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Review Article

Historical Overview of the Chinese Agricultural Sciences and Technological Development

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ABSTRACT

In the modern eras, science and technology considered as main focus of countries and economic success of the China in all fields purely linked to research. In recent decades China considered as largest market for pesticides, fertilizer, organic chemicals, food, and agriculture related product. According to history, the Neolithic era considered as beginning time of Chinese agricultural development and after 2000 they grow so rapidly; while in five (2011-2015) year plan they focused on the scientific and technological development. In this era of scientific development, many innovations has made and applied through their respective fields for development. In term of agricultural sciences and technology, they developed crop varieties and improved animal generations to produce more consumption resources for humans. After the production of food from natural resources then the main focus is on the processing and transportation of foods to far areas. They evolve the new technologies to store, process and transport the food and their products. After research and innovation Chinese public offices allow the farmers and low income community to focus on the technology rather than rely on aid and subsidies. The development and innovations at lower scales upgraded the country in terms of production and application. This review will further refine our knowledge about the Chinese historical development and innovations.

Keywords: *Economic success, development, scientific era, empowerment, innovations, historian.*

INTRODUCTION

China's economic success is directly related to technological development. China has made enormous advancements in the last ten years in terms of politics, economics, and other areas, undergoing a total transformation from the previous 200 years. China's advancements are closely watched by the world not only because China is the largest market for their products but also because China's technological achievements are gradually becoming more advanced.

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Basic and applied sciences are the foundation of technology; science and technology are closely related fields (Meyer-Krahmer & Schmoch, 1998). Technology couldn't advance in any significant way without a solid foundation in science. On the other side, technology can promote scientific advancements and industry growth (Guo et al., 2017)

The act of exploiting the products of others' work is pervasive throughout science and technology. People who have severe flaws in their research papers but refuse to fix them are not new. China's technology has advanced significantly since it opened up to the rest of the world, but some young Chinese researchers make mistakes by trying to find the quickest path to success and notoriety (Haour & Von Zedtwitz, 2016).

1.1 Investment in terms of science and technology

Science and technology investments made by a country can be both short-term and long-term. Using established technologies to reach high levels of production in the near term would undoubtedly lead to economic prosperity (Sandén & Azar, 2005). However, if this type of investment is the main focus, economic growth will only be temporary.

Long-term investment is highly correlated with a society's overall social and cultural environment. Not only may social and cultural advancement help technology, but it is also the key to scientific and technical innovation (Sandén & Azar, 2005). It is not a coincidence that significant technological and scientific advancements take place in culturally significant areas. A society's culture not only promotes the gathering of top engineers and scientists, but also fosters the development of their concepts. Hughes, (2004) studied that and viewed from the other perspective, amazing advancements in science and technology also support the expansion of culture.

1.1.1 Example of investment

A country's technological and scientific advancement stems from its universities. Over three-quarters of the copyright and patents in the United States, which are the most in the entire worlds are the result of scholarly research. Research conducted by universities and research institutions, particularly long-term investments in research that are made by a partnership between universities, corporations, and the government, is intrinsically linked to progress in industry, commerce, or the military.

1.2 Importance of Agriculture and planning of Chinese nation (ICSC)

Humans depend on crops for a variety of essential goods, such as food, feed, vegetables, cooking oil, textiles, timber, and medicines. We confront enormous difficulties in producing more crop goods to feed the world due to dwindling arable land, limited water, and frequent natural calamities (Ali et al., 2021, 2023). Crop science has become more crucial in addressing these issues in a warming world, and guaranteeing food security through scientific and technical advancements has become a priority shared by all nations. Innovation in numerous areas of crop science and technology, such as genetics, breeding, agronomy, crop physiology, genomic resources, grain chemistry, grain storage, and grain processing, crop management techniques, crop biotechnology, and biomathematics, is necessary for sustainable crop production and global food security (Ali et al., 2022a, 2022b).

Hong (2017) reported that the Ministry of Science and Technology has collaborated with related departments and local governments to develop innovative agricultural science and technology systems and mechanisms since the implementation of the 12th Five-Year Plan, particularly the 18th National Congress of the Communist Party of China.

