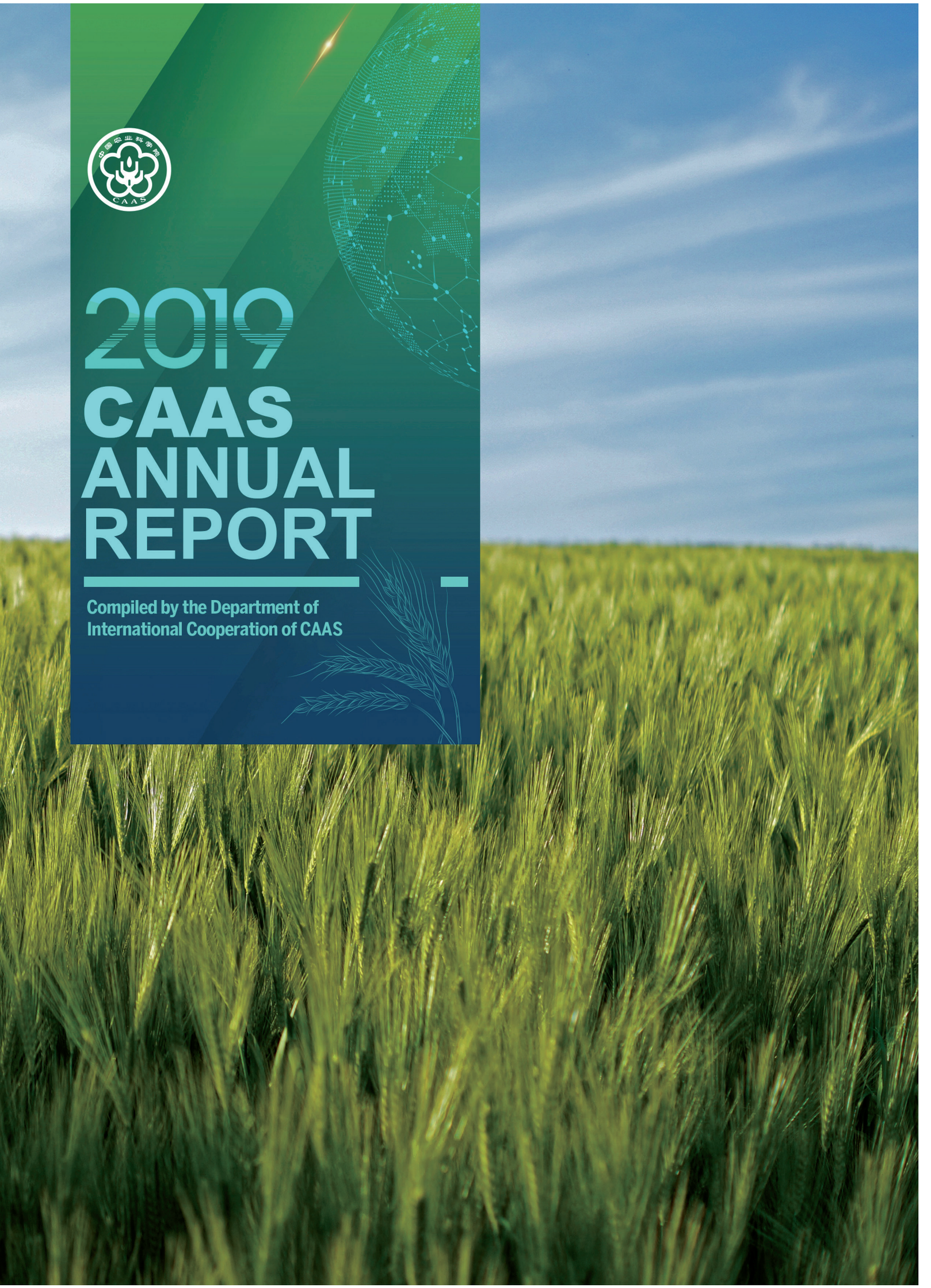

2019 CAAS ANNUAL REPORT

Compiled by the Department of International Cooperation of CAAS

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2019

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the Department of International Cooperation of CAAS

China Agricultural Science and Technology Press

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Editorial Board of CAAS Annual Report

2019

Message from the President

The year 2019 marked the 70th anniversary of the People's Republic of China. It also marked a key stage in achieving China's goal of building a moderately prosperous society in all aspects across the country for the upcoming 100th anniversary of the founding of the Communist Party of China in 2021.In addition, the year 2019 witnessed the second anniversary of the Chinese Academy of Agricultural Sciences (CAAS) to thoroughly study and implement the call of Chinese President Xi Jinping, also general secretary of the CPC Central Committee, in his congratulatory letter in celebration of CAAS' 60th anniversary in 2017.

Following the leadership of the Ministry of Agriculture and Rural Affairs (MARA), CAAS made substantial breakthroughs in fundamental research and core technologies, increased efforts in research achievements transformation, optimized talent structure, forged ahead with postgraduate education, improved arrangements of research facilities and enhanced stronger supporting capacity for the country's agricultural development. All of those demonstrated the academy's commitment and devotion as China's premier national team in agricultural research.

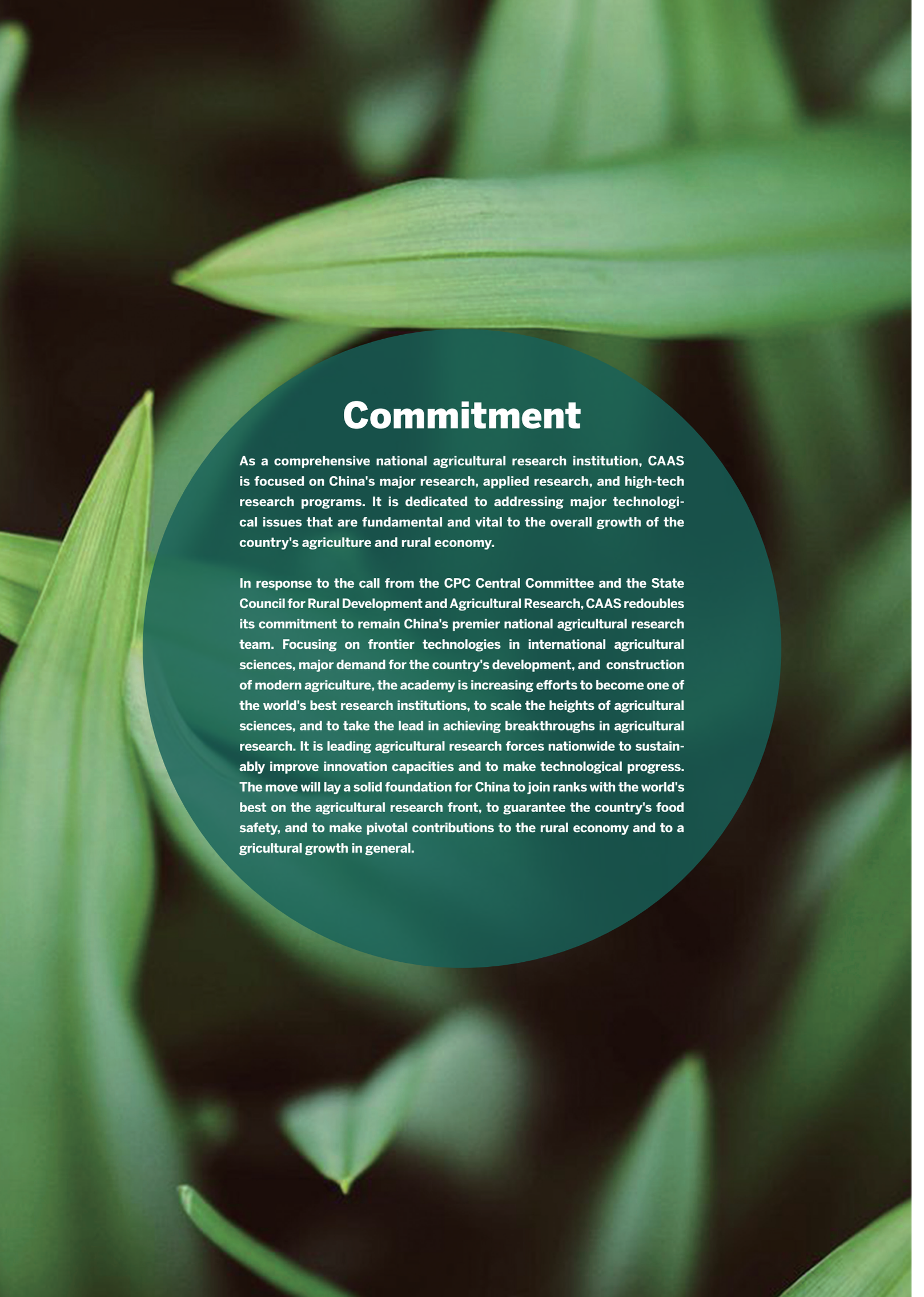
In 2019, experts at CAAS led 3,049 new research projects, an increase of 7.4 percent from 2018. The academy won 7 national science and technology awards as first authors, notching up 3 major national S&T awards for 2 consecutive years — the State Natural Science Award, the State Technological Invention Award and the State Scientific and Technological Progress Award.

Eleven papers from the academy were published in renowned international academic journals including *Science, Nature, Cell* and *PNAS*. Four scientists at CAAS were elected members of the Chinese Academy of Sciences and the Chinese Academy of Engineering, a new record in CAAS' annual number joining the ranks of CAS and CAE academicians. A total of 42 CAAS scientists took accolades in various national-level talent programs. During the year, CAAS hosted the first National Agricultural Scientific and Technological Achievements Transformation Conference, advanced the construction of an S&T innovation alliance, further implemented a tech-assisted poverty relief campaign, and increased technological support for rural revitalization. The academy also played host to the sixth Global Forum of Leaders for Agricultural Science and Technology in Chengdu, Sichuan Province, increasing its influence worldwide. GLAST 2019 adopted the Chengdu Declaration to encourage green development of the agro-industry. During the event, a new international agricultural science program—CAASTIP was launched, aimed at creating a global innovation network for agricultural science and technology.

I would like to take this opportunity to express my sincere gratitude and best wishes to friends and peers from home and abroad, who have long been helpful and supportive of CAAS' growth. Looking back on 2019, we find our aspirations remain unchanged; looking ahead, we are poised to embrace a bright future with complete confidence.

With gratitude, I look forward to more exchanges and cooperation from all partners with CAAS.

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



Commitment

As a comprehensive national agricultural research institution, CAAS is focused on China's major research, applied research, and high-tech research programs. It is dedicated to addressing major technological issues that are fundamental and vital to the overall growth of the country's agriculture and rural economy.

In response to the call from the CPC Central Committee and the State Council for Rural Development and Agricultural Research, CAAS redoubles its commitment to remain China's premier national agricultural research team. Focusing on frontier technologies in international agricultural sciences, major demand for the country's development, and construction of modern agriculture, the academy is increasing efforts to become one of the world's best research institutions, to scale the heights of agricultural sciences, and to take the lead in achieving breakthroughs in agricultural research. It is leading agricultural research forces nationwide to sustainably improve innovation capacities and to make technological progress. The move will lay a solid foundation for China to join ranks with the world's best on the agricultural research front, to guarantee the country's food safety, and to make pivotal contributions to the rural economy and to a gricultural growth in general.

