2020 CAAS ANNUAL REPORT

Compiled by the Department of International Cooperation of CAAS

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Editorial Board of CAAS Annual Report 2020

2020

Message from the President

The year 2020 was an extraordinary year in which China succeeded in poverty alleviation and completed its goal of building a moderately prosperous society, or "Xiaokang society", in all respects. Led by the call of Chinese President Xi Jinping, also General Secretary of CPC Central Committee, in his congratulatory letter in celebration of the CAAS's 60th anniversary in 2017, against the backdrop of the global pandemic, in 2020, CAAS achieved substantial breakthroughs in scientific and technological innovation, bigger returns out of research achievement transformation, refined talent structure, better postgraduate education and talent cultivation, improved research facilities, boosted capacity in supporting China's agricultural development, and greater global influence. All of these efforts and achievements fully reflected CAAS's commitment and devotion as the premier national team in China's agricultural research.

In 2020, CAAS experts led 2,312 new research projects with an overall contract funding of 1.52 billion yuan (239 million US dollars). CAAS won 7 Second Prizes of the National Science and Technology Progress Award, accounting for 28 percent of total agricultural-related prizes awarded in 2020. Up to 7,202 papers from the Academy were published in 2020, among which 4,179 were included in the SCI/EI (Science Citation Index/Engineering Index), and the impact factor of 49 papers are higher than 10. Eight fundamental research projects revealed major scientific discovery. A total of 34 CAAS scientists won accolades in various national-level talent programs. The Academy's annual revenue from research achievement transformation surged to a historic high of 1.22 billion yuan (192 million US dollars). Making full use of science and technology, CAAS helped all its match-making impoverished counties be lifted out of poverty, contributed to China's decisive victory of poverty alleviation.

The Academy initiated CAAS International Science and Technology Innovation Program (CAASTIP) with the first series of three projects—G2P Crop Molecular Breeding, Cross-border Plant Disease and Pest Monitoring as well as Smart Agriculture, be more integrated to the global network of agricultural science and technology innovation.

The assistance and support of friends and peers from home and abroad is essential to the development of CAAS. The Academy will keep its aspirations and openness unchanged while looking forward to more exchange and cooperation with all partners and embracing a bright new future in agricultural development.

Prof. Tang Huajun
President of Chinese Academy of Agricultural Sciences
Academician of Chinese Academy of Engineering

Commitment

As a national-level agricultural research institution, CAAS is an academic institution for comprehensive agricultural scientific research and is responsible for providing strategic advisory services for agriculture and agricultural science and technology. It functions as the major national technological force for agriculture, rural areas and farmers.

In response to the call from the CPC Central Committee and State Council's policies on rural development and agricultural research, CAAS has been steadfast in its mission and positioning as China's national agricultural research team. Focusing on frontier of world agricultural science and technology, major demand from the country, construction of modern agriculture as well as the people's life and health, CAAS is striding towards building the world first-class research institute with world-first class research disciplines. It is dedicated to addressing major science and technology issues in agriculture and rural development that are nonprofit, fundamental, vital, strategic and forward-looking and leading agricultural research forces nationwide to sustainably improve innovation capacities and realize technological progress, therefore making pivotal contributions to the overall leap of China's agricultural science and technology, ensure food security and empower the development of agriculture and the rural economy.

CONTENTS

Key Events in 2020

January

The CAAS 2020 work conference was held in Beijing to sum up the work in 2019 and to map out key tasks in 2020 while sorting out the new situation and challenges. Zhang Taolin, Vice-Minister of Agriculture and Rural Affairs, attended the conference and delivered a speech.

The National Science and Technology Awards Ceremony was held in Beijing. CAAS won 7 awards: 1 second-place prize of the National Natural Science Awards, 1 second-place prize of the National Technological Invention Awards, and 5 second-place prizes of the National Science and Technology Progress Awards.

CAAS held a special work conference on the COVID-19 epidemic prevention and control and deployed related emergency response measures.

February

CAAS held the 2020 work meeting of its departments online, stressing the importance of promoting both epidemic prevention and control and scientific research, as well as raising working efficiency to support the construction of "two first-class" of the academy.

CAAS held a video conference on the progress of scientific research on the prevention and control of the African swine fever, and discussed the effects of promotion and application of pig re-breeding technology. Suggestions were raised during the conference. Tang Huajun, President of CAAS; Zhang Hecheng, Secretary of the Leading Party Group of CAAS; and Li Jinxiang, China's Chief Veterinary Officer (CVO) , attended the meeting.

CAAS carried out necessary prevention and control measures to fight against the epidemic on one hand, and on the other hand, hasten the scientific research to ensure the implementation of key research tasks.

March

CAAS held video conferences on progress of scientific research tasks on ensuring food security through technological advances, supporting, hog production resumption support, and fall armyworm issues, respectively. The conferences stressed the significance of relevant scientific research tasks to stable national crop supplies and poverty elimination.

Zhang Taolin, Vice-Minister of Agriculture and Rural Affairs, made an investigation visit to the fall armyworm prevention and control test base and monitoring center in Jiangcheng, Yunnan province.

July

Liu Huanxin, Vice-Minister of Agriculture and Rural Affairs, paid a visit to CAAS to investigate the financial work, inspected the project of the crop germplasm bank which is under construction and the laboratories of the key engineering projects, agricultural remote sensing laboratory, as well as the National Agricultural Library and the agricultural big data center. Meetings were held for related work discussions.

Bu Xiaolin, Chairwoman of the People's Government of the Inner Mongolia Autonomous Region, visited the Institute of Grassland Research, CAAS to investigate the scientific technology and innovation work supporting the development of Inner Mongolia.

Zhang Taolin, Vice-Minister of Agriculture and Rural Affairs, inspected the ramie base of the Institute of Bast Fiber Crops, CAAS and gave guidance for their work.

August

Sun Tan, Vice-President of CAAS, met with Ali Obaid Al Dhaheri, Ambassador of the United Arab Emirates to China, and his delegation. The two sides exchanged their views on strengthening bilateral cooperation on the agricultural science and technology.

Han Changfu, Minister of Agriculture and Rural Affairs, went to the Harbin Veterinary Research Institute to investigate the research and development progress of the vaccine for African swine fever, encouraging the scientists to accelerate the vaccine research with high efficiency.

CAAS launched the field classes for on-site science and technology assistance in Huachuan county, Jiamusi, Heilongjiang province. Zhang Hecheng, Secretary of the Leading Party Group of CAAS, and Wu Kongming, Vice-President of the academy, attended the event.

Wang Kejian, Professor researcher at the China National Rice Research Institute, won the 2020 Chen Jiageng Youth Science Award. It was the first time that the award went to outstanding young scientists in the field of agriculture since its establishment.

September

The symposium on strategic cooperation between CAAS and Peking University was held in Beijing. The two sides signed a strategic cooperation agreement to jointly explore a new model for the integration of agricultural science and education.

Huai Jinpeng, Secretary of the Party Group and Executive Vice Chairman of the China Association for Science and Technology, went to CAAS for inspection and discussion.

Chinese Vice-Premier Hu Chunhua, visited the Harbin Veterinary Research Institute, CAAS, saying that science should emphasize quality and asked the institute to actively promote the research and development of African swine fever vaccines.

The cultivation and physiology innovation team of the Institute of Crop Sciences, CAAS set a new record of 1,663.25 kg per mu of corn output by implementing high-yield cultivation techniques in Qitai, the Xinjiang Uygur autonomous region. This is the seventh time that the team has reset a high-yield record of corn in China.

April

CAAS held a video conference to publish the fall armyworm prevention and control handout and report on related technologies to plant protection stations from all the provinces and autonomous regions in the country.

The 2020 China Agricultural Outlook Conference was held in Beijing via livesteaming with the theme of "Information Leading High-Quality Agriculture Development". Han Changfu, Minister of Agriculture and Rural Affairs and Qu Dongyu, Director General of the FAO, were invited to make video speeches. Yu Kangzhen, Vice-Minister of Agriculture and Rural Affairs, attended the meeting.

CAAS held a working conference on poverty alleviation to better integrate and utilize scientific and technological forces and make more efforts to complete the objectives of scientific and technological poverty alleviation.

May

Zhang Taolin, Vice-Minister of Agriculture and Rural Affairs, went to the Institute of Animal Sciences, CAAS to investigate the preparation work of the construction of the national livestock and poultry gene banks, stressing that the gene banks should serve as an important platform for the conservation and utilization of livestock and poultry germplasm resources and genes for the development of industry.

CAAS together with the FAO, Slovenia's Ministry of Agriculture, Forestry and Food and other organizations held the celebration event of "World Bee Day" on May 20 via video conference. Qu Dongyu, Director General of the FAO, Tang Huajun, President of CAAS, Alexandra Pivitz, Minister of Agriculture, Forestry and Food of Slovenia, and Jeff Pettis, President of the International Federation of Beekeepers' Association, attended the meeting and delivered speeches.

The second Commendation Conference of the National Innovation Award was held in Beijing. 8 people from CAAS won the prize. The number of winners ranks top among agricultural scientific research institutions in China.

June

CAAS and the International Food Policy Research Institute (IFPRI) jointly held the 2020 China and Global Agricultural Policy Forum in Beijing and released *China's Agricultural Sector Development Report 2020* and *2020 Global Food Policy Report*.

The first member congress of the China Agricultural Green Development Research Association, sponsored by the association and organized by the Institute of Agricultural Resources and Regional Planning of CAAS, was held in Beijing. Han Changfu, Minister of Agriculture and Rural Affairs, attended the meeting and delivered a speech.

CAAS held a press conference in Beijing on its major scientific research progress from 2017 to 2020, summarizing the phased results following President Xi Jinping's congratulatory letter. The academy released "CAAS Top 10 Scientific Research Progress 2017–2020" to the public.

October

The 2020 National Poverty Alleviation Award Commendation Conference and Report Meeting of Advanced Deeds were held in Beijing. Zhang Jinxia, Professor from the Institute of Agricultural Resources and Regional planning, CAAS, won the Innovation Award for Poverty Alleviation.

Liu Huanxin, Vice-Minister of China's Agriculture and Rural Affairs inspected the Agricultural Genomics Institute, CAAS, in terms of their scientific and technology innovation, system and mechanism reform and fundamental construction.

Jin Liping, researcher from the Institute of Vegetable and Flower, CAAS was honored with the title of National March 8 Red-flag Bearer.

The workshop on the construction and development of the North Rice Research Center, which also witnessed a signing ceremony of the strategic cooperation agreement between the center and Beidahuang Group, was held in Beijing.

November

The Forum 2020 on Science and Technology for Agricultural and Rural Development was held in Nanjing. The forum released reports on *Major Progress of China's Agricultural Science in 2020, 2020 Frontier of Global Agricultural Research* and *Analysis of the Global Competitiveness of China's Agricultural Science and Technology Papers and Patents in 2020* among others.

CAAS held 2020 Working Conference on Scientific Research that comprehensively summarized the scientific achievements during 2016–2020 and deployed the priority work of scientific and technological innovation during 2021–2025. The consultation and evaluation of the progress on 18 major scientific research tasks were conducted during the conference.

The 2020 National Model Worker and Advanced Worker Commendation Conference were held in Beijing. Four people from CAAS won the honorary title of National Advanced Worker.

CAAS held the fourth Working Conference for Talent to systematically make the strategic talent cultivation plan around the goal of "promoting youth, strengthening leading scientists, making up weaknesses and improving the environment".