These initiatives have significantly advanced agricultural science and technology in China. China made substantial advances in agricultural research and technology between 2011 and 2015, which resulted in more than 56% of economic growth in agriculture in 2015 as compared to 52% in 2010 (Kang et al., 2017). The capacity of China to seek innovation has also significantly increased.

The International Crop Science Congress (ICSC), known as the "Olympics of crop science," is a regular event that enables crop scientists from all around the world to incorporate contemporary knowledge into a global context and worldwide applications. It gives participants a great chance to discuss the most recent advancements made in crop science on a global scale and to formulate suggestions for new directions in research, development, and technology transfer. Since July 1992, the congress has been held every four years (Xu et al., 2017). Jones et al. (2023) reported that ICSC was first held in Ames, Iowa, USA in 1992. Subsequent gatherings took place in India (1996), Germany (2000), Australia (2004), South Korea (2008), and Brazil (2012). Organized by the Institute of Crop Sciences and hosted by the Chinese Academy of Agricultural Sciences (CAAS) and Crop Science Society of China the 7th ICSC was held on August 14–19, 2016 in Beijing, China.

The 7th ICSC, with its focus on "Crop Science: Innovation and Sustainability," included 19 plenary lectures, more than 300 workshops sessions, more than 900 presentations, and more than 2000 attendees from more than 70 nations. The scientific topics included agronomy and agricultural physiology, breeding and seed production, crop genetics and genomics, climate change and sustainability, crop quality and processing, crop production, and socioeconomic factors (Xu et al., 2017).

1.3 Historical development in agriculture productivity

The Neolithic era has seen beginning of Chinese agriculture, and this farming culture has endured for thousands of years. Since the formation of the People's Republic of China, agriculture and the rural economy have developed quickly (Zhang, 2018). China has successfully made the switch from a country that receives food aid to one that provides it, producing 25% of the world's food and feeding 20% of its population on 9% of its arable land (Shifrew et al., 2013). As reported by Liu et al. (2016) that the China has made a number of significant advancements in the development of modern agriculture during the era five (2011-2015) years. With an annual grain output of over 620 million tons in 2015, integrated production capacity has first reached a new level, reflecting 12 years of annual rises. Second, farmer income has climbed significantly over the past six years, outpacing both urban and rural per capita disposable income increases, reaching a new high of 1739 US dollars in 2015. This represents a new record for farmer income.

Science and technology have contributed more than 56% of the advancement in agricultural output and technical equipment, demonstrating the shift in Chinese agriculture and crop production from a resource-input-driven sector to one that is predominantly driven by science and technology (Xu et al., 2017). In 63% of production processes, integrated mechanization of farming, including land preparation, planting, and harvesting, has been achieved. This transition from an operation dominated by human and animal power that lasted for thousands of years to one dominated by machines shows how agricultural products are produced today (Aryal et al., 2021). The successful irrigation of more than 52% of agricultural land has changed the dependency on rainfall probability.

As a result, almost 43% of the increase in agricultural productivity has been attributed to better, high-quality cultivars and breeds. Utilizing new scientific and technological advancements has reduced soil and water loss from sloping crops by more than 50% and emissions of nitrogen and phosphorus by over 60%. The productivity of all farmland has increased by more than 20% as a result (Kumar et al., 2022).

Khan et al. (2022) reported three categories best describe how agricultural science and technology has advanced. First, there has been a significant increase in agricultural innovation capacity. Second, significant industry technologies have frequently made advances. China is now the leading producer and consumer of slow-release fertilizers. Third, technological advancement has significantly enhanced how agricultural resources are used such as the use of rice straw mulching technology has reduced water and soil loss on sloping terrain by 70% and boosted soil productivity by 20% in the southern hill areas, including Yunnan and Guizhou provinces.