CONTENTS

Significant Progress

- 2019 in Numbers
- Key Events in 2019
- New Academicians

2019 In Numbers

4 New Academicians
Four scientists of CAAS were elected academicians. One scientist is of CAS, and the other three scientists are of CAE, which has made records of annual newly ranked numbers and total numbers.

7 National Awards
CAAS won 7 national science and technology achievement awards that covered 3 major categories — the State Natural Science Awards, National Technology Invention Awards, and National Science and Technology Progress Awards, ranking first among the agricultural scientific research and teaching institutes nationwide and accounting for 22 percent of the country's total awards in the field of agriculture.

10 Major Sci-tech Achievements
CAAS experienced highpoints in the innovation of fundamental agricultural science and cutting-edge technologies— 4 in the category of key scientific issues, 3 in the category of key technologies and equipment, 2 in the category of major varieties and products, and 1 in the category of major scientific research progress.

11 High-level Academic Papers
Significant advances were made in fundamental and advanced agricultural science with 11 papers published in top journals, including *Science* and *Nature*. CAAS published a total of 6,429 papers in 2019, of which 3,094 were included in SCI/EI, with an increase of 8.3 percent from the previous year.

311 Projects Received Funds from the Central Government
CAAS had 297 projects financed by the National Natural Science Foundation of China, ranking first among agricultural scientific research institutes nationwide. 18 of the 297 were in the category of major scientific projects. CAAS also made breakthroughs in innovative research group projects and in projects supported by the National Science Fund for Distinguished Young Scholars and the National Science Fund for Outstanding Youth.

$10 Million Invested in the International Agricultural Science Program
CAAS launched the International Agricultural Science Program and planned to invest $10 million in its first phase, with the goal of creating a global agricultural science and technology innovation network.

1,500 Sci-tech Achievements Helped Poverty Alleviation and Rural Revitalization
CAAS helped forge 8 demonstration counties of poverty alleviation and rural revitalization through science and technology and sent industrial technical expert teams to 89 impoverished counties. CAAS demonstrated and promoted 1,500 scientific and technological achievements, trained 117,000 people and helped 1,510 new business entities.

30 New Measures to Cultivate Talents
CAAS introduced 30 new measures to boost talent development. CAAS had 51 more agricultural talents and employed 32 young talents in a targeted way. Forty-two of them have been selected in various national talent programs, and the number of high-level talents has been further increased.

Key Events in 2019

January

The National Science and Technology Awards Ceremony was held by the Central Committee of the Communist Party of China and the State Council in Beijing. CAAS won 7 awards: a second-place prize at the National Natural Science Awards, a second-place prize at the National Technological Innovation Awards, and 5 second-place prizes at the National Science and Technology Progress Awards.

The CAAS 2019 Annual Meeting was held in Beijing. The meeting reviewed its work performance in 2018, sorted out new situations and problems, and established key tasks for 2019.

By simultaneous editing four genes involved in sexual reproduction, China National Rice Research Institute successfully established the apomixis strategy, obtained clonal seeds and fixed the heterozygous genotype of the hybrid rice.

February

Han Changfu, China's Minister of Agriculture and Rural Affairs, and Yu Xinrong, Vice Minister of Agriculture and Rural Affairs, visited CAAS to investigate and guide the construction of a national crop germplasm bank project.

Research team led by Prof. Wang Hanzhong at the Oil Crops Research Institute of CAAS successfully cloned a cytoplasm-located regulatory gene *orf188* in crops for the first time in the world and illustrated its mode of action in orchestrating seed high-oil accumulation in oilseed rape (*Brassica napus* L.).

March

The 2018 Beijing Science and Technology Awards were held, and CAAS won 5 awards —the only first-place prize in the field of agriculture, 2 second-place prizes and 2 third-place prizes.

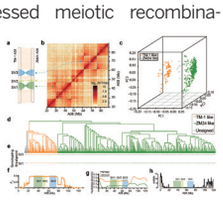
During President Xi Jinping's state visit to France, Tang Huajun, head of CAAS and a member with the Leading Party Members' Group of the Ministry of Agriculture and Rural Affairs, led a delegation to visit France's National Institute of Agronomical Research in order to promote scientific and technological cooperation between CAAS and the INRA.

Mei Xurong, Vice President of CAAS, led a delegation to visit Belgium and Switzerland for dialogue and to exchange agricultural science and technology with Europe and to inaugurate the European Laboratory of China's Ministry of Agriculture and Rural Affairs and the International Center for Applied Biology.

July

The Innovation Team of Tobacco Functional Components and Comprehensive Utilization at the Tobacco Research Institute of CAAS found the accumulation rule of bioactive compounds in Chinese wild rice (Zizania latifolia) during germination. Relevant research results were published in *Food Chemistry*.

The researchers at Institute of Cotton Research of CAAS performed a comprehensive study on the genetic variation within upland cotton intraspecies, and found that chromosome inversions suppressed meiotic recombination, reduced the population haplotype density, and eventually led to cotton population differentiation. This work was published in *Nature Communications*.



Zhang Hecheng, Secretary of the Leading Party Group of CAAS, led a delegation to visit Uzbekistan and Russia and held in-depth discussions on strengthening agricultural technological cooperation.

Tang Huajun, Member of the Leading Party Group of the Ministry of Agriculture and Rural Affairs and President of CAAS, met with Iranian Agriculture Minister Mahmoud Hojjati to hold in-depth discussions on promoting cooperation in agricultural technology.

August

CAAS released its report on the *2018 Global Agricultural Research Front*, selecting 8 disciplines and 46 frontiers of research in the agricultural field in 2018.

Wu Kongming, Deputy Secretary of the Leading Party Group of CAAS and Vice President of CAAS, met a delegation led by Arif Satria, President of Bogor Agricultural University in Indonesia, to discuss cooperation in agricultural technology.

The Chinese Government is preparing the *Outline of Food and Nutrition Development for China (2021-2035)*. A meeting to plan the Outline for this report was held at CAAS in Beijing. Minister of Agriculture and Rural Affairs Han Changfu attended and addressed the meeting.

September

During the Beijing International Horticultural Exhibition, Tang Huajun, Member of the Leading Party group of the Ministry of Agriculture and Rural Affairs and President of CAAS, attended an activity regarding Peru-CIP Honor Day. Representing Peru were Mercedes Aráoz, then Vice President of Peru, and Barbara Wells, Director of the International Potato Center, also known as CIP.

The meeting on CAAS' Poverty Alleviation Project with Technology for Huachuan county was held in Jiamusi, Heilongjiang Province. The Institute of Crop Sciences of CAAS built 4 demonstration bases featuring rice, corn, soybeans and edible beans and implemented 18 key technologies, which helped to achieve a more than 20 percent increase in crop production and efficiency.

In celebration of the 70th anniversary of the founding of the People's Republic of China, a total of 365 CAAS comrades were awarded medals, which were jointly issued by the Communist Party of China Central Committee, the State Council, and the Central Military Commission.

April

Luis Renato Alvarado Rivera, Minister of Agriculture and Animal Husbandry of Costa Rica; José Luis Repetto, Chairman of the National Institute of Agricultural Research of Uruguay; Najat Mokhtar, Deputy Director General of the International Atomic Energy Agency, and senior delegations from Pakistan paid visits to CAAS.

Wan Jianmin, Vice President of CAAS, led a delegation to visit Australia, New Zealand and Japan.

CAAS released the *China Agricultural Green Development Report 2018* in Beijing.

The 2019 China Agricultural Outlook Conference was held in Beijing and released the *China Agricultural Outlook Report 2019-2028*. Han Jun, Vice Minister of the Ministry of Agriculture and Rural affairs, delivered a speech at the event.

The first National Agricultural Scientific and Technological Achievements Transformation Conference was held in Chengdu, Sichuan Province.CAAS released 100 major achievements and 1,000 outstanding achievements.

May

The sixth International Symposium on Dairy Cow Nutrition and Milk Quality was held in Beijing. It was hosted by the Institute of Animal Sciences of CAAS, the American Dairy Science Association, the New Zealand Ministry for Primary Industries, and the Dairy Association of China.

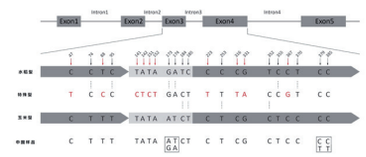
A global agricultural policy forum was held in Beijing, which released the *2019 China's Agricultural Development Report* and the *2019 Global Food Policy Report*.

The second Global Forum for Directors of Tea Research Institutes was held in Hangzhou, Zhejiang Province, with a theme of "Tea and the World, Innovation and Development".

Harbin Veterinary Research Institute of CAAS made great progress in vaccine development of African swine fever virus. Substantial research data obtained in the laboratory demonstrated that the novel vaccine is a highly safe and effective vaccine against ASFV infection.

June

The Agricultural Insect Genomics Innovation Team at Shenzhen Agricultural Genome Research Institute of CAAS, together with the Institute of Plant Protection of CAAS and the National Agro-Tech Extension and Service Center has completed the molecular identification of 318 *Spodoptera frugiperda* (fall armyworm, FAW) samples in China. These results revealed the source, and clarified the biological and molecular characteristics of FAW populations invading China. These results have been published in *Plant Protection*.



The research teams at Institute of Special Animal and Plant Sciences of CAAS and Northwestern Polytechnical University of China explored the genomic basis of biological adaptations of reindeer (Rangifer tarandus) adapting to the Arctic environment, which was published as a research article in *Science*.

October

CAAS launched 30 new measures to promote management skills in young people.

The international top journal *Science* published the paper titled as "Architecture of African swine fever virus and implications for viral assembly". These findings benefit the development of a new type of African swine fever vaccine with good protective efficiency.

A meeting on the science of national maize production, and the improved varieties and low reduction ratio of corn kernel mechanized harvesting was held in Henan Province. It demonstrated 9 representative varieties of such technique.

The Third International Agricultural Research Conference was held in Beijing, during which a series of research results and a big data platform were revealed. There was also a round-table discussion on the agricultural construction of the Belt and Road Initiative and the overseas development of agricultural science and technology.

November

Tang Huajun led a delegation to visit Italy, Austria and Switzerland and held in-depth discussions were with the heads of the United Nations Food and Agriculture Organization (FAO), International Atomic Energy Agency (IAEA), and World Trade Organization (WTO).

The sixth Global Forum of Leaders for Agricultural Science and Technology (GLAST) was held in Chengdu, Sichuan Province, co-organized by CAAS, FAO, CGIAR, IAEA, and the Chengdu city government. More than 400 representatives from 39 countries discussed agricultural green development. CAAS launched its international agricultural technology project "CAASTIP".

The Forum 2019 on Science and Technology for Agricultural and Rural Development in China was held in Nanjing. A series of special reports were released including the 2019 China Agricultural Science Major Progress.

Zhang Hecheng and Najat Mokhtar, Deputy Director General of IAEA inaugurated the "CAAS-IAEA Collaboration Center" and awarded the sub-centers.

December

Co-organized by CAAS and the British journal *Nature Genetics*, the Agricultural Genomics 2019-Big Data for Better Agriculture & Inaugural Forum of Shenzhen International Food Valley were held in Dapeng New District, Shenzhen.

Mohamad Roff Bin Mohd Noor, President of the Malaysian Academy of Agricultural Sciences, visited CAAS and signed a memorandum of understanding on cooperation.

The 2019 International Cooperation Work Conference of CAAS was held in Shenzhen, Guangdong Province. The meeting summarized CAAS' achievements in international cooperation in 2019 and detailed major work scheme in international cooperation for 2020.