December

The Sino-German Agricultural Science and Technology Forum on Food Security and Nutrition in a Changing World was held in Beijing. More than 140 Chinese and German agricultural experts attended the meeting to discuss the transformation of food systems and dietary changes in the post-pandemic era.

At the fourth Overseas Agricultural Research Conference, the Center for International Agricultural Research (CIAR) of CAAS released the latest research results.

CAAS held a working conference on poverty alleviation and achievement transformation in Beijing. The meeting stressed that science and technology should continue to support rural revitalization, and proposed to promote the achievements transformation to a new level during 2021–2025.

Tang Renjian, Minister of Agriculture and Rural affairs emphasized the importance of vitalizing the seed industry, and strengthening the protection and utilization of agricultural germplasm resources in order to ensure national food security, during his inspection visit to CAAS' national crop germplasm bank. He urged the need to accelerate the tackling of core technologies in related areas.

Achievements during 13th Five-Year Period (2016-2020)

During the 13th Five-Year Period (2016–2020), CAAS has made historic achievements in scientific and technological innovation as well as mechanism reform, and also achieved a significant increase in comprehensive innovation capacity.

Scientific research capacity has reached a higher level. CAAS has made a number of original scientific discoveries that are leading the world. In some fields such as the research of crop genomics, utilization of strong hybrids, creation of new crops, breeding of green super rice, understanding of epidemic mechanisms of major animal diseases as well as vaccine development, CAAS has reached a global pioneer position. It led 99 projects under the National Key R&D Program of China, accounting for 18 percent of all agricultural projects among the total, with a total funding of 3.37 billion yuan (532 million US dollars). The academy obtained 1,572 projects of the National Natural Science Foundation of China (NSFC) with a direct funding of 770 million yuan (122 million US dollars), representing an increase of 12 percent in the number compared with 12th Five-Year. CAAS won 36 national science and technology awards, taking up 26 percent of the national agricultural achievements. Meanwhile, it garnered 257 provincial and ministerial-level awards and 30 Chinese Patent Awards. CAAS published 28,883 papers, including 14,805 SCI papers, with a growth of 18 percent and 82 percent, respectively. Among the papers, 34 were published in top international journals such as Nature, Science and Cell. The total number of SCI papers and highly-cited papers published by CAAS ranked fourth among its international counterparts.

Research on enhancing tomato flavors by a CAAS team was published as a cover story in *Science*

Construction of human resources made new progress. CAAS held four working conferences for talent, which accelerated institutional strategy and improved talent team construction significantly. The academy has introduced around 240 overseas talented staff, cultivated over 580 of its own talent and 252 were newly selected national-level talent. Up to 6 experts were newly elected as academicians from the Chinese Academy of Sciences and the Chinese Academy of Engineering. 4 were honored as distinguished young scholars and 11 were given the honor of outstanding young scholars. Some 18 people were appointed as chiefs of modern agricultural technology systems. More than 250 high-level talent were awarded the title of national talent and the total number of agricultural talent reached more than 330. CAAS enrolled 8,126 postgraduates, an increase of 24 percent compared with the number during the 12th Five-Year Plan period (2011–2015). The number of doctoral students at the academy ranked top among the agricultural and forestry universities in China.

The Fourth Working Conference for Talent of CAAS was held in Beijing

Scientific achievements became new driver for food security and poverty elimination. CAAS promoted more than 300 new agricultural varieties, 700 new products and 200 new technologies. It sent more than 700 expert teams and 12,000 scientific and technical personnel to assist in poverty reduction on-site, helping 97,000 poor households increase their income. It adhered to the new commitment of "the coordination of innovation, entrepreneurship and excellence-creating" and strengthened the scientific achievement transformation system. CAAS embarked in 87 wholly-owned and holding enterprises and gained a total of 2,964 invention patents, 338

CAAS developed science-and-technology-driven poverty elimination project in Huachuan, Heilongjiang province

CAAS staff help farmers through field school in Xinjian"

rights to new varieties of plants and 46 new veterinary drugs and agricultural-use chemicals. Revenue realized from achievements transformation researched more than 1 billion yuan (158 million US dollars).

Support capacity of scientific research infrastructure reached new record. CAAS built the world's largest P4 laboratory single facility for large livestock and completed the construction of the national crop germplasm bank. A regional layout network was formed including the Western Center, Chengdu Center, Nanfan Institute, Shenzhen Food Valley, and Northern Rice Center. As the "three levels (city, county, township) and three categories (overall plan, detailed plan and specialized plan)" platform system was further improved, the sci-tech platform system maintained its dominant position in agriculture. Up to 79 new scientific and technological platforms

Inaugural ceremony of Western Agricultural Research Center

were newly built, which brought the total number to 567. Among the total, 6 are national key laboratories, taking up 26 percent of the total number of such facilities in China's agricultural sector. The academy has 2 national-level major infrastructure construction projects, which are the only two in the agricultural sector in China. CAAS has 18 technology R&D centers focused on a modern agricultural system, accounting for 36 percent of all centers in the country. It has 22 comprehensive key laboratories of the Ministry of Agriculture and Rural Affairs, accounting for 51 percent of the total built.

Scientific innovation forms new ecosystem. Based on the Agricultural Science and Technology Innovation Project (Innovation Project for short), CAAS improved on a new mechanism of forming industry-led scientific research tasks formed a new pattern of research organization, with disciplines as the lead and teams as the units, as well as developed a new mode of scientific investment featured by stable support and guided by output. The Project made effective explorations in terms of performance evaluation and joint research and take measures following the principle of "delegating power, streamlining administration and optimizing government services" in scientific research and breaking "the overemphasis on titles, educational qualifications and awards". All of these have provided valuable experiences for the innovation of the national science and technology system.

The signing of task performance statement for the full promotion period of Innovation Project

International cooperation forms new chapter. CAAS established an extensive international cooperation nexus with more than 330 foreign governmental institutions, research organizations, universities, private sector entities, as well as around 50 international organizations, foundation and cross-border enterprises. The partners hail from 85 countries worldwide. 10 foreign institutions have established their representative offices at CAAS. 127 international cooperation platforms at different levels were established by CAAS and its partners, among which 23 joint labs and demonstration centers are located overseas. The academy possesses 9 International Reference Laboratories recognized by FAO and OIE. Up to 11 cooperation bases were recognized by national science authorities. It successfully held the 5th and 6th Global Forum of Leaders for Agricultural Science and Technology, or GLAST, and initiated a new International Science and Technology Innovation Program—CAASTIP—for the first time with an investment of 10 million US dollars to the first phase of the program, aiming at creating a global agricultural science and technology innovation network. The launch of the program has received positive responses and extensive support from more than 20 global partners, and largely enhanced influence for global coordination.

The sixth Global Forum of Leaders for Agricultural Science and Technology (GLAST-2019) held in Chengdu

05

Science and Technology Innovation

- Summary on Research Achievements
- Important Progress of Scientific Research
  - CAAS Major Scientific Discoveries in 2020
  - CAAS Top 10 Science and Technology Achievements in 2020

Summary on Research Achievements

National Major Science and Technology Projects

CAAS led 4,761 research projects (topics) at all levels of various categories, with a total annual contract value of 7.92 billion yuan (1.25 billion US dollars), of which 2,312 projects were new, with an overall contract value of 1.52 billion yuan (240 million US dollars) and funding of 820 million yuan (129 million US dollars) remain available for institutes. It had 315 projects funded by the National Natural Science Foundation of China (NSFC), with quantity of projects and direct funds increasing by 9 percent and 7.2 percent, respectively, year-on-year. Among them, there were 15 major projects, including 2 projects supported by the National Science Fund for Distinguished Young Scholars and 5 by the Excellent Young Scientists Fund. It made a breakthrough in the development of major projects for talent. CAAS was also granted 3 new projects from National Key R&D Program.

High-Level Papers

A total of 7,202 scientific and technical papers were published, of which 4,179 were included in SCI/EI, 49 papers had an impact factor above 10.

Transformation and Promotion of Scientific Achievements

CAAS registered 9 new veterinary drug certificates, including 3 new class-I drugs. 359 varieties were validated (registered), of which 233 were examined by the national authority. CAAS developed 487 standards of various types and its 58 research reports and policy advice notices were approved by Party and State leaders, doubling the number from the previous year.

Cultivation of Major Achievements

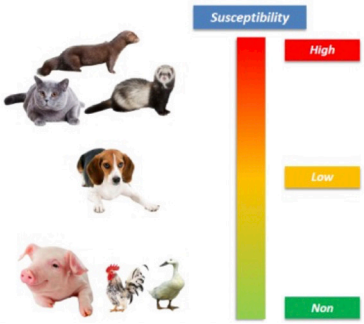
CAAS won 7 national awards—yet to be officially received—as first authors, including 1 National Technology Invention Award and 6 National Science and Technology Progress Awards, which account for 28 percent of the country's awards in the field of agriculture. 25 projects led by CAAS won awards at the provincial and ministerial level, including 5 first-class awards and 11 second-class awards, along with 15 awards for scientific and technological achievements at the institute-level.

Important Progress of Scientific Research

CAAS Major Scientific Discoveries in 2020

Susceptibility of ferrets, cats, dogs, and other domesticated animals to SARS-coronavirus 2 (Bu Zhigao's team at Harbin Veterinary Research Institute)

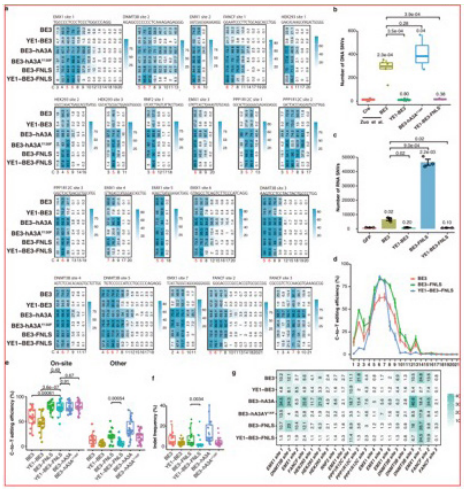
Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causes the infectious disease COVID-19. SARS-CoV-2 is thought to have originated in bats; however, the intermediate animal sources of the virus are completely unknown. Bu Zhigao's team investigated the susceptibility of ferrets and animals in close contact with humans to SARS-CoV-2. They found that SARS-CoV-2 replicates poorly in dogs, pigs, chickens, and ducks, but efficiently in ferrets and cats, and the virus transmits in cats via the airborne route. This study provides important insights into the establishment of SARS-CoV-2 animal models and animal management for COVID-19 control.



▲ The susceptibility of different animals to SARS-CoV-2

A rationally engineered cytosine base editor retains high on-target activity while reducing both DNA and RNA off-target effects (Zuo Erwei's team at Agricultural Genomics Institute at Shenzhen)

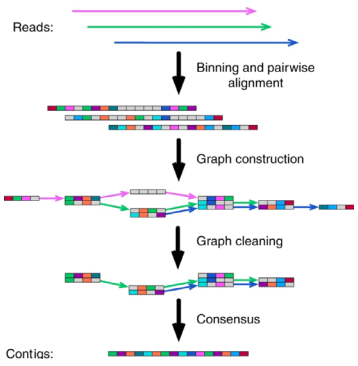
Cytosine base editors (CBEs) use the rat apolipoprotein-B-editing enzyme, catalytic polypeptide-1 APOBEC1 (rAPOBEC1), a cytidine deaminase binding to single-stranded DNA (ssDNA) and is fused to nCas9, to convert cytosine to thymine. CBEs offer a powerful tool for correcting point mutations, yet their DNA and RNA off-target activities have caused concerns in biomedical applications. We described screens of 23 rationally engineered CBE variants, which revealed that mutation residues in the predicted DNA-binding site can dramatically decrease the Cas9-independent off-target effects. Furthermore, we obtained a CBE variant, YE1-BE3-FNLS, which retains high on-target editing efficiency while causing extremely low off-target edits and bystander edits. Our work illustrates examples of how the off-target effects of base editors can be minimized via biological-insight-driven engineering to extend the utility of these powerful gene-editing tools for both research and therapeutic applications.