1.3.1 *Innovation in crop science and sustainability*

Chinese nation done major developments in crop science and technology have been made in the representative fields of hybrid rice breeding (Jia et al., 2017), minor cereal production (Diao, 2017; & Aulakh et al., 2001) and genetic improvement, food legume production, rapeseed research and production, cotton domestication (Fang et al., 2017), cropping system innovation, rice agronomic management, genomics-based germplasm research (Xu et al., 2017), and QTL mapping (Xu & Zhu, 1994; Xu et al., 1997, & Wu et al., 1999).

1.3.2 Breeding of hybrid rice

Over 50% of China's rice field has been planted with hybrid rice, one of the world's most significant contributions to agricultural science. Three-line to two-line systems, indica x indica to japonica x japonica and indica x japonica hybrids have all been introduced (Li & Yuan, 2000). Professor Longping Yuan details the advances made in hybrid rice breeding in this special issue, including the four high-yield breeding stages that resulted in yield increases from 10.5 t ha^{-1} in phase I to 15.0 t ha $^{-1}$ in phase IV (Diao, 2017).

1.3.3 *Genetic improvement and production of cereals*

Numerous minor grains, in addition to big cereals like rice, maize, and wheat, provide significant contributions to Chinese agriculture and the country's food supply (Yang et al., 2017). With changes in governmental policy, consumer tastes, and lifestyles, the planting areas and relative importance of minor cereals have increased and decreased when compared to main cereals and each other (Moberg et al., 2021). Numerous minor cereals exhibit significant drought resistance and high fertilizer usage efficiency, opening up new possibilities for the development of environmentally friendly crops and a more varied supply of food for both humans and animals (Newton et al., 2011).

1.3.4 Legumes production

China's huge landmass and intricate ecosystems have resulted in a wide range of legume species. Those legumes used for dry grains and vegetables are considered food legumes in China, with the exception of soybean and groundnut, which are considered oil crops (Li et al., 2017). The legumes and cereals are considered as main crop for food production (Ali et al., 2002c, 2022d; & Riaz 2022b). Culinary legumes serve as a significant crop category in Chinese traditional and sustainable agriculture, providing significant dietary protein, vitamin B, and a variety of food dishes, preserving the fundamental health of the Chinese people (Singh et al., 2022).

1.3.5 Rapeseed research and production

Rapeseed (*Brassica napus* L.), the largest oilseed crop and the fourth largest crop in China after maize, rice, and wheat, contributes to around 20% of global production (Hu et al., 2017). New methods for managing rapeseed fields, as well as complete mechanization of the rapeseed producing process. Advances in breeding and production techniques could result in a significant increase in oil yield and quality, as well as the development of desirable features including early maturation, high yield, robust tolerance to biotic and abiotic stressors, and mechanized compatibility (Riaz 2022a; 2022c).

1.3.6 Crop system innovation and rice crop management

In order to create a sustainable ecological system, China has a long history of inventing beneficial cropping techniques in agriculture, such as crop rotation and intercropping. China has successfully adapted to climate change with significantly increased soil organic carbon content, decreased greenhouse gas emissions, and dramatically enhanced crop productivity and resource use efficiency (Ding et al., 2023). About half of the water used in agriculture worldwide is used to grow rice, one of the most significant food crops. In Asia, rice uses around 80% of the fresh water utilized for irrigation. In addition to producing 15%–20% of the world's anthropogenic methane emissions (Aulakh et al., 2001), rice fields also produce nitrous oxide as a result of nitrogen fertilization and water management.

1.3.7 QTL mapping

Genetic manipulation of quantitative trait loci (QTL) has drawn a lot of attention because the majority of agronomically significant traits are quantitatively inherited. This includes the development of statistical tools and methodologies for QTL mapping. The genetic mapping of QTL environment interactions (Wang et al., 1999), a modified technique for composite interval mapping (Li et al., 2007), and dynamic QTL mapping strategies (Wu et al., 1999; & Xu, 1997) are just a few of the research groups in China that have made contributions to QTL mapping. Genetic mapping has been transformed by recent advancements in sequencing, high-throughput genotyping, and GWAS.