New Academicians

Hu Peisong,
academician of the Chinese Academy of Engineering

Hu Peisong, academician of the Chinese Academy of Engineering, is an expert in rice genetic breeding and quality improvement. He is the Director General of the China National Rice Research Institute. He has been engaged in long-term research on genetic improvement of indica rice quality. His research on the "Breeding and Application of Super Special Early Rice Zhongjiazao 17" won the first prize for scientific and technological progress in Zhejiang Province in 2016. His research on "The Cultivation and Application of High-quality Indica Rice Varieties" won the second prize in the State Science and Technology Progress Award competition in 2009. Hu's research on "The Efficient Breeding Technology for High-quality Early Indica and the Selection and Application of New Varieties" won the second prize in the State Science and Technology Progress Award competition in 2012. He has won more than 10 provincial and ministerial second-class awards. Zhongjiazao 17 has been the leading variety of the Ministry of Agriculture and Rural Affairs for 7 consecutive years and has been planted in fields of 63 million mu (4.2 million hm^2) in total. Hu was elected an academician of the Chinese Academy of Engineering in 2019.

Li Peiwu,
academician of the Chinese Academy of Engineering

Li Peiwu, academician of the Chinese Academy of Engineering, is an expert in the quality and safety of agricultural products. He is currently the Director of the Key Lab for Mycotoxins Detection, MOA. He has long been involved in research on the quality and safety of agricultural products, and has achieved important results in the detection and control of grain and oil biotoxins. Li won 3 second prizes in the State Technological Invention Award and the State Science and Technology Progress Award as the first completion person, first prize of the invention award in Hubei Province. He was selected a national candidate for the New Century National Hundred, Thousand and Ten Thousand Talent Project of China, enjoying special allowances from the State Council. Li won the following national awards: Outstanding Worker in Science and Technology, Advanced Individual in Agriculture, and Expert in China's Agricultural Development. He was elected an academician of the Chinese Academy of Engineering in 2019.

Qian Qian,
academician of the Chinese Academy of Sciences

Qian Qian, academician of the Chinese Academy of Sciences, is an expert in rice germplasm resources. He is the Director General of the Institute of Crop Sciences of CAAS and Director of the State Key Laboratory of Rice Biology. He has made significant achievements in the discovery and innovation of rice genetic resources, analysis of important agronomic traits, and molecular breeding. Qian was selected as a national candidate for the New Century National Hundred, Thousand and Ten Thousand Talent Project of China and an Outstanding Agricultural Research Individual in China. He won the first prize for the State Natural Science Award, ranking third; second prize for the State Science and Technology Progress Award, ranking second; and 10 other provincial and ministerial awards in science and technology. Qian is a recipient of the National Science Fund for Distinguished Young Scholars and the Foundation for Innovative Research Groups of the National Natural Science Foundation of China. He has published more than 90 papers in key international academic journals as corresponding or co-corresponding authors. He was elected an academician of the Chinese Academy of Sciences in 2019.

Yao Bin,
academician of the Chinese Academy of Engineering

Yao Bin, academician of the Chinese Academy of Engineering, is an expert in microbiological engineering. He has also long been engaged in the research of feed enzymes. Yao established a complete and efficient feed enzyme research and development system as well as a series of products. He has realized the full localization of feed enzymes and supported the rapid development of China's feed enzymes into an internationally competitive high-tech industry. He is a recipient of the National Science Fund for Distinguished Young Scholars and a national candidate for the New Century National Hundred, Thousand and Ten Thousand Talent Project as well as Outstanding Agricultural Research Individual and Expert in China's Agricultural Development. Yao has won 2 second prizes in the State Science and Technology Progress Award competition, the first prize in the Beijing Science and Technology Award competition, and special prize in the Dabei Agricultural Science and Technology Award competition. Yao has authorized more than 70 invention patents and more than 40 technology transfers. He was elected an academician of the Chinese Academy of Engineering in 2019.

Note: 1 mu≈667 m^2, 15 mu=1 hm^2, sic passim.

Science and Technology Innovation

- Summary of Scientific Research
- National Science and Technology Awards
- CAAS Top 10 Research Progress in 2019
- Frontier Scientific Breakthroughs in 2019
- Research and Development of Core and Key Technologies
- Agricultural Science and Technology Achievements and Contributions

Summary of Scientific Research

In 2019, CAAS gave full play to the leading role of innovative engineering, further summed up the orientation of disciplines, optimized the team layout, improved the management mechanism, and made a series of new advancements in the implementation of major projects, the cultivation of major achievements, and research of major strategies.

Major National Science and Technology Plans

CAAS presided over 5,325 research projects, of which 3,049 were new ones, up 7.4 percent year-over-year. There were 297 projects supported by the National Natural Science Foundation of China. Twelve new projects were eligible for funding support in the national major research and development plan.

High-Level Papers

CAAS published 6,429 scientific papers, of which 3,094 were included in SCI/EI, up 8.3 percent year-over-year. A total of 11 high-level papers were published in *Science*, *Nature*, *Cell* and *PNAS*.

Commercialization and Promotion of Scientific Achievements

CAAS examined 346 new varieties. It approved the rights of 89 new plant varieties, registered 14 new veterinary drug certificates, and published 280 works. There were 899 domestic-granted invention patents. One patent was awarded a silver medal and five were given awards for excellence at the 2019 China Patent Awards announced by the National Intellectual Property Administration. CAAS has promoted 377 new varieties, 731 new products and 392 new technologies. The total area of land that used the new research findings reached 28 million hm^2 and approximately 1.03 billion livestock and poultry benefited from the new findings. In 2019, income from commercializing CAAS achievements reached 1.065 billion yuan ($153.5 million).

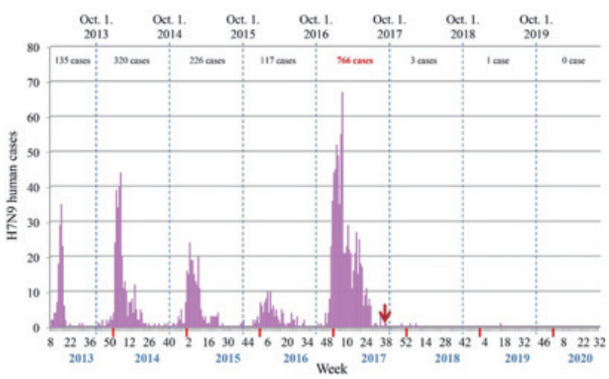
Cultivation of Major Achievements

Seven achievements won the second prize at the National Science and Technology Awards, accounting for 22 percent of the total awards in the agricultural field in China. Thirty-five projects won awards at the provincial level.

National Science and Technology Awards

The project "Transmission potential of different animal influenza viruses in humans: insights from animal studies" finished by Chen Hualan's team at Harbin Veterinary Research Institute of CAAS was awarded the second prize of the National Natural Science Awards of China.

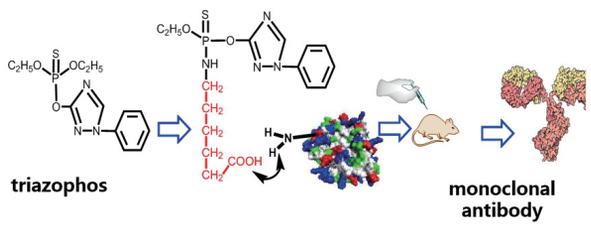
Scientists of this project focused on the widely circulating H1N1 swine influenza viruses, H5N1 and H7N9 avian influenza viruses in nature, and evaluated and revealed their capacity to cross animal-human host barrier and to transmit from human to human. A series of findings of this project provided key insights into the pandemic potential of different influenza viruses and important information for animal influenza control and human influenza pandemic preparedness. Importantly, this project has provided important information for the successful control of H7N9 influenza from animal source in China.



▲ Human infection with H7N9 viruses before and after application of the vaccine in poultry. The red arrow indicates when H5/H7 vaccine administration to poultry was initiated in China

The project "Key technology for accurate identification and detection of typical chemical pollutants in agricultural products" led by Wang Jing at Institute of Quality Standard and Testing Technology for Agro-products of CAAS, won the second prize of the National Technology Invention Awards of China.

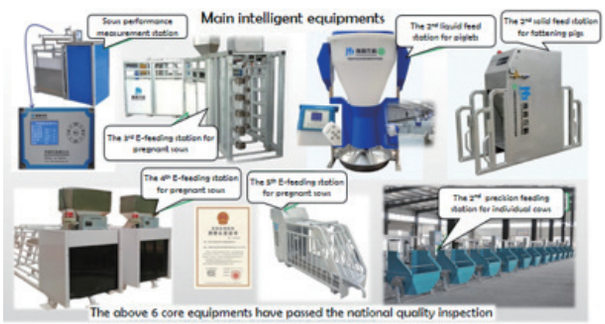
In these studies, a series of novel molecular imprinting preparation technologies were invented by introducing dual template and virtual template; hapten designing method based on lipophilic-chain arm relevance and highly sensitive chemiluminescent immunoassay were verified; 56 kinds of ELISA kits (or test strips) and 34 sets of 600 kinds of high-throughput instrument verification and testing technology were developed. These studies accomplished the whole process innovation from sample preparation, recognizing material development to precise identification and high-throughput detection technology application. These technologies and products have been applied in 3000 entities among 31 provinces nationwide in China and the products have also been exported to 21 countries, which made an important contribution for ensuring the consumption safety of agro-products.



▲ Hapten design proposal for pesticides based on lipophilic-chain arm relevance

The project "Development and application of the key digital technology and intelligent feeding Equipment for livestock production" led by Xiong Benhai's research team at Institute of Animal Sciences of CAAS, awarded the second prize of the National Science and Technology Progress Awards of China.

The project has developed a complete Chinese Feed Database, a series of nutrition requirement models, RFID chips and precision feeding equipment, and formed a complete digital technology system of intelligent livestock production.



▲ Main intelligent equipments

The project "Development and application of maize hybrids for Zhongdan 808 and Zhongdan 909 with the characteristics of high-density tolerance, high yield, and broad adaptability" led by Huang Changling's research team at Institute of Crop Sciences of CAAS, won the second prize of the National Science and Technology Progress Awards of China.

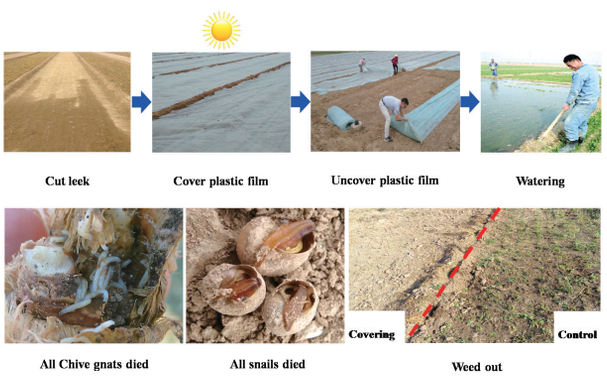
A selection technology for density tolerance and high resistance was proposed in this project, and then was used to create Zhongdan 808 and Zhongdan 909 and established an efficient

system of seed production and promotion. The cultivated area of these hybrids was about 6,693,333.3 hm^2 by 2018, which contributed to an increase of 5.31 billion kilograms of grain and significant social and economic benefits.