▲ The on-target C-to-T editing efficiency of engineered CBEs at 21 target sites

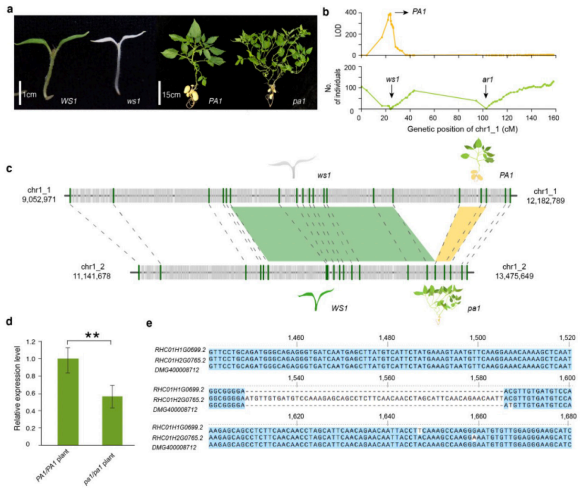
Fast and accurate long-read assembly wtdbg2 (Ruan Yu's team at Agricultural Genomics Institute at Shenzhen)

The third-generation DNA sequencing technologies have changed the approach to genomics and brought up the research of large-scale population genome assembly. Genome assembly is the first step in genomics and also a touchstone for new technologies. Existing long-read assemblers require thousands of central processing unit hours to assemble a human genome and are being outpaced by sequencing technologies in terms of both throughput and cost. We developed a long-read assembler wtdbg2 (https://github.com/ruanjue/wtdbg2) that is 2–17 times as fast as published tools while achieving comparable contiguity and accuracy. It paves the way for population-scale long-read assembly in future.



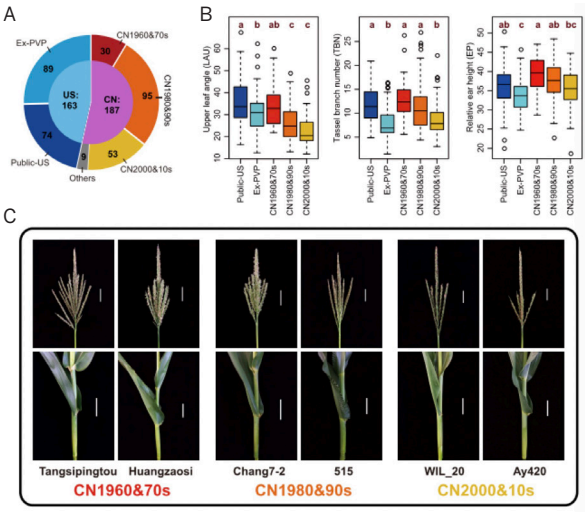
▲ It groups 256 bp into a bin, a small box in the figure
Outline of the wtdbg2 algorithm

Haplotype-resolved genome analyses of a heterozygous diploid potato (Huang Sanwen's team at Agricultural Genomics Institute at Shenzhen)
Potato (Solanum tuberosum L.) is the most important tuber crop worldwide. To accelerate genetic improvement in potato, several projects have been initiated to re-domesticate potato from a tuber-propagated, tetraploid crop into a seed-propagated, inbred-line-based diploid crop, which requires a better understanding of the potato genome. Huang Sanwen's team reported the first haplotype-resolved assembly of a diploid potato. Comparison of the two haplotypes revealed intra-genome diversity, including 22,134 predicted deleterious mutations in annotated genes. In total, 16.6 percent and 30.8percent of allelic genes in homolog haplotypes exhibited differential expression and methylation between alleles, respectively. Deleterious mutations and differentially expressed alleles were dispersed throughout both haplotypes, complicating strategies to eradicate deleterious alleles or stack beneficial alleles, via meiotic recombination. This study offers a holistic view of the genome organization of a clonally propagated diploid species, as well as provides insights into technological evolution in resolving complex genomes.



Tight linkage of two deleterious alleles, white seeding (*ws1*) and plant architecture (*pa1*) in repulsion phase

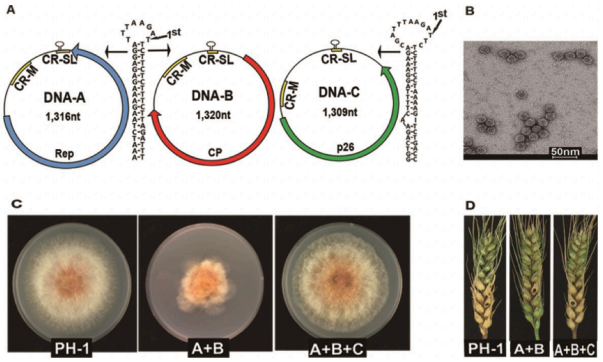
Genome-wide selection and genetic improvement during modern maize breeding (Wang Haiyang's team at Biotechnology Research Institute)
The success of modern maize breeding derives from the development of hybrid maize breeding programs begun in the first half of the 20th century. Since then, much of the seven-fold increase in yield can be attributed to the tolerance of increased planting density and an increased density. To investigate the genetic impacts of selection during breeding and identify the key genes contributing to adaptation to increased planting density, Wang Haiyang's team conducted a comprehensive analysis of the genomic and phenotypic changes associated with modern maize breeding through chronological sampling of 350 elite inbred lines representing multiple eras of germplasm from both China and the United States. They documented several convergent phenotypic changes in both countries. Using genome-wide association and selection scan methods, they identified 160 loci underlying adaptive agronomic phenotypes and more than 1,800 genomic regions representing the targets of selection during modern breeding. This work demonstrates the use of the breeding-era approach for identifying breeding signatures and lays the foundation for future genomics-enabled maize breeding.



Morphological trait improvement during modern maize breeding

A tripartite ssDNA mycovirus from a plant pathogenic fungus is infectious as cloned DNA and purified virions (Guo Lihua's team at Institute of Plant Protection)
Here, we describe a tripartite circular single-stranded (ss) DNA mycovirus, named Fusarium graminearum gemytripvirus 1 (FgGMTV1). The genome of FgGMTV1 comprises three circular ssDNA segments (DNA-A, DNA-B, and DNA-C). Sequence alignments and phylogenetic analyses showed that FgGMTV1 is nested within the family Genomoviridae. We also constructed the first infectious DNA clones of a DNA mycovirus. Our results

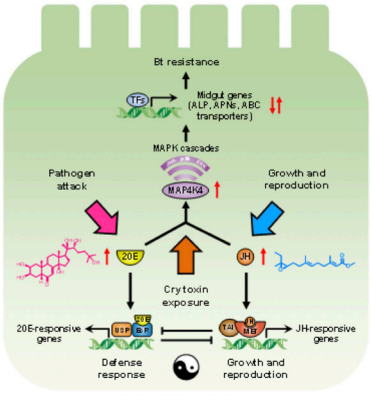
show that DNA-A and DNA-B are mutually interdependent for their replication and are associated with severely reduced colony growth and hypovirulence. DNA-C relies on DNA-A and DNA-B for replication and is necessary for the recovery of abnormal fungal phenotypes. DNA-C also enhances the accumulation of viral DNA in infected fungi and permits stable colonization and easy transmission via conidia. This is the first multipartite DNA virus isolated from a fungus. Our phylogenetic analyses also suggest that the multipartite genome of FgGMTV1 may have evolved from a monopartite genome of an ancient genomovirus.



▲ Molecular characterization and biological function of FgGMTV1

MAPK-dependent hormonal signaling plasticity contributes to overcoming Bacillus thuringiensis toxin action in an insect host (Zhang Youjun's team at Institute of Vegetables and Flowers)

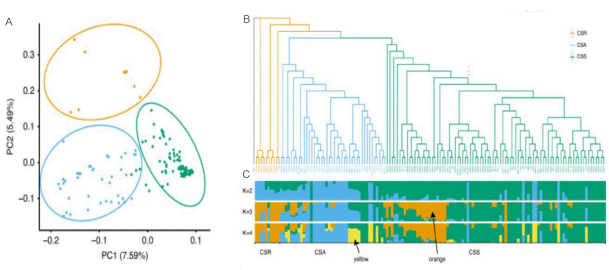
The arms race between entomopathogenic bacteria and their insect hosts is an excellent model for decoding the intricate coevolutionary processes of host-pathogen interaction. The research team demonstrated that the MAPK signaling pathway is a general switch to trans-regulate differential expression of aminopeptidase N and other midgut genes in an insect host, diamondback moth (Plutella xylostella), thereby countering the virulence effect of Bacillus thuringiensis (Bt) toxins. Moreover, the MAPK cascade is activated and fine-tuned by the crosstalk between two major insect hormones, 20-hydroxyecdysone (20E) and juvenile hormone (JH) to elicit an important physiological response (i.e., Bt resistance) without incurring the significant fitness costs often associated with pathogen resistance. Hormones are well known to orchestrate physiological trade-offs in a wide variety of organisms, and our work decoded a hitherto undescribed function of these classic hormones and suggests that hormonal signaling plasticity is a general cross-kingdom strategy to fend off pathogens.



◀ Insect hormones activate the MAPK signaling pathway to mediate the molecular mechanism of Plutella xylostella resistance to Bt Cry1Ac toxin

Solve the complex genome assembly problem of Longjing tea cultivar and reveal the origin and evolution of the tea plant (Yang Yajun's team at Tea Research Institute)

The tea plant is an important cash crop characterized by a large genome, high heterozygosity, and high species diversity. The research team assembled a 3.26-Gb high-quality chromosome-scale genome for the 'Longjing 43' cultivar of Camellia sinensis var. sinensis. Genomic resequencing of 139 tea accessions from around the world was used to investigate the evolution and phylogenetic relationships of tea accessions. The results illuminated that hybridization had increased the heterozygosity and wide-ranging gene flow among tea populations with the spread of tea plant cultivation. Population genetic and transcriptomic analyses revealed that during domestication, selection for disease resistance and flavor in C. sinensis var. sinensis populations had been stronger than that in C. sinensis var. assamica populations. This study provided resources for marker-assisted breeding of tea plants and set the foundation for further research on tea plant genetics and evolution.



▲ Distribution and evolution of tea

CAAS Top 10 Science and Technology Achievements in 2020

Breeding and extension of new wheat variety Zhongmai 895 with high yield, good noodle quality, and outstanding heat tolerance (He Zhonghu's team at Institute of Crop Sciences)

High temperature during grain-filling stage is a limiting factor for wheat production in Yellow and Huai Valley, and breeding methodology has been established for improving heat tolerance in wheat. New wheat variety Zhongmai 895 with high yield, good quality, and outstanding heat tolerance was developed, with accumulated sowing acreage of 3 million ha, while the maximum annual sowing acreage of 700,000 ha, being the third largest wheat variety in 2019. It is characterized with top grain-filling rate and heat tolerance among current varieties, short stature and lodging resistance, high and stable yield, resistance to yellow rust and powdery mildew, outstanding performance under reducing irrigation and late sowing conditions, excellent qualities for noodle and steamed bread, and is recommended for extension in large area. Zhongmai 895 is also an outstanding parent, and 6 elite varieties and advanced lines were derived.