1.4 Major development in scientific research

On important topics including resource gathering and gene mining, disaster prevention and control, the agricultural environment and its evolution, Chinese scientists have achieved a number of outstanding discoveries.

1.4.1 National system for germplasm collection and conversion

China has set up a reliable national system for conserving and collecting genetic material (Volis, 2018). The second-largest economy in the world is conservation. A bank of agricultural microbiological resources, a germplasm bank for special animals, and the largest somatic cell bank of cattle and poultry in the world have also been constructed in China (Guan et al., 2011).

1.4.2 Draft genome sequence of aegilops tauschii

Putting an end to the absence of an assembled genome sequence for wheat, Chinese researchers became the first in the world to finish sequencing the aegilops tauschii genome, which is the D genome donor of common wheat (Luo et al., 2017)

1.4.3 Sequencing oyster genome and whole-genome selective breeding

An innovative genomic study of lophotrochozoa was conducted by Chinese researchers who constructed a genome sequence map of oyster species. Chinese researchers made notable strides in the field of genomics and created novel genotyping methods and algorithms (Zhang et al., 2012).

1.4.4 Draft genome sequence of moso bamboo

Chinese researchers were the ones to start and finish the first draught genome sequence of any type for the moso bamboo. The study uncovered 31,987 very reliable genes and their expression profiles, as well as the evolutionary history of moso bamboo going back 50 million years (Li & Cheng, 2021).

1.4.5 *A planting pattern that boosts yield and cuts environmental costs*

A planting strategy that can increase crop yields and lower environmental costs was devised and validated by Chinese researchers. Researchers found that adopting an integrated soil-crop system management considerably increased rice, wheat, and maize yields while using fewer nitrogenous fertilizers overall (Wang et al., 2020).

1.5 Development in national food security

Any nation's primary goal should be ensuring food security in order to maintain social stability, economic growth, and national independence. These accomplishments have greatly benefited China's seed business and food security.

1.5.1 Technological innovations in hybrid rice and large-scale application

With a record yield of 1,026.7 kilograms per mu (666.67 square meters) of farmland, researchers made a substantial advancement in the fourth phase investigation of super rice. China planted 700 million mu of bilinear hybrid rice in total, adding up to significant economic gains of over RMB 40 billion. Achieving this has improved China's food security (Zhang et al., 2021).

1.5.2 Maize variety "Zhongdan 909"

Zhondan 909 is a new maize variety characterized by steady yield, tolerant to high density, eurytopicity, fruitfulness, high seed rate, quality seeds, and strong disease resistance. The yield per mu ranges from 600 to 800 kilograms on average, with trial plantations in the northwest and the Huang-Huai-Hai Plain (a sizable alluvial plain in northern China formed by the deposits of the Huang He (Yellow River), the Huai River, the Hai River, and a few other minor rivers in northern China) occasionally exceeding 1,000 kilograms. The new variety was awarded the Second Prize of State Scientific and Technological Progress in 2014 (Chen et al., 2021)

1.5.3 *Innovations of planting pattern that cuts environmental impacts and boosts crop yield*

A planting strategy that can increase crop yields and lower environmental costs was proposed and validated by Chinese researchers. Researchers found that adopting an integrated soil-crop system management significantly increased rice, wheat, and maize yields while using fewer nitrogenous fertilizers overall (Wang et al., 2020).

1.5.4 National food security

Any nation's primary goal should be ensuring food security in order to maintain social stability, economic growth, and national independence (Godfray et al., 2010). In order to ensure food security, China has traditionally prioritized domestic seed innovation and made technological advancements in hybrid, molecular, and new variety breeding. These accomplishments have greatly benefited China's seed business and food security (Li et al., 2009).

1.5.5 Breeding and promotion of "Jingke 968"

Common maize cultivars with benefits including large yields, good quality, robust resilience, eurytopicity, and ease of sowing were created using innovative breeding techniques. From 2012 through 2015, the Ministry of Agriculture endorsed the "Jingke 968" as the best maize variety. In these years, it planted a total of 35.1 million mu, boosting its output value by RMB 491.4 billion and its yield by 2.457 billion kilos. One of the maize types that is currently grown the most in China is "Jingke 968" (Erenstein et al., 2022).