▲ The field display of maize hybrids for Zhongdan 808 and Zhongdan 909

The project "Innovation and application of key technologies for green prevention and control of major vegetable pests Chive gnats, *Bradysia odoriphaga* (Diptera: Sciaridae)" led by Zhang Youjun's team at Institute of Vegetables and Flowers of CAAS, won the second prize of the National Scientific and Technological Progress Awards of China.

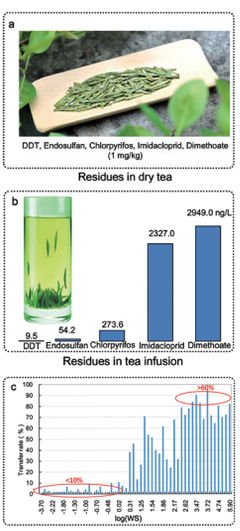
The crucial biological characteristics on the development of Chive gnats were formulated systematically for the first time, and its occurrence regularity and outbreak mechanism were deconstructed. A green prevention and control technology system including "soil solarization method" as the core, "feed attractant" and "black sticky trap" as supplementary had been created, and had been applied more than one million hm^2 in the main growing areas of Chinese chives. The harm of Chive gnats and the problem of "poisonous Chinese chives" had been solved.



▲ The technological operation process and application effect

The project "Innovation and application of control system for pesticide residues and contaminants in tea" completed by Chen Zongmao's research team at Tea Research Institute of CAAS, won the second prize of the National Science and Technology Progess Awards of China.

The study clarified that the pesticide level in tea brew rather than that in dry tea should be regarded as an effective risk dosage, based on which, the setting rule of the global maximum residue limits (MRLs) on tea would be reconstructed; the key point in the control of pesticide residues and important contaminants was revealed; the *in-situ* and high-throughput analytical methods for pesticides and contaminants were developed. It helps China to strengthen its discourse power in the fixation of global MRLs of pesticides in tea. It also helps to achieve the scientific and technological progress in the sustainable development of China tea industry.



▲ Pesticide residue difference between dry tea and tea infusion

The program "Key technology Q&A of high-quality and specialized wheat production" completed by Zhao Guangcai's team for 15 years at Institute of Crop Sciences of CAAS, won the second prize of the National Science and Technology Progress Awards of China.

This book illustrated key knowledge and technologies through setting answer to each question, and combined text with graphics. This book has been published and printed for 17 times, and has been awarded as National Key Books and Excellent Books of Agriculture, Countryside, and Peasantry. A great many of important technologies and knowledge propagandized more than 150 times by CCTV, CNR, training courses, front-line production and internet, thereby promoting the development of high-quality & specialized wheat production and popularization of science.

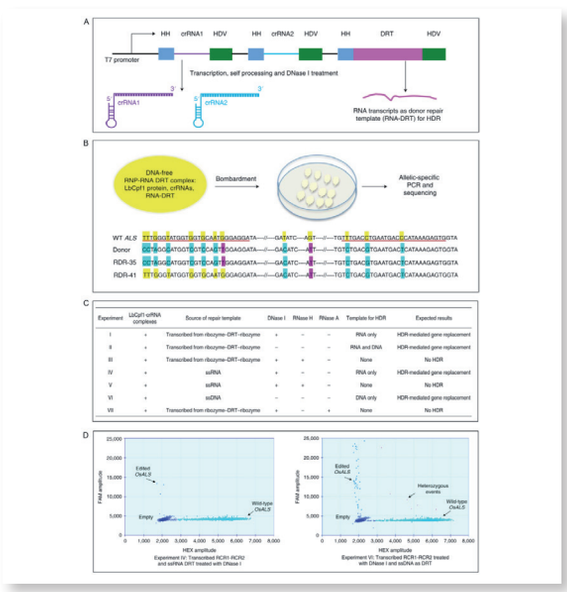
▲ The 1st, 2nd and 3rd edition book of *Key Technology Q&A of High-quality and Specialized Wheat Production*

CAAS Top 10 Research Progress in 2019

Establishment of the novel CRISPR/Cas mediated allele replacement systems in crop plants

By collaborating with University of California, San Diego, the research team led by Xia Lanqin at Institute of Crop Sciences of CAAS, established a novel CRISPR/Cas mediated allele replacement system in crop plants by using DNA and/or RNA transcripts as repair templates and successfully achieved precise gene replacement of rice ALS gene. The newly established gene replacement system overcomes the difficulties in delivering sufficient donor repair template for targeted gene replacement in plant. This research was published in *Nature Biotechnology*.

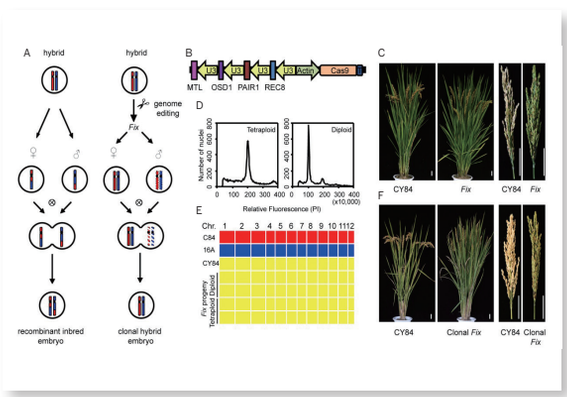
RNA transcript-templated homology-directed DNA repair of double-stranded DNA breaks



Creation of apomixis in hybrid rice

The research team led by Wang Kejian at China National Rice Research Institute introduced apomixis into hybrid rice by genome editing, and successfully obtained the clonal hybrid seeds for the first time. The work constitutes a quantum leap in the field of apomixis and was published as a cover story in *Nature Biotechnology*.

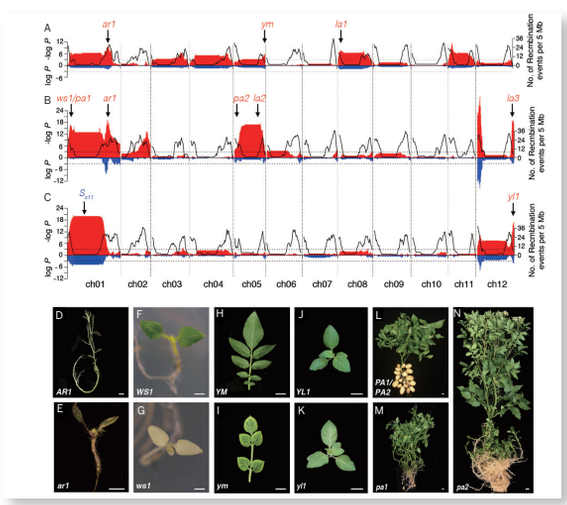
Fixation of rice heterozygosity by multiplex gene editing in hybrid rice



Overcome self-incompatibility and inbreeding depression of diploid potato

The team led by Huang Sanwen at Shenzhen Agricultural Genomics Research Institute of CAAS, collaborating with the researchers in Yunnan Normal University, overcame the self-incompatibility in diploid potato. They also deciphered the genetic basis of inbreeding depression, and proposed a method to overcome inbreeding depression. These studies open up a new way for potato breeding, and related results were published in *Nature Plants* and *Nature Genetics*.

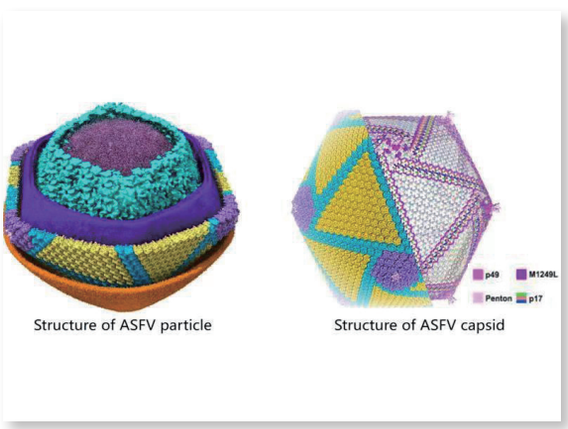
Genome-wide segregation distortion in three selfed population and inbreeding depression-related traits



Creation and application of novel alternatives to antibiotics (ATAs) for livestock and poultry

The bottlenecks of creation and application of key products for ATAs were broken through by Prof. Wang Jianhua's group at Feed Research Institute of CAAS. They revealed the mechanism of antimicrobial peptides with high internalization to host cell as "close compatibility from intracellular-innate, early-defense from hypersensitive-warning" and low resistance to bacteria as "strong-penetration and multi-targets", and established a 20 m^3 scale fermentation and relative SP-nanofiltration system. The agents could significantly reduce the amount of pathogens, such as *Staphylococcus aureus*, and relieve the symptoms in cow mastitis.

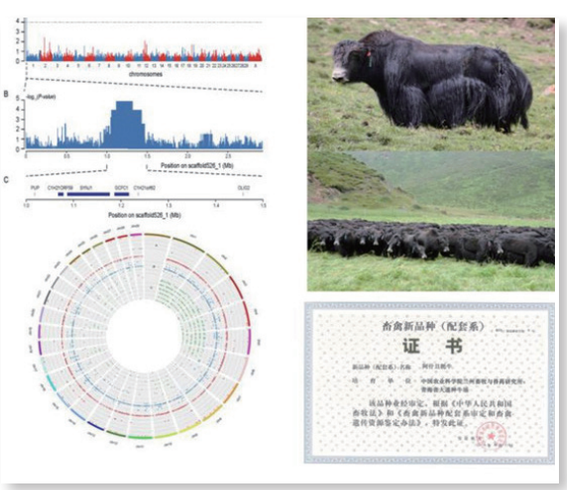
Large-scale trial manufacture of AMPs



Analyze the structure and assembly mechanism of African swine fever virus

Bu Zhigao's team at Harbin Veterinary Research Institute of CAAS, and Rao Zihe and Wang Xiangxi's team at Institute of Biophysics of CAS together first comprehensively illuminated fine three-dimensional structure of African swine fever virus particles. African swine fever virus is the biggest virus whose structure has been resolved at near atomic resolution world widely. This study helps to explore the mechanisms of the invasion of African swine fever virus into host cells and host antiviral immune against virus infection.

The structure and capsid of African swine fever virus



The new variety of Ashdan yak has been approved by the state

The new variety of Ashdan yak is bred by Yan Ping's team at Lanzhou Institute of Husbandry and Pharmaceutical Sciences of CAAS together with the Datong Yak Farm of Qinghai Province, China. This work has been issued the National Certificate of New Breed of Livestock and Poultry of China. It provides the diverse variety for large-scale, intensive and standardized feeding of yaks, and plays an important leading role in the improvement of yak breeds, construction of yak breed supply system and transformation of yak feeding mode in China.

New variety and the certification of Ashdan yak

The rapeseed variety Zhongyouza 19 with high yield, high oil content, double-low quality, and multi-resistances was widely applied in China

Zhongyouza 19 bred by Wang Hanzhong's team at Oil Crops Research Institute of CAAS, was the first nationally approved winter-type rapeseed variety with oil content up to 50percent as well as high yield, double-low quality, multi-resistances, and adaptable for mechanization in China. The oil production was 1,463.5 kg/hm^2 that increased by 12.7percent than control in national regional trials in China. Now it was cultivated up to 1.33 million hm^2 totally.