Zhongmai 895 in late grain-filling stage

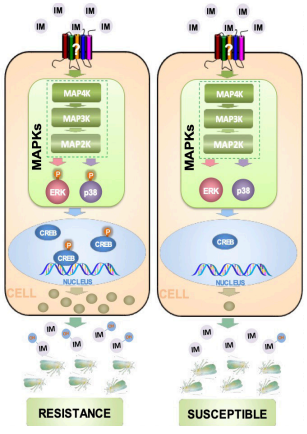
Developing of Zhonghuang 6106, a new transgenic soybean with tolerance to glyphosate (Qiu Lijuan's team at Institute of Crop Sciences)

To address the challenges of high cost and poor effect of current weed management in soybean production, we innovated soybean genetic transformation technology and glyphosate tolerance identification technology, and constructed a transgenic soybean breeding system. Using the genes owning intellectual property, we developed Zhonghuang 6106, a new transgenic soybean with high tolerance to the broad-spectrum and low herbicide residual glyphosate, which obtained a safety certificate for production and application in the Northeast and Huang-Huai region in China. The new soybean lines derived from Zhonghuang 6106 reduced the amount of herbicides, saved more than 50 percent of weeding costs and more than 10 percent of yield losses, respectively, which providing technological support for the industrial application of herbicide-tolerant transgenic soybean, cost reduction and increasing effectiveness of crops and green agricultural development in China. The research results were selected as one of the top 10 landmark achievements in agricultural science and technology in the 13th Five-Year Plan Period of the Ministry of Agriculture and Rural Affairs of the People's Republic of China.

Treatment of glyphosate in transgenic soybean (left) is more effective than conventional herbicide in non-transgenic soybean (right) for weed controls

Deciphering the resistance mechanism of important vegetable pests to insecticides (Zhang Youjun's team at Institute of Vegetables and Flowers)

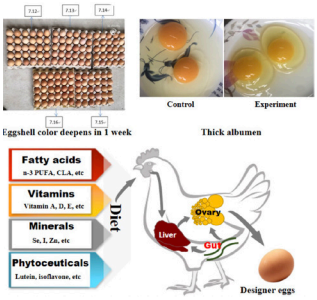
The resistance evolution of vegetable pests in the field in China is becoming more and more serious, but the resistance mechanism is still unclear. This study has discovered the pivotal signal pathways for orchestrating the resistance of the important vegetable pests including the whitefly (Bemisia tabaci) to the chemical insecticide imidacloprid and the diamondback moth (Plutella xylostella) to the Bt bioinsecticide, and it initially developed a precise field resistance monitoring and early warning technology oriented by the key genes of these signaling pathways. These findings have important theoretical and practical significance for the monitoring, early warning and field management of the resistance evolution of major agricultural pests and for the development of new, green and efficient insecticides.



The molecular mechanism of MAPK-directed activation of the whitefly transcription factor CREB leads to P450-mediated imidacloprid resistance

Key technology of nutritional modulation for quality egg production had been developed (Qi Guanghai's team at Institute of Feed Research)

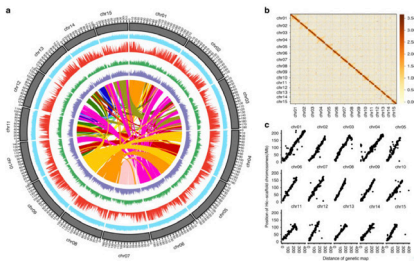
To conquer the technological bottlenecks of quality egg production, the group initiated the innovative study of eggshell ultrastructure based on the new concept of "corresponding characteristics between time sequence and space location", and established the nutritional modulation technology of eggshell quality with micro-nutrients, which can decrease the broken egg percentage by more than 35 percent for laying hens in late production phase. The problems of albumin thining and shell life transience induced by non-soybean meal protein sources and reduced crude protein diet had been resolved by the interpretation of dose-response relationship between dietary amino acids and albumen protein quality. The cost can be lowered by 50–60 yuan per ton feed with this technology. The concept of designer eggs enriched with functional lipids was firstly introduced in Chinese market by Qi's team. The integrative technologies covered with the enrichment of beneficial lipids and elimination of undesired ingredients in the egg yolk contribute to the invention of more than 10 kinds of designer eggs, which satisfy the diverse needs of various consumers. This scientific achievement was nominated as one of the Top 10 New Technologies for Chinese Agriculture issued by the Ministry of Agriculture and Rural Affairs of China in 2020. The technologies of the achievement are applied in over 55 million laying hens yearly, and result in significant economic, social and ecological benefits.



Effects of eggshell, albumen modulation and route for designer egg

Solve the complex genome assembly problem of Longjing tea cultivar and reveal the origin and evolution of the tea plant (Yang Yajun's team at Tea Research Institute)

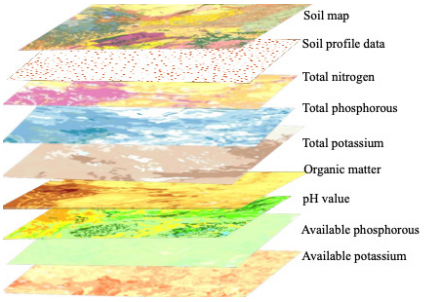
The high-quality chromosome-scale genome of 'Longjing 43', a representative tea plant cultivar in China, was obtained by using the self-developed third-generation sequencing assembly algorithm to solve the complex genome assembly problem of tea plant genome with high heterozygosity and high repeat sequence ratio. Based on the in-depth resequencing of 139 tea accessions from around the world, the origin of cultivated tea plants from the perspective of population genetics is revealed for the first time, and the differences in the selection pressure of genes related to flavor metabolism and disease resistance during the domestication of the two main varieties (C. sinensis var. sinensis and C. sinensis var. assamica) are found. The research results lay a solid theoretical foundation for the molecular breeding and evolution of the tea plant.



Characterization and quality of the LJ43 genome

Developing large-scale digital soil maps covering the whole country of China (Zhang Weili's team at Institute of Agricultural Resources and Regional Planning)

Large amount of paper soil maps and archives as well as data from soil surveys were kept by different counties and provinces in China. For integrating soil information from heterogeneous resources, however, the existing methods cannot solve the scientific and technical challenges and problems. Combining the methods of soil science, artificial intelligence, data science and cartography, a new method for integrating and mapping big data of soil has been developed, which is 80 times more efficient than the conventional approach. By using the new approach, high-resolution digital soil maps containing nine map layers and covering the whole country have been created. The precision soil information provided by high resolution digital soil maps of China has been applied to take care of arable land, control non-point source pollution, protect farmland, etc., which benefited hundreds of millions of farmers and different branches.



The high-resolution digital soil maps of China consisting of 9 map layers

Clinical trial for the live attenuated African swine fever virus vaccine proves the vaccine is safe and effective in the field (Bu Zhigao's team at Harbin Veterinary Research Institute)

Under the powerful leadership and instruction of the Ministry of Agriculture and Rural Affairs of China and CAAS, the Harbin Veterinary Research Institute promoted the research and development of African swine fever virus vaccine actively, steadily and orderly. Bu Zhigao's team developed a safe and effective seven-gene deletion attenuated vaccine (HLJ/18-7GD strain). They have successively completed the laboratory quality research of vaccine products, established an efficient production process with controllable quality, and passed the intermediate trial production. In strict accordance with the implementation scheme approved by the Ministry of Agriculture and Rural Affairs of China, the clinical trial has been successfully implemented. The results further proved that the vaccine is safe and effective in the field, which laid a solid foundation for industrialization and application.

▲ The safety and protective efficacy evaluation of ASFV vaccine in biosafety laboratory

Major breakthroughs in critical technologies and patterns of toilets renovation in typical rural areas Zheng Xiangqun's team at Agro-Environmental Protection Institute, Ministry of Agriculture and Rural Affairs

The team carried out a monitoring and assessment of rural toilet waste in 18 provinces throughout China for the first time, identified the regional characteristics of the harmlessness in rural toilet waste of China. A series of rural toilet conversion techniques and equipment were developed, such as unpowered integrated new compost household toilet, double-layer insulation septic tank, rainwater reuse instead of water flushing, etc. Moreover, the team has also constructed 7 sets of scattered farm households' technologies for manure disposal in the courtyard and established a big data platform for the simulation and evaluation of rural toilet manure production, discharge and utilization. These research results have been applied in 11 provinces (autonomous regions) throughout China, and two national standards have been established. The research results provide technical model and important support for rural toilet conversion in China.

▲ The team carried out the rural toilet renovation demonstration project in Jianhe County, Guizhou Province

Successful creation of new drug changed the situation that no drugs were available for the control of drug resistance of coccidia in China (Xue Feiqun's team at Shanghai Veterinary Research Institute)

The team independently developed the first new triazine anti-coccidiosis veterinary drug with completely new chemical structure, Ethanamizuril, in China. This drug has outstanding characteristics such as high safety, wide anti-coccidiosis spectrum and excellent effect. It improves the prevention and treatment of coccidiosis. At the same time, the research results have broken through the key technologies such as drug production process, quality standard and residue standard formulation by the innovation of synthetic process and preparation process. The dosage form and administration mode of Ethanamizuril are more suitable for the poultry breeding mode in China, and help to delay the development of coccidia resistance. It has obtained 2 national Class-I new veterinary drug certificates, and thereby becoming the first innovative veterinary drug that can be used for food animals in the field of chemical drugs in China in the past 17 years, which has improved the situation of drug resistance and no drug availability in coccidia control in China. The research achievements of Ethanamizuril have also applied for and obtained 3 Chinese national invention patents and 2 international invention patents (PCT).


中华人民共和国
新兽药注册证书
证号：(2020) 新兽药证字 54 号
新兽药名称：沙咪珠利
注册分类：一类
研制单位：中国农业科学院上海兽医研究所、山东国邦药业有限公司、湖北中牧安达药业有限公司
根据《兽药管理条例》，该兽药符合规定，准予注册，特发此证。
发证日期：二〇二〇年十一月五日

中华人民共和国
新兽药注册证书
证号：(2020) 新兽药证字 55 号
新兽药名称：沙咪珠利溶液
注册分类：一类
研制单位：中国农业科学院上海兽医研究所、天津市中升挑战生物科技有限公司、中牧金药（南京）动物药品有限公司、山东国邦药业有限公司
根据《兽药管理条例》，该兽药符合规定，准予注册，特发此证。
发证日期：二〇二〇年十一月五日

▲ New veterinary drug certificates

The overall straw-barrier removal and high quality machine-seeding technology significantly improved the sowing quality under the condition of straw returning to the field (Hu Zhichao's team at Nanjing Institute of Agricultural Mechanization, Ministry of Agriculture and Rural Affairs of China)

Initially proposed the overall straw-barrier removal and fine-coverage seeding technology and equipment of straw-returning machine based on the combination of evenly-covered translocated smashed stubble and regularly inter-row windrowing of lateral-displaced smashed stubble. It can overcome the technical bottleneck of straw blocking, seed-hanging and seed-exposuring, which commonly existed in machine-seeding link of hard-stubble field with full straw, and therefore effectively solve the problem of poor sowing quality during the straw returning process, and provide strong support for the promoting of green development.

