council of Registered Engineers of Nigeria, Nigerian Institution of Agricultural Engineers, American Society of Agricultural and Bio-Resources Engineers, Chinese Society of Agricultural Engineers and Jaycees International.