▲ The variety demonstration site of Zhongyouza 19 in Wuhu, Anhui Province, China in 2016

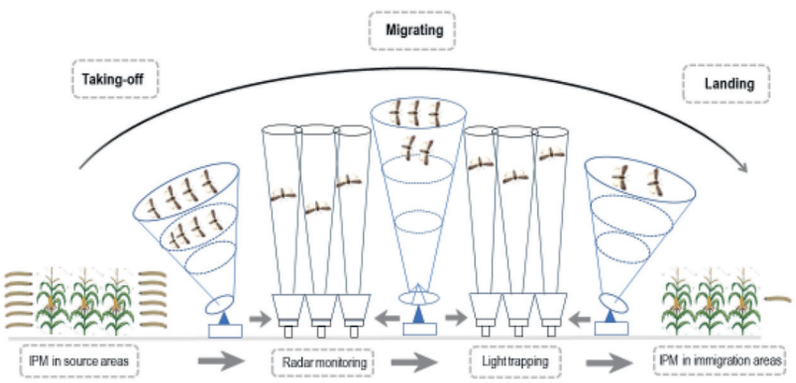
Integration of maize high-yield and mechanical grain harvesting technology

Crop Cultivation and Physiology Innovation Team at Institute of Crop Sciences of CAAS using the innovative technology of quantitative matching between drying performance of maize varieties and the regional ecological conditions, realized the low-crushing grain harvest. By combining the high-yield cultivation technology under dense planting, the maize yield and production benefit were synergisticly improved. This technology has been widely applied and popularized throughout the country, and leaded the development of modern maize production in China.

▲ Maize mechanical grain harvesting technology

Monitoring and management of invasive pest fall armyworm *Spodoptera frugiperda*

Institute of Plant Protection of CAAS took the lead in reporting the early warning of the invasion of fall armyworm *Spodoptera frugiperda*, and accurately detected the first adult fall armyworm in China. The biological law of the pest was clarified, five kinds of pesticides were proposed in time for emergency control, and four kinds of biological control products with independent intellectual property rights were developed, and biological technologies of regional management and control were brought forward, which provided essential technical support for the effective control of this insect pest species.



▲ Diagram of national engineering of fall armyworm monitoring, early warning and management

The key technology of crop and livestock integrated system (CLIS) with high nutrients use efficiency and low pollutants

Prof. Zhang Qingwen's team at Institute of Environment and Sustainable Development in Agriculture of CAAS, in cooperation with the Outputs for Research Center for Eco-Environmental Sciences of CAS and Binzhou Zhongyu Food Co., Ltd., has made a breakthrough into agricultural pollutant control technology of CLIS with eco-industrial chain of high-efficiency cropping, ecological livestock farming and waste reuse. This technology provides a systematic solution for both non-point source pollution control and food security.

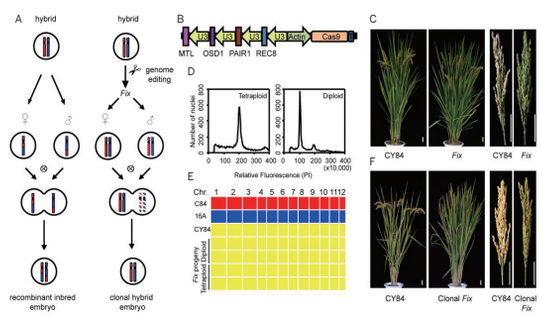
▲ Demonstration project of the key technology of crop and livestock integrated system (CLIS) with high nutrients use efficiency and low pollutants

Frontier Scientific Breakthroughs in 2019

In Frontier and Interdisciplinary

Overcoming self-incompatibility and inbreeding depression in diploid potato provides theoretical basis for diploid potato breeding and the reference for deciphering the inbreeding depression in other species, which promotes the process of potato as staple food.

The work successfully obtained clonal seeds, established the apomixis strategy in hybrid rice and opened up a new direction for the research of fixing heterosis and crop breeding.



▲ Fixation of rice heterozygosity by multiplex gene editing in hybrid rice

The newly established CRISPR/Cas-mediated allele replacement system in crop plants, overcomes the obstacle in delivering sufficient donor repair template into plant cells, and provides new light on achieving precise gene replacement of an existing allele with an elite allele through genome editing to accelerate breeding process and generate novel germplasm.

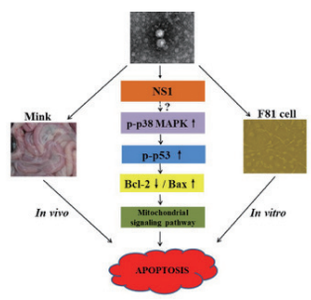
The findings demonstrated that two novel regulatory ncRNAs respond differently to various environmental signals and cooperatively optimize nitrogenase activity, which provides the first insight into the regulatory network underlying biological nitrogen fixation.

In Prevention and Control of Major Animal Diseases

The study on the structure of African swine fever virus found a variety of potential key epitopes of ASF virus, which provides important clues for revealing the mechanisms of ASF virus invading host cells and host antiviral immunity, and opens up new avenues for African swine fever vaccine development.

The study of recombinant *Eimeria* as a vaccine vector showed that the co-immunization of multiple strains of recombinant *Eimeria* expressing different protective antigens of pathogens can enhance the protective immunity of the host. The result is of great significance for the development of new safe and efficient coccidiosis vaccines.

The results demonstrated firstly that mink enteritis virus (MEV) induces apoptosis through activation of p38 mitogen-activated protein kinase (MAPK) and the p53-mediated mitochondrial apoptotic pathway induced by NS1 protein, which sheds light on the molecular pathogenesis of MEV infection.



▲ A proposed model for MEV NS1-induced mitochondrion-mediated apoptosis

The study revealed the molecular mechanism by which the H7N9 avian influenza virus rapidly acquires a PB2/E627K mutation that enhances the virus pathogenicity to humans, thus contributing to an in-depth understanding of the important scientific issue of how avian influenza viruses infect, adapt to, and transmit among mammalian hosts.

In Plant Protection

The chromosome-level genome of *Sitobion miscanthi*, the dominant wheat pest in China, from a parthenogenetic female aphid colony was successfully assembled and further analyzed. The progress makes *S. miscanthi* an ideal model for studying host specificity, phenotypic plasticity, and interactions between aphid and various trophic levels and may drive an application breakthrough of aphid control.

Yielded new insights into the mechanism of baculovirus infection in insects. It is for the first time confirmed that baculovirus infection caused reorganization of the nucleoli and redistribution of nucleolar components, which favor viral replication in infected cells.

Revealed the molecular mechanism of seasonal breeding in Brandt's vole. The close relationship between the expression of hypothalamic genes and seasonal breeding in wild rodent was firstly verified. The molecular mechanism of age-dependent reproductive strategy in Brandt's vole was also reported. These results will promote further research on antifertility control for pest rodents.

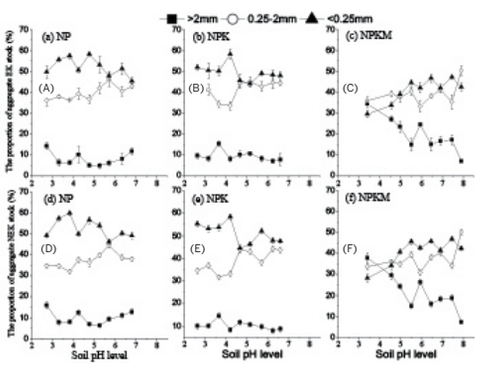
Completed the genome sequence analysis of the white-spotted flower chafer (*Protaetia brevitarsis*). The study provided the first report of the genomic characteristics of *P. brevitarsis* and therefore has important theoretical significance and application value in revealing the adaptive evolution mechanism of its feeding habits, strengthening control of the *Scarabaeidae* insects.

▲ The larva and the adult of white-spotted flower chafer (*Protaetia brevitarsis*)

In Resource and Environment

Both *kat*B, a catalase gene, and *oxy*R, a peroxide sensor gene, play important roles in oxidative resistance and optimal nitrogenase activity. This study sets the foundation to explore the defensive mechanism of nitrogenase activity against oxidative damage in nitrogen-fixing bacteria.

The distribution of potassium in different aggregate fractions was adjusted by acidification improvement for red soil. Moreover, the proportion of potassium stock in aggregate fractions was varied by adjusting pH. The result could guide the improvement of potassium stock in red soil under acidification conditions.

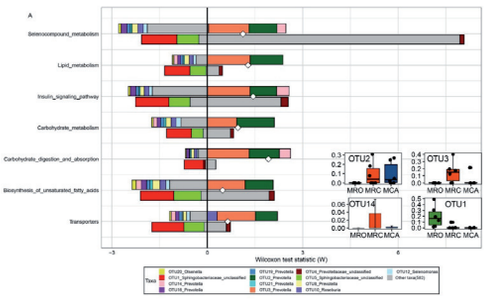


▲ The proportion of exchangeable K (EK) and non-exchangeable K (NEK) stocks in aggregates at different pH levels in soils with three fertilization patterns

Reasonable substitution of organic fertilizer for chemical fertilizer can coordinate crop yield and environmental effect. Substituting stored swine fertilizer mixed with biochar for compound fertilizer reduced gaseous N losses by 7.6 percent, and increased N uptake by 54.1 percent and yield by 7.3 percent in vegetable system. Reasonable organic manure substitution provides decision support for agricultural green development.

In Animal Nutrition

A combination of machine learning algorithms was first used to elucidate the mechanism of signature microorganisms and their symbiotic partners to promote the rumen volatile fatty acids production and rumen function development in early feeding lambs, providing insights into the ruminant rearing theory.



▲ Comparing taxon-level contribution profiles of rumen functional shifts

Plant protein diet suppressed immune function by inhibiting spiral valve intestinal mucosal barrier integrity, anti-oxidation, apoptosis, autophagy and proliferation responses in Amur sturgeon (*Acipenser schrenckii*), and thereby increased mortality. These findings guide a nutritional intervention for application of plant protein in diet of Amur sturgeon.

Honeybee reproductive investment reveals the regulatory mechanism of trait that genetic selected bees for increasing royal jelly production (RJBs). The nurse bees of RJBs evolve a stronger olfaction to sense and response to brood pheromones than that of non-selected Italian bees (ITBs), which increases the larval acceptance rate and boosts the royal jelly production in turn. This is driven by the induced olfactory function in RJBs of chemosensation and energy meta relative to (ITBs). These findings reveal novel aspects of pheromonal communication in honey bees and explain how sensory changes affect communication and lead to a drastic shift in colony-level resource allocation to sexual reproduction.

It is a unique feature that fat can be deposited in sheep tails or rumps and thereby adapt to the environment. The major genes related to sheep tail types were identified from the genome level using the Mongolian sheep. The findings elucidated the molecular mechanism of tail fat deposition in sheep.

Research and Development of Core and Key Technologies

With the goal of improving the utilization rate of agricultural resources, labor productivity and land output rate, breakthroughs have been made in a number of core and key technologies to provide effective support for improving industrial quality, efficiency and competitiveness and promoting sustainable agricultural development.

Variety Breed and Efficient Breeding

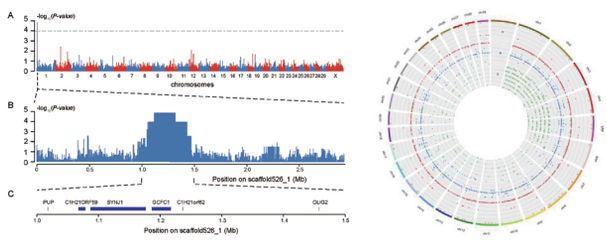
Maize high yield with mechanization technology under dense planting broke through the record of 22.5 t/hm². The team led by Li Shaokun at Institute of Crop Sciences of CAAS established the ideotype and population structure of high yield maize (22.5 t/hm²) for the first time in the world, created the cultivation theory and key technology for regulating the maize high-quality population and obtained the highest yield record in six continuous years in China, thereby realizing the significant improvement of real productivity and efficient utilization of resource for maize.