▲ Overall straw-barrier removal and fine-coverage seeding technology and equipment of straw-returning machine

Strategic Programs

- Agricultural Science and Technology Innovation Projects
- Rural Revitalization and Poverty Alleviation through Science and Technology
- National Agricultural Science and Technology Innovation Alliance
- Research and Demonstration Program of Integrated Technology-based Green Development
- Talent Project
- Think Tank Construction

Agricultural Science and Technology Innovation Projects

Following the 14th Five-Year Plan, CAAS further advancing the Innovation Project with focus on tasks management, team-building and performance management in 2020.

Lists of missions and of tasks for the 14th Five-Year Plan were proposed. Based on the major needs of ensuring national food security, industrial safety, biosecurity and promoting rural revitalization, CAAS proposed lists of 10 missions and of 55 key tasks for the 14th Five-Year Plan to guide the optimal allocation of scientific and technological resources and accelerate scientific breakthroughs.

The three-tier (academy-institute-team) mission management model was fully promoted. CAAS issued Management Measures for Major Scientific Research Tasks of Science and Technology Innovation Project (for trial implementation). At the academy-level, major collaborative research tasks were with the launch of research task groups and 18 Major Collaborative Research Tasks in the fields of ensuring food security via technology and the breeding of major livestock and poultry, etc, followed by timely monitoration and evaluation. CAAS deployed key tasks across teams at the institute level, and issued Guidance on Strengthening the Management of Key Tasks at the Institute Level, promoting the full implementation of the "task-oriented research system" that closely aligns with national needs. Meanwhile, CAAS implemented disciplinary orientation tasks at the team tier and established a system of unifying innovative team tasks with key tasks at the institute tier, and strengthened the management of team tasks.

The building of scientific research teams was optimized. CAAS standardized the team building procedure, and formed an organizational process that goes through strategic research of discipline development, consultation of team building plans, public announcements of agreements by the institute, and approval by the academy executive meeting. The echelons of team leader was established which requires "team chief" should transform to "senior chief" at the age of 58, and "executive chief" should be nominated to back up the team chief over age of 55.

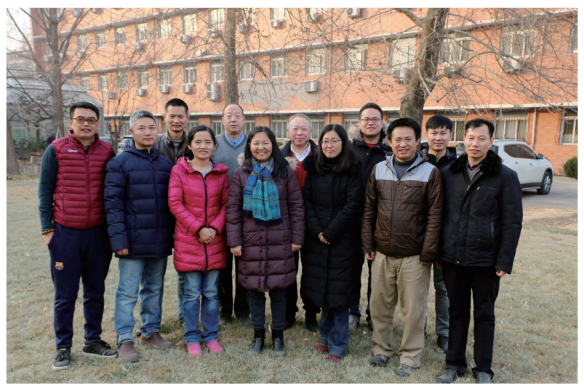
The moves improved performance management. CAAS organized the annual monitoring of projects and accomplished The 2019 Annual Monitoring Report of Science and Technology Innovation Project of CAAS. The academy formulated an evaluation plan for the expiration of the comprehensive promotion of the Innovation Project and clarified its orientation, contents and methodology. The academy scored above 90 in all respects after evaluation from the higher authority, including the assessment of 6 randomly selected research institutes of CAAS.

Many major breakthroughs were made with the leading role of the Innovation Project. In 2020, with support from Innovation Project, CAAS improved its innovative capacity and efficiency. It realized a series of major scientific and technological achievements and made significant progress in a number of major collaborative tasks. For example, "Huazheyou 261" rice with high yields, high quality, multiple resistance and wide adaptability features was awarded first prize in the indica rice category in the third Heilongjiang International Rice Festival in Northeastern China. As for the high-yield demonstration field featuring "Zhongmai 578" Wheat, a new high-quality wheat, its average output per mu reached 841.5 kg, setting a yield record in the Huanghuai wheat zone. It established a comprehensive program for green, efficient and completely automated production of corn, with yields reaching 1,663.25 kg per mu. In addition, CAAS developed its own technology for producing the first chicken 55K genotyping array in China, and screened two new support systems with outstanding productivity suitable for industrialized promotion. Major breakthroughs were made in the prevention and control of African swine fever and the technology of resuming breeding and processing of live pigs. For the first time, the three-dimensional structure of the African swine fever virus was comprehensively analyzed, and the results were published in the journal Science. Meanwhile, CAAS created a safe and effective gene-deleted attenuated vaccine with completely independent and proprietary intellectual property, completing the first phase of clinical trials and successfully carrying out the second phase. It also made breakthroughs in the prevention and control of spodoptera frugiperda to ensure national food security. Thanks to the unremitting efforts of the research team, some progress was made in the determination of fall armyworm biotypes, ensuring better control over the pest going forward.

- **Innovation Projects**
  - **Lists of missions and tasks for the 14th Five-Year Plan**
    - List of 10 missions
    - List of 55 key tasks
  - **Three-tier (academy- institute-team) mission management model**
    - Issuing management measures for major scientific research tasks
    - Implementing major collaborative research tasks at academy level
    - Deploying key tasks across teams at academy tier
    - Implementing disciplinary orientation tasks at team tier
  - **Optimized team building**
  - **Good performance management**
    - Initiating annual monitoring of innovation projects
    - Drafting evaluation plan for expiration of comprehensive promotion
    - Assisting performance appraisal by the Ministry

Rural Revitalization and Poverty Alleviation through Science and Technology

CAAS continued to promote scientific and technological assistance in 4 demonstration counties for poverty alleviation, namely Lintan in Gansu province, Ziyang in Shaanxi province, Huachuan in Heilongjiang province and Fuping in Hebei province. It also took place in 4 demonstration counties in terms of rural revitalization, namely Donghai in Jiangsu province, Lankao in Henan province, Wuyuan in Jiangxi province and Qionglai in Sichuan province. The academy issued its Notice on the Main Missions of Constructing Demonstration Counties in 2020, putting forward requirements in 8 aspects—improving the cooperative working mechanism, strengthening industrial consultation, intensifying technical demonstration, establishing demonstration bases, upgrading vocational skills training, sending expert groups, and strengthening public awareness. CAAS established its 3+*N* mechanism led by an academy leader, coordinated by an academy department and organized by a research institute. With the rallying cry of "where there is the battlefield of modern agriculture, there is an expert team of CAAS", the academy sent more than 1,000 experts from 18 institutes to the forefront of rural revitalization, providing technologies, sharing strategies and giving demonstrations. By doing so, there integrated a number of technologies on display, a batch of leading industries, a group of technical talent with knowledge of agriculture and a love for rural areas and farming. CAAS created a new model of field school to help farmers, and built replicable models by using science to help those in poverty, such as the Huachuan and Lintan models, as well as the county-wide model of providing scientific support for rural revitalization. Such initiatives provided strong sci-tech support for involved counties to emerge from poverty and offered technical support for consolidating the effective connection between poverty eradication and rural revitalization.



National Agricultural Science and Technology Innovation Alliance

With a focus on quality, the environment and effectiveness, the National Agricultural Science and Technology Innovation Alliance convened more than 1,000 teams and over 20,000 experts from over 6,000 units to carry out 526 collaborative innovation tasks covering research and development, technological integration, project demonstrations, promotion and application along with technical services, with a collection of some 6.32 billion yuan (998 million US dollars) in funding. The alliance innovated 1,590 sets of integrated technologies and published 547 standards. On the basis of the existing 2,038 demonstration bases, 610 demonstration bases were newly built. More than 2,600 training courses were conducted, with 350,000 people trained and a total of 1,548 on-site meetings were held. The work of alliance support and contribute to the implementation of the strategy of rural revitalization, and the promotion of the innovative development of modern agriculture.

The system design of the alliance gradually improved. Its secretariat formulated Guidance on the Construction of National Agricultural Science and Technology Innovation Alliance, which was released by the General Office of the Ministry of Agriculture and Rural Affairs on June 30, 2020.

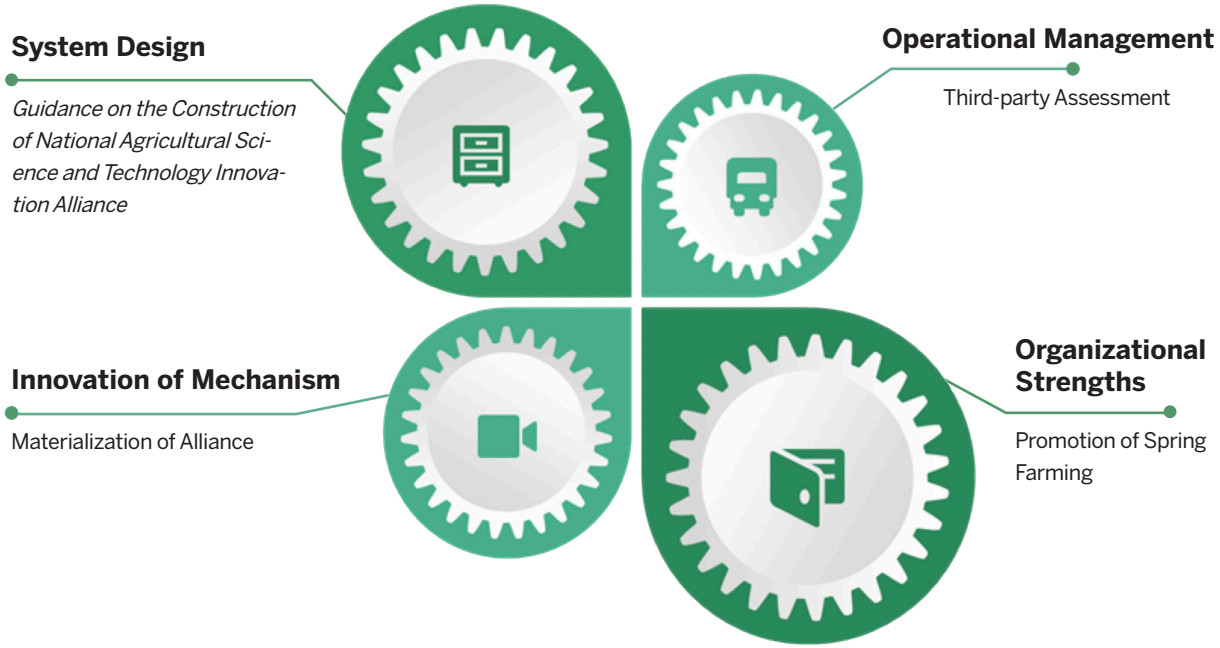
The operation and management of the alliance were further strengthened. After third-party evaluation of 25 sub-alliances eligible for assessment under the framework of the alliance, 17 recognized alliances including 5 model alliances were announced, 3 were suggested to rectify their problems and 5 were recommended to be withdrawn from the alliance.

▲ Promotion of agricultural production by alliance

The exploration of mechanism continued to deepen. The alliance focused on a physical mechanism to promote the construction of alliances, establishing four industrial alliances and their entities, including functional agriculture, intelligent agricultural robots, and sheep breeding and modern agricultural projects in South China, which led to a deep integration of enterprises, universities and research institutes in related industries.

The advantages of the alliance were used to promote spring farming. With the outbreak of COVID-19 in early 2020, the alliance gave full play to its advantages as a collaborative organization and coordinated strengths of various industries and regional members to strike a balance between contagion control and spring plowing, so as to provide strong support to achieve annual economic development goals.