1.6 Upgradation of food industry

In order to assure a consistent supply of vegetables, fruits, meats, eggs, and dairy products throughout the year, scientists have developed a number of high-yielding, high-quality novel varieties. They have also developed efficient, healthy, and clean cultivation and breeding technologies. Today, China is the world's top producer of fruits, vegetables, meats, seafood, poultry, and eggs.

1.6.1 Nongda 3 breeding and its application

The "Nongda 3" small layers are distinguished from other high-yield layers by their high feed conversion rate and higher breeding density, which lowers feed consumption and the size of the hen house. The hens have been widely raised in many parts of China because of their benefits, including high survival rates, robust disease resistance, and high egg quality (Nie et al., 2013).

1.6.2 Beijing duck breeding and new varieties application

Researchers created novel breeding techniques for Beijing duck and successfully produced two new top-notch kinds. The variations can overcome the issues caused by conventional breeding techniques, such as poor development and low feed conversion rate, by growing to 3.5 kg 39 days after birth and increasing feed efficiency by at least 35%. With the introduction of the new types, labour productivity has increased, a cooperative breeding model between research institutions and poultry enterprises has been established, and there have been significant social and economic advantages (Safi et al., 2022; & Farrell, 2013).

1.6.3 Waxberry or loquat storage and its transportation

Fruits that are unique to China include waxberry and loquat. However, owing of the difficult storage and transportation conditions, losses might range from 25% to 50%. Scientists established that tissue lignification causes the red loquat's firmness and created key technologies to store the fruit in a secure, eco-friendly setting with remote controllable humidity and temperature (Shah et al., 2023). The commercial fruit rate for waxberry and loquat increases by 30% to 80% with the implementation of new technologies and standards for storage and transportation, and the average profit rises by RMB 3,500-5,000 per ton.

1.7 Service system of grassroots science and technology development

The Ministry has dispatched TTFs to assist farmers in starting their own farms and has intensified up efforts to create a reliable science and technology service network in rural areas.

1.7.1 Stronger presence of TTF

TTF is a useful innovation based on real needs from the rural community, and it's a significant accomplishment from the agricultural reform and development as well as the science and technology system reform (Menon, 2013). The service was first introduced in 2002 as a test project before being made available nationwide in 2009. Currently, the initiative has covered around 90% of China's territory and has helped to resolve difficulties with agriculture, farmers, and rural areas as well as push for balanced development in both rural and urban areas (Chen et al., 2009).

1.7.2 Formation of new research institute

A complete system of agricultural technology services is taking shape as a result of the establishment of 39 research institutions for modern rural development at universities. A total of 44,753 mu of farmland, planted with crops, economically advantageous trees, fruits, and vegetables, is covered by over 1,400 full-time professionals providing grassroots agricultural technology services at 414 bases across the nation (Ritchie et al., 2022). They investigated various agricultural technology service models.

1.7.3 Aiding the poor with technology

The National Science and Technology Commission first proposed the concept of assisting the underprivileged through technology in 1986. From five different angles, the three-decade campaign has been successful and productive. Chinese promoted the idea that poor people should rely on science, technology, and innovation to become wealthy rather than requesting government aid and subsidies (Schoff & Ito, 2019).

CONCLUSION

Chinese nation considered as most advanced in agriculture and technology development from crop production to food processing and transportation. The Neolithic eras are considered as begging of Chinese agriculture and after 2000 Chinese agriculture develop fastly; while in five (2011-2015) years they made substantial advancement in agricultural sciences and technology that starts from field management to germplasm improvement, genetics innovations and development of new high yielded verities of plants and animals. Food security considered as main purpose of the nation to secure the public from food shortage. The Chinese nation self-esteemed their farmer to produce own food and even export to other world and now the China is considered as main food supplier and highly advanced in agriculture and food production. The upcoming years made the Chinese nation more developed and effective over the world due their more educational and technological research.

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