▲ On-site meeting of high yield maize with green production technology under dense planting pattern

Establishing a technical system for the repopulation of pig farms. Based on the deep understanding of African swine fever (ASF) and the core concepts of biosecurity and comprehensive ASF control practices, guidelines for the repopulation of industrialized pig farms were formulated for biosecurity-based prevention and control of ASF, including review of the epidemic, cleaning and disinfection of pig houses and in-out standard operating procedures for personnel, supplies, vehicles and pigs, which provides protocols for the production resumption of ASF-affected farms.

▲ Prof. Qiu Huaji was giving technical guidance for a pig farm

The new variety of "Ashdan yak" has been issued the National Certificate of New Breed of Livestock and Poultry. The variety of "Ashdan yak" was bred by 20 years' systematic breeding. Its excellent characteristics are hornless, good meat production performance, strong adaptability, genetic stability and easy to feed and manage. In this work, the molecular mechanism of the yak horn development regulation was characterized, and the genetic variation sites of controlling horn traits were identified. This work could help to shorten the breeding cycle and improve the breeding efficiency.



▲ Genome wide selection of horn traits in "Ashdan yak" and annotation of CNVR variation region and QTL

The system of Rice-Eel-Toad complex cultivation was developed by Agro-Environmental Protection Institute of Ministry of Agriculture and Rural Affairs of China, which includes some techniques, such as multistory cropping and raising, drainage control, straw conversion, pest biological control, etc. It can recycle resources, prevent agricultural non-point source pollution effectively, and the economic benefit is three times more than the traditional rice planting model.

▲ The model of Rice-Eel-Toad complex cultivation

Agricultural Resource and Environment

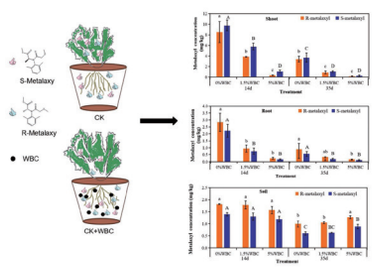
Monitoring and management of invasive pest fall armyworm. The monitoring and forecasting techniques, including light traps and pheromone traps, were developed to make early warning of fall armyworm that had invaded China; the online identification service and population dynamics forecasting system were developed; effective chemical pesticides to control fall armyworm were screened and the proper application techniques were proposed; four kinds of biological control products with independent intellectual property rights were developed; and the ecologically regional pest management and control strategy against fall armyworm was also put forward.

▲ Monitoring and forecasting of fall armyworm and its biological control technology

Serial solid organic fertilizer spreaders. The Biomass Conversion and Utilization Equipment Innovative Team of Nanjing Institute of Agricultural Mechanization of CAAS has overcome key technical problems in fertilizer spreading, such as stable feeding and uniform spreading. And they have developed three kinds of multi-functional solid fertilizer spreaders: trailer for field, wheeled self-propelled and crawler self-propelled spreaders with a wide range of application. It provides the equipment and technical support for promoting sustainable agricultural development.

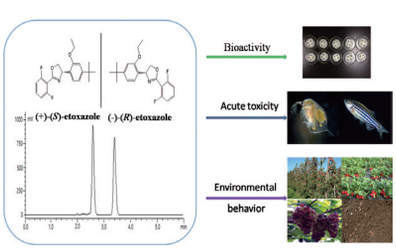
▲ Organic fertilizer spreading in the greenhouse

Biochar reduces the environmental risk of contaminates in soil. The Innovation Team of Mudflat Bioresource Protection and Utilization, Tobacco Research Institute of CAAS found that the amendment of functional biochar at proper rate increased the adsorption ability of soil to contaminate like atrazine, reduced their bioavailability and ultimately decreased their accumulation in plants. These results were helpful to develop the biochar remediation technology for soil contamination.



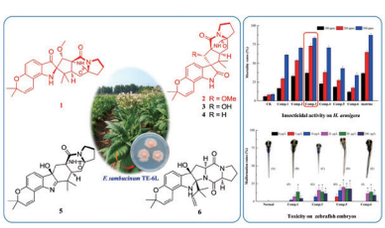
▲ Biochar reduces the environmental risk of contaminates in soil

Systemic stereoselectivity study of chiral pesticide etoxazole. The stereoselectivity of chiral pesticide etoxazole was assessed systemically by the Team of Monitoring and Assessment of Fruit Quality & Safety Risk of CAAS. Significant difference was observed between the two enantiomers of etoxaozle, including stereoselective bioactivity, acute toxicity, and the degradation in fruits and soils under open-field conditions. The results of this work can facilitate the safe use, risk assessment and scientific management of etoxaozle in orchard.



▲ The stereoselectivity of chiral pesticide etoxazole: bioactivity, toxicity, and degradation

New lead compounds used for developing biopesticides with high efficiency and low toxicity. The Innovation Team of Tobacco Functional Components and Synthetical Utilization from Tobacco Research Institute of CAAS characterized new prenylated indole alkaloids (PIAs) from a tobacco-associated endophytic fungus. PIAs possess high antifungal activity against several plant-pathogenic fungi and remarkable larvicidal activity against the cotton bollworm *Helicoverpa armigera* with low toxicity, suggesting these compounds have potential to be biopesticides. This study will offer novel lead compounds for the agrochemicals development with independent intellectual property rights.



▲ PIAs characterized from tobacco-associated endophytic fungus and their agricultural bioactivities

The key technology of Crop and Livestock Integrated System (CLIS) with high nutrient use efficiency and low pollutants. The Institute of Environment and Sustainable Development in Agriculture of CAAS, has made a breakthrough into agricultural pollutants control technology of the CLIS with eco-industrial chain of high-efficiency cropping, ecological livestock farming and waste reuse based on effective matter cycling within the system. This technology provides a systematic solution for both non-point source pollution control and food security.

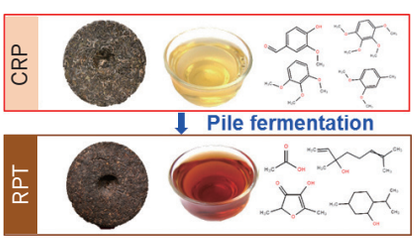
▲ Demonstration project of the key technology of crop and livestock integrated system (CLIS) with high nutrients use efficiency and low pollutants

Key Product Creation and Value- Added Processing

Innovation for key creation technology of new green alternatives to antibiotics (ATAs) in animal production. The bottlenecks of creation and application of antimicrobial peptides (AMPs) were broken though by the AMP-ATA group at Feed Research Institute of CAAS. The key novel products and techniques would shorten the gap period of ATAs products shortage after the prohibition of antibiotic additives as feed usage at the middle of 2020, support the sustainable green development of the husbandry, and promote the whole upgrading for green feed industry in China.

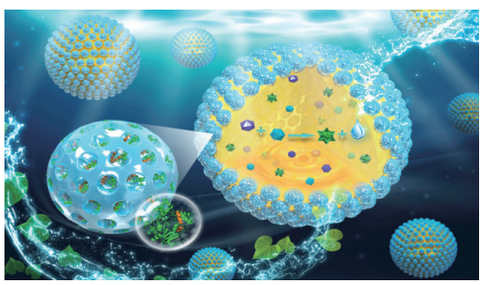
▲ Application of AMPs in cows and piglets

The accumulation and transformation of aroma components of Pu'er tea. The Tobacco Quality and Safety Research Center of the Tobacco Research Institute of CAAS revealed the accumulation and transformation of aroma components of Pu'er tea during pile-fermentation based on sensomics and chemometrics methods. It provides basic data for the application research of Pu'er tea flavor enhancement. It could also provide new ideas for flavor, color and biological activity enhancement of cigar leaf fermentation.



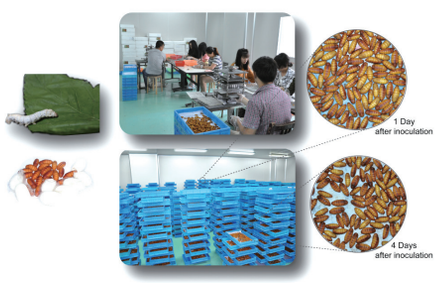
▲ Transformation of aroma components of Pu'er tea during pile-fermentation

Establishing a green and efficient functional lipid "emulsion enzyme reaction factory". The Oil Quality Chemistry and Nutrition Innovation Team from Oil Crops Research Institute of CAAS has created a novel Pickering emulsion enzyme reaction system, which solves the bottleneck problems of low efficiency and organic solvent residues in the enzymatic modification of lipids. The method described herein could be applied in the green production of reconstituted lipids because of enzyme recoverable and easy scale-up.



▲ Schematic diagram of lipid "emulsion enzyme reaction factory"

New Products produced using Silkworm-Baculovirus Expression System. The Biotechnology Research Institute (BRI) of CAAS obtained two Production and Application Security Certificates about chicken interferon γ and feline interferon ω approved by the Ministry of Agriculture and Rural Affairs of China. This marks a further expansion of the scope of genetically engineered products for animals using silkworm bioreactor.



▲ The interferons produced using silkworm bioreactor has the advantages of high expression level and low production cost

Quality and Safety Technology Innovation

Suscess in DUS Data Analysis Software development. The success of DUS (Distinctness, Uniformity, Stability) Data Analysis Software development by DUS Research Group from Vegetables and Flowers Institute of CAAS has filled in the blank of statistical analysis for new plant variety test in China. It can significantly optimize the trial design, improve the trial accuracy, and realize the joint correction and accurate judgment of trials data from more locations and years. This software has been approved by the International Union for the Protection of New Varieties of Plants (UPOV).

Untargeted and targeted metabolomics strategies. Using HS-GC-IMS and HS-SPME-GC-MS technologies were established by the Institute of Apicultural Research of CAAS to screen six volatiles as markers for discriminating the honeys from *Apis cerana* and *A. mellifera*, which provided promising evidence for identifying the authenticity of honey.

Agricultural Science and Technology Achievements and Contributions

With the important mission and responsibility given by the times, CAAS strives to take a leading role in agricultural technology innovation, to reduce poverty through science and technology, and to promote green development. These efforts will contribute to overall rural revitalization and agricultural modernization.
CAAS has integrated the United Nations' sustainable development goals with China's poverty alleviation and rural revitalization aims in a bid to realize the 2030 sustainable development goals early.

Scientific Innovation and Food Security

Food security is a major strategic issue in China as well as the focus of the UN's sustainable development goals. In 2019, China's grain output reached 663.85 billion kg and the self-sufficiency rate of main grains exceeded 95 percent.

To reach goals of high-quality, high-yield, and high-efficiency, CAAS has developed mechanization technologies for maize dense planting, hitting a record high yield of 1,500 kg. The academy has also established the hybrid rice apomixis system, revealed the self-compatible depression mechanism of diploid potatoes and developed a set of technologies to prevent and control *Spodoptera frugiperda*. These technologies provided vital scientific support for China's fight against *Spodoptera frugiperda*, laid a solid foundation for the country's food security, and ensured China could offer the international community effective solutions to control crop diseases and pests.