National Agricultural Science and Technology Innovation Alliance



Research and Demonstration Program of Integrated Technology-based Green Development

To meet the technical needs of the green and high-quality development of regional modern agriculture, CAAS adhered to the principle of "increasing both yield and efficiency, germinating good seeds and methods, integrating agricultural machinery and techniques, and coordinating production and ecology" and advanced 14 research and demonstration programs on integrated technology-based green development, including oilseed rape, potatoes, cotton, vegetables, tea, melons, fruits and other agricultural commodities, as well as dairy cattle, sheep, hogs, ducks, etc. By developing annual work programs and setting clear major objectives, the academy overcame negative impacts brought about by the epidemic, and realized sound achievements through joint efforts on various projects. In the farming sector, output increased by an average of 28 percent. Consumption of water, fertilizers and pesticides fell by 35 percent, 25 percent and 30 percent, respectively, and expenditure was lowered by 400 yuan per hectare on average via cost savings and increased efficiency. Average expenditure reductions in the animal breeding sector reached 30 percent. Some 197 advanced and practical technologies were integrated and 61 sets of comprehensive agricultural green development technical models suitable were formed for various ecological conditions in different regions. CAAS established 171 demonstration bases, covering an area of 890,000 mu and radiating across an area of 7.16 million mu, with 14.8 million head of livestock and poultry. These efforts supported stable food production and supply, and provided technology for rural revitalization and poverty eradication.

Talent Project

Young Talent Project Plan (2017–2030)

The "Young Talent Project Plan" (2017–2030) is a forward-looking project that CAAS initiated in 2017 to strengthen its core competitiveness and achieve rapid development. CAAS will construct a comprehensive talent system and build an innovative, transformative and supportive team of the proper scale, with clear structure and functions, a rational layout of disciplines and age composition that can properly address the needs of agriculture, villages and farmers. By 2030, CAAS hopes to build a young talented team of 4,750, all under the age of 45. This team should account for two-thirds of all frontline research professionals. At the same time, the number of innovative young talent will reach about 3,450, transformative young talent will reach some 340, supportive young talent will stand at roughly 960, and outstanding young talent will total about 570.

Special Supportive Policies for CAAS Outstanding Talent

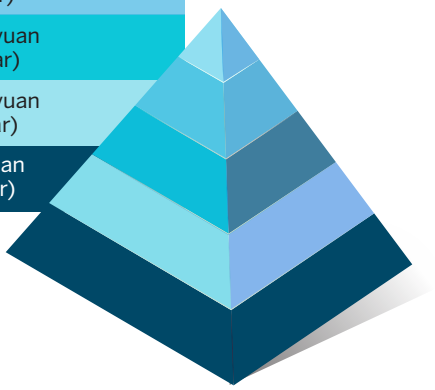
CAAS has developed a set of policies to support outstanding agricultural talent both at home and abroad. The policies will assist with attracting, recruiting and cultivation high-level scientific and technological talents, to construct an improved talent-development system and to encourage innovation and creativity.

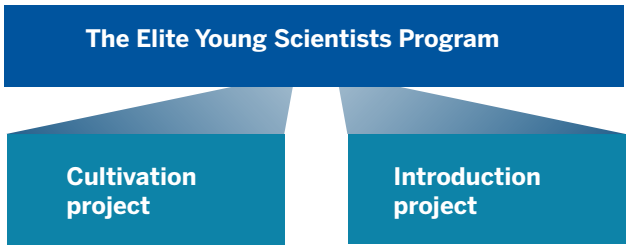
Especially for full-time employees (including contract personnel) who are mainly engaged in achievement support and transformation, Implementation Plan of Special Support for Supporting Talent of the Chinese Academy of Agricultural Sciences and Implementation Plan of Special Support for Transformative Talent of the Chinese Academy of Agricultural Sciences were both issued. The selected candidates will be given a subsidy of about 100,000 yuan (15,790 US dollars) per person annually, and special support in terms of capability improvement, professional promotion, project support, talent recommendation and humanistic care.

The special support policies are mainly extended to full-time science and technology professionals working in research posts at CAAS. These posts can be divided into three levels—top talent, leading talent, and young talent. CAAS provides each group with research funds and annual subsidies.

By the end of 2020, CAAS had 339 CAAS Outstanding Talent, among whom 17 were top talent, 210 leading talent, 102 young talent, 5 supporting young talent and 5 transformative young talent.

Top talents	Research funds: 2 million yuan ($314,000) (per person a year)	Annual subsidy: 500,000 yuan ($78,500) (per person a year)
Leading talents in Class A	Research funds: 1.5 million yuan ($235,500) (per person a year)	Annual subsidy: 300,000 yuan ($47,100) (per person a year)
Leading talents in Class B	Research funds: 1 million yuan ($157,000) (per person a year)	Annual subsidy: 250,000 yuan ($39,250) (per person a year)
Leading talents in Class C	Research funds: 800,000 yuan ($125,600) (per person a year)	Annual subsidy: 200,000 yuan ($31,400) (per person a year)
Young talents	Research funds: 600,000 yuan ($94,200) (per person a year)	Annual subsidy: 100,000 yuan ($15,700) (per person a year)





Elite Young Scientists Program

The Elite Young Scientists Program is a high-intensity young science and technology talent introduction program initiated by CAAS in 2013 that promotes high goals and standards. The plan was listed as one of China's first 55 key initiatives aimed at recruiting high-level overseas experts and specialists in 2014. It now consists of two projects—an introduction project and a cultivation project. It aims to attract and cultivate high-level leading scientists and innovative talent both domestic and foreign with strong global perspectives who are under age 40. In 2020, 14 young talented individuals were brought on at the academy level through the introduction project.

Introduction of High-level Talent with Flexible Policies

In 2018, CAAS issued interim measures for the Management of High-level Talent Introduction with Flexible Policies, providing support to such individuals in terms of staffing, project applications and research conditions. It aims to widen talent introduction channels and implement more positive, open and effective staff introduction policies. The policies ultimately strive to attract more high-level Chinese and foreign agricultural elites to serve the cause of the development of modern agriculture.

Postdoctoral Work

CAAS' center for postdoctoral studies was established in 1991, covering four academic fields: natural science, engineering, agronomy agriculture and management. It is composed of 11 mobile research centers for postdoctoral studies in veterinary medicine, animal husbandry, crop science, plant protection, agriculture and forestry management, agricultural resources as well as environmental, biological, horticultural, agrostology-related and agricultural engineering. By the end of 2020, 2,006 postdoctoral researchers have been enrolled, including 185 Chinese graduates from foreign universities and 95 foreign specialists. In 2020, CAAS enrolled 232 postdoctoral researchers (including 20 foreigners), and there are currently 607 postdoctoral researchers, which ranked first among agricultural and forestry universities and scientific research institutions across the country.

▲ The fourth Talent Work Conference of CAAS in 2020

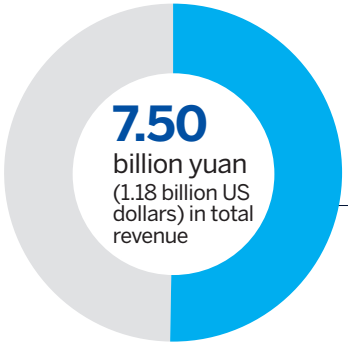
Think Tank Construction

CAAS enjoys a continuously increasing influence and popularity of its high-end agricultural science and technology think tank brand. On June 3, 2020, CAAS, together with the International Food Policy Research Institute (IFPRI), hosted the 2020 China and Global Agricultural Policy Forum in Beijing and released the China Agricultural Sector Development Report (2020) that looked both back and forward to macroeconomic conditions in the agricultural industry at home and abroad from the perspective of the agriculture-food system. On June 5 in Beijing, China Agricultural Green Development Report (2019) was released which objectively and authoritatively reflected the overall level, major actions and important progress of China's green agricultural development from 2018 to 2019. On Nov. 20, CAAS hosted the Forum 2020 on Science and Technology for Agricultural and Rural Development in Nanjing, Jiangsu province, and released several research reports, including Major Progress of China's Agricultural Science in 2020 that published 10 basic scientific research achievements representing frontier research and major breakthrough progress in global agricultural science and technology. Another study, 2020 Frontier of Global Agricultural Research, published 50 global agricultural research theses regarding eight subjects. A third, Analysis of the Global Competitiveness of China's Agricultural Science and Technology Papers and Patents in 2020, showcased that China has become the country with the most published agricultural science and technology papers, and ranks third in terms of the competitiveness of agricultural patents. Lastly, Evaluation of Innovation Ability of China's Agriculture-related Enterprises 2020 revealed that the innovation ability of listed agriculture-related enterprises in China was still at an insufficient level across the country. The summit attracted over 800,000 on-site and online participants. More than 20 official media such as Xinhua News Agency, People's Daily and CCTV, as well as 10 new media outlets such as Tencent, Sina and Toutiao.com have issued a series of reports on the results of the think tank. CAAS' social influence on the achievements of agricultural science and technology think tanks has greatly improved, which provides decision-making references for agricultural scientific and technological innovation and the implementation of rural revitalization strategies.

Support Capability

- Annual Budget
- Staff
- Integrated Coordination between Science and Agricultural Industry
- International Agricultural Technology Cooperation
- Major Scientific Research Layout
- Research Facilities Construction
- Field Stations
- Intellectual Property
- Graduate Education

Annual Budget



7.50 billion yuan (1.18 billion US dollars) in total revenue

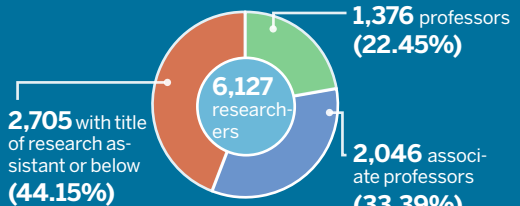
3.58 billion yuan (565 million US dollars) from state funding

Staff

CAAS had 11,422 staff members by the end of 2020

69 employees for the CAST Press | **6,903** permanent employees | **4,450** contract employees

Among them, **1,634** are managerial staff **(23.67%)**; **6,127** are professors, including **1,525** people who also hold managerial posts **(88.76%)**, and **667** are technicians and logistics workers **(9.66%)**



Researchers

(Postgraduate degree holders account for **78.65%**)

3,111 hold doctorate degrees

1,709 hold master's degrees

Managerial staff

(Postgraduate degree holders account for **64.69%**)

566 hold doctorates degrees

491 hold master's degrees

816 are under 45 years old **(49.94%)**

Technicians and logistics workers

(135 technicians have college degrees and above, accounting for **20.24 %**)

13 in first-class technical posts

155 in second-class technical posts

46 are under 45 years old **(6.90 %)**

Integrated Coordination between Science and Agricultural Industry

CAAS strengthened the integration of science and industry, focused on the work of serving the main field of modern agricultural development, and issued Opinions of CAAS on Deepening the Integration of Enterprises, Science and Industry. CAAS has established a comprehensive strategic cooperative partnership on science and technology with four local governments including Jiangsu and Shanxi provinces; the Inner Mongolia and Xinjiang Uygur autonomous regions; as well as 12 city-level governments including Suzhou, Pinggu, Nanping, Anqing and Yan'an to build a large platform for the transformation of scientific achievements. The cooperation focuses on strategic consultation, collaborative innovation, joint construction of pilot demonstration bases and technical training to promote the development of modern agriculture, rural revitalization and poverty alleviation. CAAS sent experts to visit Pinggu, Suzhou, Weifang, Nanping, Yan'an, Ankang, Jinhua, Chuzhou, Anqing and other areas to provide technical guidance, training, consultation and other scientific and technological services in order to promote the implementation of the strategic cooperation agreement. The experts completed the drafting of modern agricultural development plans for Yan'an, Anqing and other places, and built new R&D institutes together with Suzhou, Weifang and elsewhere. The CAAS training center was established in Nanping. The academy has organized more than 40 experts from eight research institutes to visit Anqing to carry out research projects and provide advice and technical guidance on rural revitalization, industry development and talent training by delivering CAAS's advanced and applicable varieties, techniques and achievements to farmers.

