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editorial

A Chinese renaissance

For millennia, Chinese knowledge of agriculture and crop breeding influenced the whole world. After an extended period of introspection, Chinese plant biology is once again establishing global eminence.

The 28 January 2017 was the Chinese Lunar New Year, also known as Nian (the Chinese character is: 年) or the Spring Festival. According to the legend, Nian was a god who killed the fierce monster Xi (夕). However, in ancient Chinese hieroglyphics, Nian is shaped like a person carrying crops on their back (), suggesting that the Spring Festival was once a celebration of harvest. Crops underpin the rise of this ancient civilization and have been an important element in Chinese culture. Fittingly, its similarly long history of crop science research has seen China make continuous and tremendous impacts on the world's crop science, from ancient times to the present day.

Archaeological evidence suggests that the Chinese learned to grow cereal crops over 8,000 years ago. Rice was one of the earliest cultivated crops and was originally domesticated on the Yangtze River, according to the archaeological record. Genomic data, however, point to different geographical regions, such as regions of the Pearl River Delta in addition to the Yangtze River. The cultivation of rice and wheat, which was imported later from the Middle East, largely contributed to the ancient population expansion in China.

The earliest written records of Chinese crop science, such as the descriptions in *Guanzi*, date back to the pre-Qin period (before 221 BC). From the Han dynasty (202 BC–AD 220) to the Ming dynasty (1368–1644), some encyclopaedic books were written to systematically record Chinese people's agricultural practices, such as *Fansheng Zhishu* and *Qimin Yaoshu*. These books cover agricultural techniques, including grafting, irrigation, tilling and weeding. But there are also discussions of different crop species, seed selection and breeding. The books also spread to other countries such as Japan, where they had a substantial impact. At the end of the nineteenth century, when *Qimin Yaoshu* was introduced to Europe, Charles Darwin cited it as "an ancient Chinese encyclopaedia" in *On the Origin of Species*.

Medicinal crops are another Chinese contribution to the world's knowledge. The fact that many herbs can be effective in treating diseases suggests that there are effective, active ingredients contained in these plants. *Artemisia annua* L. is used for treating malaria; this was originally documented in the *Handbook of Prescriptions for Emergencies* (*Zhou Hou Bei Ji Fang*), written during the Eastern Jin Dynasty (AD 317–AD 420). In 1972, a group of Chinese scientists, led by Tu Youyou, isolated artemisinin from this plant. Youyou pioneered the use of artemisinin as a treatment for malaria, saving millions of lives, especially in developing countries, for which she was awarded the 2015 Nobel Prize in Medicine.

The *Compendium of Materia Medica* (*Bencao Gangmu*) is undoubtedly the most influential Chinese herbal medicinal work. Written by the great medicinal plant biologist Shizhen Li during the Ming dynasty, it took 30 years to finish and it was published after his death. It summarized and categorized all contemporaneous knowledge about herbal medicine, including the descriptions of 1,892 types of medicine, most of which are herbs. It included a novel and scientific classification method to assign herbs into classes based on their morphological, ecological and functional features. After publication, the book quickly spread to many countries, such as Japan, Korea and Europe, and was translated into multiple languages. Carl Linnaeus obtained a copy from the Swedish botanist Magnus von Lagerstroem, and it is believed that this book inspired his ideas for plant taxonomy. In *The Descent of Man*, Darwin cited the compendium's examples of plants under human selection. Furthermore, the historian of science Joseph Needham claimed it to be the greatest scientific achievement of the Ming dynasty.

In the eighteenth century, the Qing dynasty government decided to close the doors to the outside world, leaving an isolated China to lag behind in societal and scientific progress. This did not change until the establishment of the People's Republic of China in the twentieth century. Deng Xiaoping's reforms and opening up in 1978 boosted economic growth and reinvigorated scientific progress. Over the past 40 years, China has invested heavily in the development of crop sciences to feed what is the largest population in the world.

A steady increase in funding and investment has seen the proportion of Chinese gross domestic product spent on research and development climb to over 2% since 2013. The importance of food security has led to substantial support from major funding sources, including the National Natural Science Foundation of China, the Ministry of Science and Technology, the Ministry of Agriculture, and the Chinese Academy of Sciences. The proportion of Chinese publications on agricultural sciences indexed in Web of Science increased from 7.1% in 2006 (ranked third after the United States and Brazil) to 17.7% in 2016 (ranked first). High-quality research has also increased dramatically. China published 6.3% of the papers in prestigious plant journals in 2006, but by 2016 this had risen to 20.6% (second only to the United States).

China's balance of talent imports and exports has also reveresd. In the 1980s and early 1990s, excellent Chinese researchers tended to pursue careers in Western countries, but since the mid-1990s, various talent programmes have continuously driven the return of expatriate scientists and attracted foreign researchers.

Among the many fast-developing subfields of crop sciences, rice biology and crop genomics are two areas where China has made a particular impact. Hybrid rice developed by Chinese breeders has significantly enhanced rice production in many countries. Chinese researchers are prominent in cloning rice functional genes for multiple agronomic traits, such as plant architectures, grain sizes and stress resistance. Moreover, population genomic research led by Chinese scientists has provided deeper insights into basic questions, such as rice domestication and heterosis.

Thanks to the development of next-generation sequencing and the rise of the Beijing Genomic Institute as one of the biggest sequencing centres in the world, China has taken the leading position in crop genomic research. Numerous crop genomic projects have been completed or jointly accomplished by Chinese scientists, such as genomes of rice, wheat, cucumber, cabbage, cotton, citrus and watermelon.

With a fast-growing economy and research investment, China's crop sciences will continue to make great progress. In the Spring Festival, the Chinese should not only celebrate legendary acts of monster slaying, but also the no less heroic contributions that they and their ancestors have made, through the crop sciences, to tackling a monster more destructive than Xi: world hunger. ❐