Funded by the central government and Bill and Melinda Gates Foundation, the project "cultivate green super rice for resource-poor areas in Asia and Africa", led by CAAS, pools strengths and resources of 58 rice research institutes from home and abroad. The project, based on

advanced breeding technologies, has cultivated a large number of new green super rice varieties in the past 11 years. These varieties featuring high yield and good quality resist many pests and diseases.

Among these varieties, 78 have been approved in 18 countries in Africa and Asia, and have made great contributions to local food security and sustainable development of agriculture. To date, these varieties have been planted in areas covering 61,200 km^2 in total and helped 1.6 million farmers raise their income.

Poverty Reduction and Industrial Prosperity

CAAS adheres to the central government's guiding strategies on poverty relief and continues to send experts and professionals to poverty-stricken areas. Focusing on 12 poor counties, the academy has built a mechanism which utilizes science and technology to reduce local poverty. Under the mechanism, CAAS chose 57 excellent cadres to work in poor areas. A total of 650 teams of experts and 3,300 researchers were dispatched to poor areas to give aid and support.
As a result, CAAS carried out 321 projects on poverty eradication and set up 255 demonstration bases, with display areas covering some 183 km^2.
The academy has helped farmers boost employment and increase their income. Last year, participating farmers saw their annual income grow by 635 million yuan ($91.5 million).
In addition, 2,095 technical training classes were organized by CAAS, attracting 127,000 visits.

An expert team from CAAS carries out an on-the-spot investigation in Maguan County, Yunnan Province to provide stronger support for poverty reduction

Experts from CAAS instruct local people about edible fungi cultivation in Fuping County, Hebei Province

CAAS stepped up efforts to develop, promote, and apply new agricultural varieties in 2019—especially important ones including rice, wheat, soybeans and cattle.

Last year, 377 new varieties of crops were promoted, with a combined planting area of 37,800 km^2. As for livestock and poultry, CAAS promoted a total of 1.33 billion.

Green Development and Rural Management

CAAS plays a leading role in using science to improve rural management and build a livable countryside.

Focusing on environmental issues in rural areas, the academy is committed to making innovations and achieving breakthroughs in technical researches. A multi-function platform has been established to ramp up production, improve living conditions, and protect the ecology in China's rural areas.

Headed by CAAS, a group of 102 organizations, including scientific research institutes, universities, and enterprises formed the National Agricultural Waste Recycling Innovation Alliance with the aim of enhancing the utilization ratio of agricultural waste through scientific and technological innovations.

The alliance has developed a range of key technologies, such as the anaerobic fermentation of low-concentration sewage, compost regulation and concentration of biogas slurry, to transform animal waste into energy sources and fertilizer. These technologies can reduce related odor by 80-96 percent and cut ammonia emissions by more than 80 percent.

In terms of the re-utilization of mulch films, new biodegradable mulch films such as KF16-1 have been created. Moreover, the alliance also conducted an in-depth study on mulch film recycling equipment which helped increase the recycle rate over 85 percent.

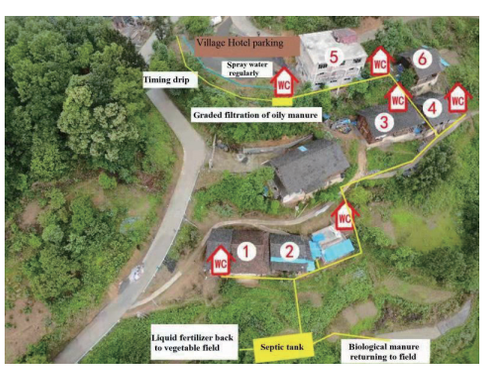
In Anping County, Hebei Province, the alliance spent just 3 years turning 90 percent of the county's livestock waste into new resources, energy, and green organic fertilizer, solving one of the county's major problems.

▲ The "Jing'an model" created by the National Agricultural Waste Recycling Innovation Alliance

As part of the project "Toilet Improvement in Rural Areas and Integrated Technology Application", a team led by CAAS created a mode to improve toilets and local environment for mountainous areas lacking water in Southwest China. The mode can enhance the effective possessing rate of rural manure to over 95 percent and generate considerable ecological benefits with low cost. The project is supported by the National Rural Environmental Management Science and Technology Innovation Alliance.

It has been used widely in Jianhe County, Guizhou Province and was awarded first prize in the first National Rural Toilet Improvement Technological Product Innovation Competition.

Along with its partners, CAAS has established China's first set of calculation models for pollutant generation coefficients and discharge coefficients in the breeding industry, providing scientific bases for identifying pollution sources and developing pollution control strategies. Technologies have been applied to reduce sewage at



▲ The Rural Environmental Management Science and Technology Innovation Alliance demonstrated the reconstruction and improvement of toilets in highly populated areas in Dalao Village, Guizhou Province

pollution sources, control the pollution process and increase the utilization ratio of sewage. As a result, farm wastewater was reduced to 30 percent less than the country's quantity limit. Key technologies and facilities for compost deodorization, wastewater recycling, and biogas slurry reuse were also developed.

Strategic Programs

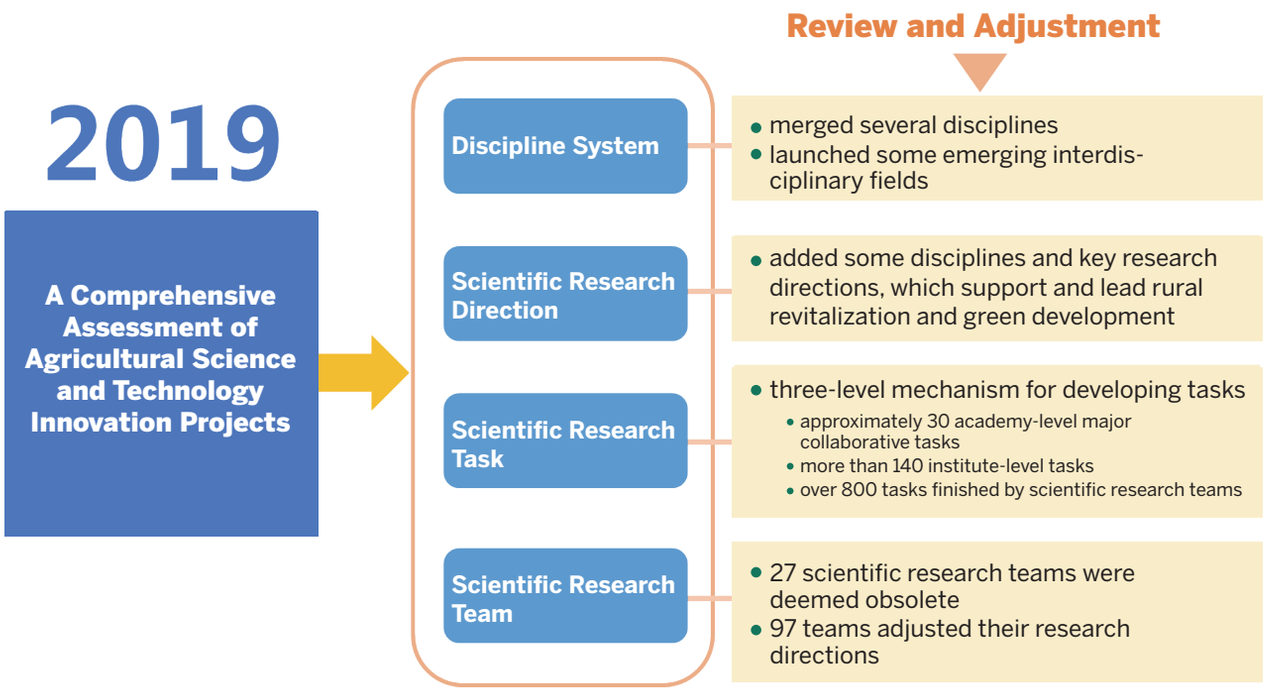
- Agricultural Science and Technology Innovation Projects
- Rural Revitalization and Poverty Alleviation through Science and Technology
- National Agricultural Science and Technology Innovation Alliance
- Research and Demonstration Program on Integrated Technology-based Green Development
- Talent Project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

Agricultural Science and Technology Innovation Projects

In 2019, CAAS has comprehensively teased out and adjusted the discipline system, innovation focus, and innovation tasks on the basis of comprehensive evaluation of innovation projects. According to the general requirements of "following the latest trends of international agricultural science, meeting the country's strategic demands and catering to the development of modern culture in China".

CAAS merged disciplines with narrow scope, scattered strength and overlapping contents. It launched a batch of emerging interdisciplinary fields and key research directions that needed urgently to be opened up, and added a batch of disciplines and key research directions that support and lead rural revitalization and green development.

CAAS worked through and organized innovation tasks according to 3 levels – academy-level, institute-level and team-level. It carried out approximately 30 major collaborative tasks at the academy-level, more than 140 tasks at the institute-level, and over 800 tasks finished by scientific research teams. A total of 27 scientific research teams were deemed obsolete, and 97 teams adjusted their research directions.



Agricultural Science and Technology Innovation Project (2013-2025) divides into three phrases:

Pilot period (2013-2015)

Comprehensively carrying forward period (2016-2020)

Leapfrog development period (2021-2025)

Rural Revitalization and Poverty Alleviation through Science and Technology

CAAS held a conference on poverty alleviation and rural revitalization, It launched construction in 4 counties as the demonstration of Sci-tech Poverty Alleviation - Fuping in Hebei Province, Huachuan in Heilongjiang Province, Ziyang in Shaanxi Province and Lintan in Gansu Province. Construction 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.

A total of 220 teams and more than 3,300 scientific research personnel served on the front line of modern agricultural construction and achieved remarkable results.

▲ CAAS held a conference on poverty alleviation and rural revitalization

CAAS established the 3+*N* cooperative working mechanism. The construction of each demonstration county is led by 1 leader of the academy, coordinated by 1 department in the academy, organized and implemented by 1 research institute as well as relevant institutes and teams. These units at CAAS collaborated with the provincial and municipal agricultural science and education units in the demonstration counties to establish a cooperative working mechanism bringing together enterprises, universities and research institutes.

The academy used its full intellectual strength to carry out strategic consultation for these counties. It helped Lintan, Donghai and Qionglai to complete the overall planning and implementation plan and to come up with top-level designs with high standards and high starting points.

CAAS conducted more surveys and offered guidance to help counties spot and develop their niche. For example, the academy advised Donghai to focus on the development of competitive industries with local characteristics such as grain, vegetables, flowers, and fruit trees; offered suggestions to Lankao on developing characteristic agricultural brands such as musk melon, peach, sweet potato, and goats' milk; and encouraged Ziyang to develop leading industries such as tea and edible mushrooms.

The academy strengthened its leading role and integrated the application of key technologies. Five popular science demonstration bases combining agriculture with tourism were established in Wuyuan, integrating more than 10 green, productive and efficient technologies. These helped Wuyuan successfully shape the rape flower landscape in autumn with revenues from scenic spots doubling year-over-year. In Huachuan, 5 rice and corn demonstration bases were established, integrating 18 key technologies. In Donghai, a demonstration park for intelligent agriculture was built, which has introduced 50 new varieties of vegetables and 6 flower varieties.