In order to lead research in line with industry development and accelerate the transformation of scientific achievements, CAAS initiated the consortium for integrated development between scientific research and enterprises at the beginning of 2020, which will better make use of the advantages of the academy's science and talent resources, incentivize greater investments into R&D by enterprises and promote better overall performance. The proposal to prepare the consortium based on an investigation report received support from more than 100 companies including China National Agricultural Development Group Co., Ltd.(CNADC), Da Bei Nong Group, Alibaba and JD.com. They have formed a cooperative model in which companies raise questions with investments while CAAS solves the problems. The two sides have strengthened cooperation via top-level planning, stable cooperation mechanism and joint application for major science and technology projects. By the end of 2020, CAAS signed strategic cooperation agreements with CNADC and Da Bei Nong Group, where CNADC promised to establish a cooperation fund of no less than 500 million yuan (79 million US dollars) during the 14th Five-Year Plan period (2021–2025) and Da Bei Nong Group will invest 250 million yuan (39 million US dollars) for cooperation and establish a 10 million yuan (1.58 million US dollars) Technology Innovation Award.

▲ CAAS signed a strategic cooperation agreements with China National Agricultural Development Group Co., Ltd.

International Agricultural Technology Cooperation

With an open and cooperative attitude, CAAS has actively overcome the adverse effects of the epidemic, innovated ideas and took the initiative to consolidate and expand its international "circle of friends". A series of highlights have been achieved in its international cooperation, which has made a solid foundation for the development of cooperation in the post-epidemic era.

Focusing on the key concerns of global agricultural community, CAAS launched the first patch of three tasks of CAASTIP, namely "G2P crop molecular design and breeding", "cross-border monitoring and control of major crop diseases and pests" and "key technologies and core equipments for smart agricultural farmland parameter acquisition". Facing the forefront of international agricultural science and technology, the academy has attracted more than 10 important international scientific research institutions, including the National Research Institute for Agriculture, Food and Environment (INRAE) of France, the University of Liege in Belgium, the University of Tokyo in Japan, the University of Melbourne in Australia, CABI, CIMMTY and IRRI, to jointly conduct cutting-edge exploration and theoretical research, work on key technology breakthroughs, resource and data exchanges and sharing, so as to promote international cooperation of the academy into a new stage of development.

CAAS actively participates in the application of competitive international cooperation projects at home and abroad, which has achieved good results. The academy signed an agreement with Syngenta Group to jointly set up an "innovation fund" to support bilateral cooperation in the seed industry, plant protection and other fields. The academy has strengthened partnerships with the EU, the Danish Embassy in China and other institutions for more project support.

CAAS has expanded multiple channels to actively organize its institutes and graduate school to apply for government-sponsored overseas education programs in an attempt to cultivate scientific research talent with international vision. Meanwhile, the academy actively introduced overseas intellectual resources and improved the internationalization level of the talent team.

During the COVID-19 epidemic, CAAS sent letters of condolences to 59 cooperative institutions that were affected by the epidemic, and organized the donation of masks to partners, which has consolidated the friendship between the academy and the partners. CAAS held World Bee Day online jointly with FAO and organized relative institutes to participate in the construction of the FAO-CAAS regional innovation center. The academy signed seven academy-level cooperation agreements with partners from Germany, Australia and ICBA. CAAS organized meetings such as "China-Australia Seminar on Sustainable Agriculture"

▲ CAAS held World Bee Day online jointly with FAO

▲ The UAE Ambassador to China visited the CAAS

▲ CAAS signed cooperation agreement with Syngenta Group

and "Sino-German Agricultural Science and Technology Forum on Food Security and Nutrition" to mobilize resources for and promote practical cooperation in areas of common interests.

The academy hosted 22 online international conferences and training courses. More than 370 scientists from the academy participated in 115 online international conferences and jointly published more than 130 high-quality papers with international partners. By strengthening online communication and cooperation, the academy has maintained good communication with international partners.

Scientists from the academy have served for a number of posts in international mechanism such as FAO Global Action for Fall Armyworm Steering Committee Member, 2021 UN Food Systems Summit Advisory Committee Member, and Member of the Steering Committee of the High Level Panel of Experts on Food Security and Nutrition. They have shared Chinese experiences to the world. Some 183 experts from CAAS have served in international institutions and initiatives on a part-time basis, and 263 people have served in well-known international journals, making their contribution to global agricultural challenge addressing and knowledge sharing.

Major Scientific Research Layout

Existing Key Major Science and Technology Facilities

The national high-level biosafety laboratory for animal disease prevention and control is the only P4 biosafety research facility for large animals in China. It has played an important role in the prevention and control of major infectious diseases, biological counterterrorism and ensuring national public health security.

The national high-level biosafety laboratory for animal disease prevention and control

Key Major Science and Technology Facilities under Construction

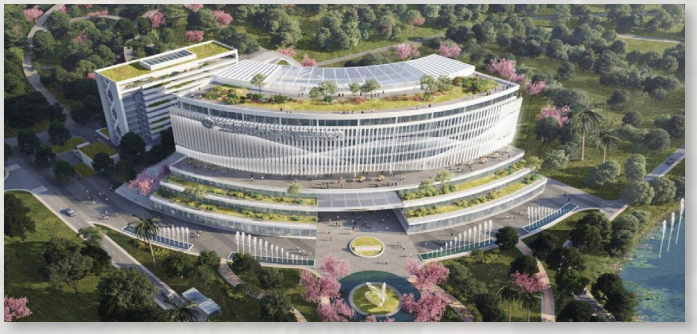
The National Crop Germplasm Bank of China can meet the needs of national crop breeding, basic research, industrial development and international competitiveness improvement for the next 50 years.

Design sketch of the National Crop Germplasm Bank of China

The National Nanfan Crop Phenotype Research Facility is a pilot project to promote the construction of China's Silicon Valley of agriculture and the National Tropical Agricultural Science Center. It is also a major scientific and technological infrastructure project focused on crop field environment and environmental phenotype identification in China.

Design sketch of the National Nanfan Crop Phenotype Research Facility

Key Major Science and Technology Facilities in Operation



Focused on the national demand for food security, biological security and ecological security, the **Agricultural Genomics Research Center** focuses on solving major cutting-edge and technical problems in agricultural genomics and building a global powerhouse in the field of agricultural genomics research.

Design sketch of Agricultural Genomics Research Center

Research Facilities Construction

Major Science and Technology Facilities

CAAS has 2 major national scientific facilities, 1 national high-level biosafety laboratory for animal disease prevention and control, 6 state key laboratories, 1 state key laboratory jointly built with provincial governments, 22 comprehensive key laboratories under the Ministry of Agriculture and Rural Affairs, 40 special key laboratories under the Ministry of Agriculture and Rural Affairs, 30 agro-products quality safety risk evaluation laboratories under the Ministry of Agriculture and Rural Affairs and 52 academy-level key laboratories.

Major Technology Innovation Platforms

CAAS has 5 national engineering technology research centers, 6 national engineering laboratories, 2 national engineering research centers, 22 national centers (sub-centers) for the improvement of crop varieties, 18 national agricultural industry technology research and development centers, and 32 academy-level engineering technology research centers.

Major Support Platforms

CAAS has 6 national science and technology resource sharing and service platforms, 12 national quality crop seed resource banks and 13 national nurseries for quality crop seed resources. The academy boasts 520,000 accessions of crop germplasm resources under long-term preservation, which ranks second in the world. It also has 7 national field stations for scientific observation and experiments, 3 national product quality supervision and inspection centers, 32 ministerial-level quality supervision and inspection test centers, 5 national agricultural testing reference laboratories, 9 national reference and professional laboratories, 2 FAO reference centers and 7 OIE reference laboratories. CAAS owns the National Agricultural Library, in which the collection of agricultural books and journals ranks top in Asia and third globally.

▲ The National Agricultural Library of CAAS

Field Stations

By the end of 2020, CAAS had 122 research field stations in 27 provinces, municipalities and autonomous regions. The stations cover 30 directly-affiliated research institutes, with a total area of 6,713 ha, including 3,340 ha of land owned by CAAS and 383.5 ha of land used for construction. CAAS owns 98 stations with land use right certificates in part or in whole. A total of 1,384 staff members work at the field stations, of whom 688 work full time and part time, and 696 have signed long-term employment contracts.In 2020, CAAS launched 71 projects for construction, maintenance and purchase affiliated with field stations involving 725 million yuan (114 million US dollars) in total. Actual spending was 282 million yuan (44.5 million US dollars). The newly-built area reached 28,500 square meters. The academy also improved 92.8 ha of experimental fields and purchased 23 agricultural implements along with 313 sets of instruments and equipment. Based on data from field stations, CAAS received 32 provincial-level scientific and technological awards, published 1,798 high-level papers, examined and approved 271 new varieties and was also granted 371 patents.The academy held 486 on-the-spot meetings and demonstrations in its field stations, attracting 41,000 visits, and 359 opening days, welcoming 18,600 visits. It also organized 824 training classes, which attracted 55,000 visits from farmers and agricultural technicians. It promoted 925 new crop varieties and sowed them in an area of 3.23 million ha. It promoted 156 new agricultural techniques and adopted them on 3.28 million ha of land. It also promoted 57 new products and applied them to 200,000 livestock and poultry, covering an area of 30,667 ha.

Intellectual Property

The Agricultural IP Index has continued to rise, reaching 86.67 percent in 2019, or 5.73 percentage points higher than that in 2018. Measures for Rewarding Achievements Transformation of CAAS (Provisional) and Rules for Evaluating Achievements Transformation Awards of CAAS (Trial) were formulated. By setting up the Outstanding Team Award for Achievements Transformation and the Intellectual Property Transformation Award, the academy encourages not only the integration of innovation, creation and startups, but also encourages teams and individuals to make outstanding contributions to social and industrial progress. By doing so, the academy can set a model in terms of the transfer, transformation and industrialization of scientific and technological achievements and IP rights. In view of the sometimes disorderly taxonomical practices of animal and plant varieties in the academy and on the basis of historical inheritance, initiatives including Scheme for Further Standardizing the Working Method of Animals and Plants in CAAS and Draft Naming Rules were formulated to optimize the taxonomy protocols for animal and plant varieties. The graduate school offered an optional 10-week course called Introduction and Practice of Agricultural Intellectual Property Rights. The academy held a seminar on achievements transformation and IP rights training, which attracted more than 90 people from the three academies affiliated with the Ministry of Agriculture and Rural Affairs as well as related enterprises.

▲ CAAS signed a strategic cooperation agreement with DBN Group

Graduate Education

In 2020, the Graduate School of CAAS (GSCAAS) has made great efforts in terms of pandemic prevention and control measures and continuously advances the reform and innovation of graduate education, achieving a steady rise in educational quality and school operations. The academy summarized the development achievements of postgraduate education in the 13th Five-Year Plan Period, and took the lead in formulating the Development Plan of Postgraduate Education in the 14th Five-Year Plan Period of CAAS (2021–2025). A series of rules and regulations including Working Rules of the GSCAAS Committee of CPC, Articles of Association of GSCAAS, and several other important documents were issued including Several Opinions of CAAS on Further Strengthening the Management of Postgraduate Education (Trial). The Graduate School made a trial of "application-examination" mechanism for doctorate enrollment in animal science, which is running smoothly. The interdisciplinary subject of "Agricultural Synthetic Biology" was set up independently. For the first time, training programs for doctoral students in two first-level disciplines—ecology and herbalism—were formulated. The course "Theory and Practice of Rural Revitalization" was included in the catalogue of degree courses of postgraduate training programs. For the first time, a Diligence Scholarship and International Exchange Scholarship were set up in CAAS graduate students. The special training program for rural revitalization talent (2020–2022) applied to the China Scholarship Council for the first time and was approved. The Graduate School in Shenzhen has received its first class of freshmen to check in.

In 2020, there were 2,104 supervisors at GSCAAS, including 17 academicians of the Chinese Academy of Sciences and the Chinese Academy of Engineering, 803 supervisors for doctoral programs and 535 teachers working full-time or part-time. They teach 170 courses in Chinese (including 79 online) and two courses in English. A total of 5,480 postgraduates study at GSCAAS: 2,124 are PhD candidates, 1,498 seek academic master's degrees and 1,858 eye professional master's degrees. Of that total, 1,666 students joined GSCAAS in 2020, 575 of them for doctorate degrees, 509 for academic master's degrees and 582 for professional master's degrees. In 2020, 336 postgraduates were awarded doctoral degrees and 1,005 master's degrees, and 437 PhD holders and 956 master's degree holders graduated from GSCAAS in 2020. The school's over-

Graduate students in 2020 have quality development training

A GSCAAS international student volunteering in waste-sorting activities in the community

Graduate students from CAAS participate in the first Harvest Festival

all employment rate for graduates was 90.3 percent, which ranks at the forefront of scientific research institutions in Beijing.

In 2020, GSCAAS has 111 enrolled international students—94 for doctorate degrees, 15 for master's degrees and 2 participants in further study program. Currently, 486 students from overseas are studying at GSCAAS—422 for doctorate degrees, 60 for master's degrees and 4 participating in advanced programs. Of them, 328 were awarded Chinese Government Scholarships. They hail from 59 countries and their studies cover 41 majors. Of 146 international graduates from GSCAAS in 2019, 138 were PhD holders and 8 were master's degree holders. Of them, 9 won the honor of GSCAAS's outstanding graduates and 3 of the doctorate degree holders were awarded Chinese Government Scholarships for Outstanding International Students. On a per-capita basis, the international graduates' published papers, papers' average impact factors and single paper impact factors all recorded new highs in the history of GSCAAS.

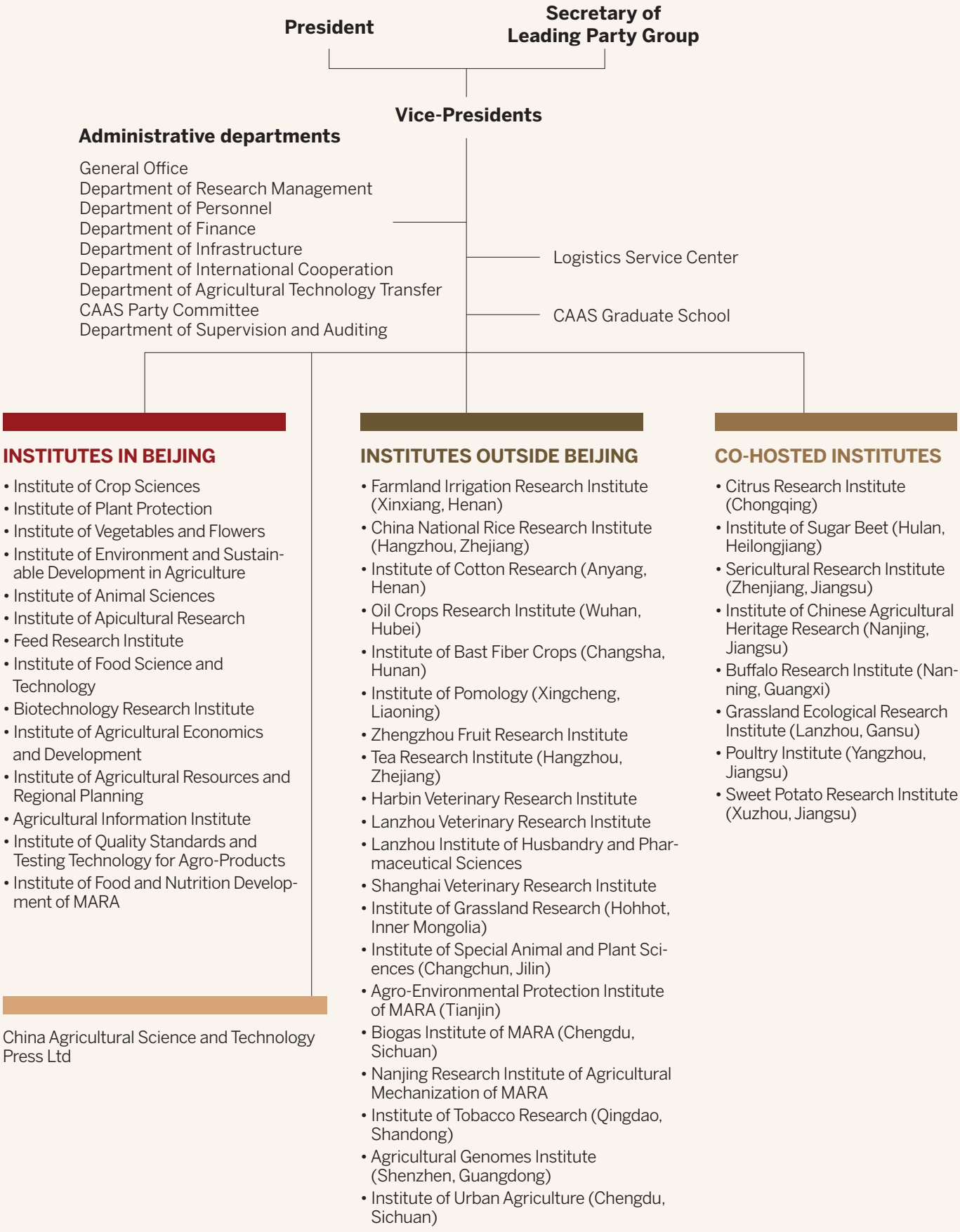
In 2020, the cooperation project between GSCAAS and Wageningen University & Research in the Netherlands for training doctors passed the evaluation of the Ministry of Education and started the second phase of the cooperation project. GSCAAS had 52 new students registered for joint doctorates in international cooperation programs, and 8 participants in the joint PhD programs graduated last year. At present, 198 students are enrolled in the programs, covering 32 disciplines across 28 CAAS institutes. GSCAAS has signed 3 MOUs on postgraduate education cooperation with foreign scientific research institutions and universities.

Foreign students of GSCAAS win the first prize in a writing contest about "100 reasons to love Beijing" sponsored by the Information Office of the Beijing Municipal People's Government

Appendix

- Organizational Structure of CAAS
- Key Laboratories and Centers

Organizational Structure of CAAS



Key Laboratories and Centers

Major National Facilities

No.	Facilities	Research	Institutes
1	National Key Facility for Crop Gene Resources and Genetic Improvement	New gene discovery and germplasm innovation; crop molecular breeding; crop functional genomics; plant proteomics; and crop bioinformatics.	Institute of Crop Sciences; Biotechnology Research Institute
2	National Center for Agricultural Biosafety Sciences	Significant agricultural and forestry diseases and insect pests; invasive alien species; and genetically modified organism biosafety for agriculture and forestry.	Institute of Plant Protection

Key National Laboratories

No.	Facilities	Research	Institutes
1	State Key Laboratory for Biology of Plant Diseases and Insect Pests	The mechanisms of calamities caused by important crop diseases and insect pests, monitoring and forecasting, and control technologies; the mechanisms of invasive alien species; functional genome for plant protection, and gene biosafety.	Institute of Plant Protection
2	State Key Laboratory of Animal Nutrition	Nutritional requirements and metabolic regulation; feed safety and evaluation; animal nutrition and environment; animal nutrition and immunology; molecular nutrition and genetics.	Institute of Animal Sciences
3	State Key Laboratory of Rice Biology	Genetic basis of rice germplasm improvement and innovation; physiological and the biochemical mechanism of rice growth and development; interrelation studies between rice plants and environment, and rice molecular breeding.	China National Rice Research Institute
4	State Key Laboratory of Veterinary Biotechnology	Genetic engineering of animal pathogens, cell engineering, molecular biology, and other areas of basic research in veterinary medicine.	Harbin Veterinary Research Institute
5	State Key Laboratory of Veterinary Etiological Biology	Infection and pathogenesis; etiological ecology, immunity, early warning and prophylaxis of veterinary and major zoonotic diseases .	Lanzhou Veterinary Research Institute
6	State Key Laboratory of Cotton Biology	Cotton genomics and genetic diversity research; cotton quality biology and functional genes research; cotton fiber yield biology and genetic improvement research; and cotton stress biology and environment regulation research.	Institute of Cotton Research

International Reference Laboratories

No.	Facilities	Research	Institutes
1	FAO Reference Center of Animal Influenza	The Laboratory is in charge of the confirmative diagnosis of highly pathogenic avian influenza, animal influenza surveillance, development and update of vaccines and diagnostic reagents.	Harbin Veterinary Research Institute
2	FAO Reference Center of Biogas Technology Research and Training	Policy study and technology research in biogas-related sectors.	Biogas Institute of MARA
3	OIE Reference Laboratory for Equine Infectious Anemia	Research focused on epidemiology and immunology of Equine Infection Anemia. An equine infectious anemia virus vaccine model is used to study the mechanism of protective immunity for lentiviruses.	Harbin Veterinary Research Institute
4	OIE Twinning Laboratory for Equine Influenza	The laboratory is to carry out the research on the epidemiology, etiology, and diagnosis of Equine Influenza and development of a vaccine and diagnostic reagent.	Harbin Veterinary Research Institute
5	OIE Foot and Mouth Disease Reference Laboratory	Technical consultations and services, etiology studies, molecular epidemiology research and immunology research; R&D on techniques and products for FMD prevention and control.	Lanzhou Veterinary Research Institute
6	OIE Ovine Theileriosis Reference Laboratory	Pathogen identification, epidemiology, diagnosis, prevention and control of ovine theileriosis.	Lanzhou Veterinary Research Institute
7	OIE Reference Laboratory for Infectious Bursal Disease	Studies related to basic pathogen research, epidemiological studies and the prevention and control of the infectious bursal disease virus.	Harbin Veterinary Research Institute
8	OIE Reference Laboratory for Avian Influenza	In charge of the confirmative diagnosis of avian influenza, avian influenza surveillance, development and update of vaccines and diagnostic reagents.	Harbin Veterinary Research Institute
9	OIE Collaborating Center for Zoonoses of Asia-Pacific	Carries out research on the regional epidemiology, etiology, the mechanism of interspecies pathogen transmission, molecular mechanism of pathogenesis and immune mechanism.	Harbin Veterinary Research Institute

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