CAAS cultivated the team of agricultural operators with knowledge of agriculture and love for rural areas and farming, and it improved incentives for internal development. The academy organized 50 training courses with different topics, attracting more than 14,000 visits from cadres with the bureaus of agriculture and rural affairs in demonstration counties and towns as well as new business entities. This provided intellectual support and human resources for the construction of demonstration counties.

National Agricultural Science and Technology Innovation Alliance

In 2019, 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 10,000 experts from more than 6,000 units. It collected funds of 2.14 billion yuan ($305.8 million) and carried out 960 collaborative innovation tasks covering research and development, technological integration and project demonstration, promotion and application, and technical service.

It also demonstrated 544 sets of integrated technologies, established 767 criteria, and published 267 criteria. On the basis of the existing 1,645 demonstration bases and 620 new demonstration bases were built. More than 3,300 training courses were conducted, with 330,000 people trained. A total of 910 on-site meetings were held and 10,570 news reports were published by state and provincial media outlets.

The alliance has promoted the innovative development of modern agriculture.

First, the system design of the alliance gradually improved. After the third-party evaluation of 62 sub-alliances, 34 recognized alliances including 15 model alliances were determined, 14 were suggested to rectify their problems and 14 were suggested to withdraw from the alliance. A three-level construction and management system, comprised of guidance, charter, and management measures, was formed, which ensures the orientation, standardization and sustainability of alliance's operation.

▲ A third-party evaluation meeting is held by the National Agricultural Science and Technology Innovation Alliance

Second, a large number of innovations emerged. The alliance strengthened the collaborative innovation of key technologies used in the whole industrial chain of fishery equipment, smart agriculture, dairy industry, and cotton. Many technologies were improved and industrial transformation promoted. It also strengthened the collaborative innovation of technical models, such as comprehensive utilization of straw, reduction of fertilizers to increase efficiency, and recycling of agricultural wastes, which promotes the green development of agriculture. In some regions, to tackle major issues such as groundwater overexploitation, heavy metals pollution and rocky desertification in hot regions, comprehensive technical solutions were used to support the sustainable development of regional agriculture.

Third, exploration of mechanisms continued to deepen. In 2019, the alliance focused on the promotion and implementation of a physical mechanism. Alliances such as the dairy alliance and rice commercialization molecular breeding alliance established 12 physical entities, which led to a deeply integrated mechanism of enterprises, universities and research institutes.

Research and Demonstration Program on Integrated Technology-based Green Development

CAAS advanced 16 research and demonstration programs on integrated technology-based green development, namely rice, corn, wheat, soybeans, oilseed rape, potatoes, cotton, vegetables, tea, apples, pears, musk melons, dairy cattle, mutton sheep, pork and duck meat.

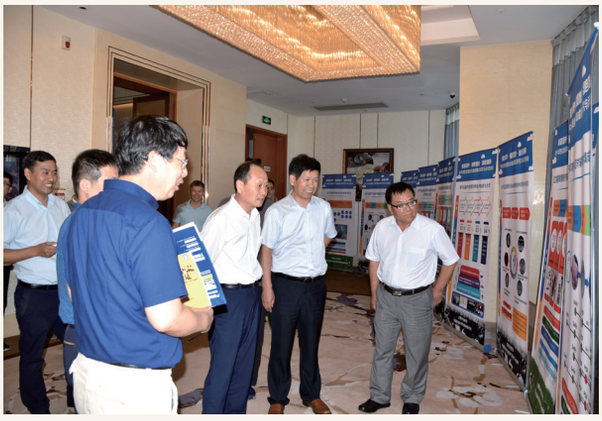
In the farming sector, output increased by an average of 23 percent, the consumption of water, fertilizers, and pesticides was reduced by 33 percent–20 percent and 30 percent respectively and expenditure was lowered by 78,750 yuan ($11,250) per hectare on average via cost saving and increased efficiency. The average expenditure reduction in the animal breeding sector reached 28 percent.

The academy set up a series of technical models for green development. It integrated 211 advanced and practical technologies at home and abroad and formed 57 sets of comprehensive agricultural green development technical models suitable for various ecological conditions in different regions. Among them, CAAS' wheat project developed close cooperation with JINSHAHE Flour Group.

The model covers the entire industry chain from field to workshop and enables the collaboration between science and enterprises. The academy's duck meat project achieved revolutionary breakthroughs from stuffing to non-stuffing and a disruptive innovation from raising ducks in water to farming them on land.

The academy held a series of on-the-spot demonstrations and meetings. A total of 55 were held throughout the country, attracting more than 6,000 visitors, including leaders of agricultural authorities and local governments, agricultural technology extension agents, and large producers.

The academy provided extensive technical training and consulting services. It organized 277 training classes, which attracted more than 30,000 visits from agricultural technicians, agricultural producers of new agriculture, and farmers. More than 58,000 copies of materials were distributed. These classes effectively promoted the improvement of agricultural production technology in surrounding areas.



▲ Feng Zhongwu, Vice President of CAAS, participates in an on-site meeting of the research and demonstration program on integrated technology-based green development of dairy cows

▲ Li Jieren, Head of the Discipline Inspection Team at CAAS, attends an on-site meeting of the research and demonstration program on integrated technology-based green development of apples

Talent Project

Young Talent Project Plan (2017-2030)

The "Young Talent Project Plan" (2017-2030) is a forward-thinking 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 with proper scale and clear structure and functions. Having a rational layout of disciplines can properly address the needs of agriculture, villages, and farmers. By 2030, CAAS hopes to build a young talent team of 4,750 people, all under the age of 45. This team would account for two-thirds of all frontline research professionals. At the same time, the number of innovative young talents would reach approximately 3,450, transformative young talents would reach some 340, supporting young talents would reach roughly 960, and outstanding young talents would reach about 570.

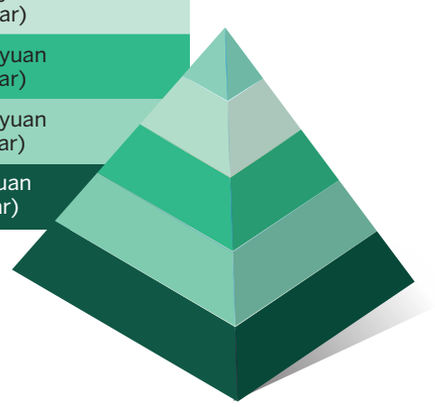
Special Support Policies for Outstanding Agricultural Talents

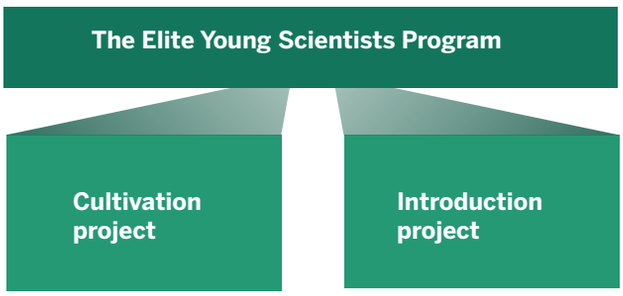
CAAS has developed a set of policies to support outstanding agricultural talents from both home and abroad. These policies will help in recruiting leading high-level talent, giving priority support to jointly promote and construct complete talent-development and cultivation systems to attract and cultivate high-end science and technology talents while encouraging innovation and creativity.

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 3 levels: top talent, leading talent and young talent. CAAS provides each group with research funds and annual subsidies. For top talents, the research funds are 2 million yuan ($285,200) per person each year and every talent also receives an annual subsidy of 500,000 yuan ($71,300). The research fund for each leading talent in Class A is 1.5 million yuan ($213,900), and the annual subsidy is 300,000 yuan ($42,780). The research fund for each leading talent in Class B is 1 million yuan ($142,600), and the annual subsidy is 250,000 yuan ($35,650). The research fund for each leading talent in Class C is 800,000 yuan ($114,080) and the annual subsidy is 200,000 yuan ($28,520). The research fund for each young talents is 600,000 yuan ($85,560), and the annual subsidy is 100,000 yuan ($14,260).

By the end of 2019, CAAS has made a bigger and stronger talent pool than ever. Of 333 outstanding agricultural talents, 17 were top talents, 205 were leading talents and 111 were young talents.

Top talents	Research funds: 2 million yuan ($294,854) (per person a year)	Annual subsidy: 500,000 yuan ($73,713) (per person a year)
Leading talents in Class A	Research funds: 1.5 million yuan ($221,141) (per person a year)	Annual subsidy: 300,000 yuan ($44,228) (per person a year)
Leading talents in Class B	Research funds: 1 million yuan ($147,427) (per person a year)	Annual subsidy: 250,000 yuan ($36,856) (per person a year)
Leading talents in Class C	Research funds: 800,000 yuan ($117,941) (per person a year)	Annual subsidy: 200,000 yuan ($29,485) (per person a year)
Young talents	Research funds: 600,000 yuan ($88,456) (per person a year)	Annual subsidy: 100,000 yuan ($14,742) (per person a year)





The 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 to promote 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 2 projects: an introduction project and a cultivation project. It aims at attracting both domestic and foreign high-level leading scientists and innovative talents in various disciplines who are under 40 years old and have a strong international perspective. In 2019, 15 young talents were brought on at the academy-level through the introduction project, and 22 young talents were included at the institute-level through the introduction project.

Introduction of High-level Talents with Flexible Policies

In 2018, CAAS issued interim measures to provide flexible policies for the management of high-level talents introduction and to provide support to such talents in terms of staffing, project application, and research conditions. The interim measures are intended to widen the talent introduction channels and implement more positive, open, and effective talent introduction policies. The policies ultimately strive to attract more high-level Chinese and foreign agricultural elites to expedite the development of modern agriculture.

Post-doctoral Work

CAAS' center for post-doctoral studies was established in 1991. It covers 4 academic fields: natural science, engineering, agronomy, and management. It also includes mobile research centers for post-doctoral studies in the following areas: veterinary medicine, animal husbandry, crop science, plant protection, agricultural and forest economy management, agricultural resources and environment, biology, horticulture, agrostology, agricultural engineering and ecology. In total, 1,818 post-doctoral researchers have been enrolled, including 168 Chinese graduates of foreign universities and 75 foreigners. In 2019, CAAS enrolled 167 post-doctoral researchers, and there are currently 520 post-doctoral researchers, including 17 foreigners.

▲ A training class is held for those employed by CAAS in 2019

Think Tank Construction

The influence of high-end agricultural science and technology think tank brands is continuously increasing. CAAS hosted the second China Agricultural and Rural Science and Technology Development Summit in Nanjing, Jiangsu Province, at which it released several reports, including the *2019 Global Agricultural Research Front* containing 62 world agricultural research frontiers and hot issues in 8 subjects. Another study, the *2019 Analysis on the Competitiveness of Global Scientific Papers and Patents*, showcased China's competitive level of agricultural science and technology globally. A third, the *2019 Major Advances in China Agricultural Science*, released 10 basic scientific research achievements representing frontier research and major breakthrough progress of agricultural science and technology nationwide in 2018.

The summit attracted approximately 1,300 attendees. Leaders of the Ministry of Agriculture and Rural Affairs and of the Jiangsu government also delivered speeches at the summit. The summit strengthened CAAS' macro-strategic research and resulted in a series of agricultural strategy studies and agricultural think tanks, including *the China Agricultural Green Development Report* and *the China Agricultural Industrial Development Report*, which provides powerful decision references for CAAS' construction of world-class academic disciplines and scientific research institutes as well as implementation of rural revitalization strategies.

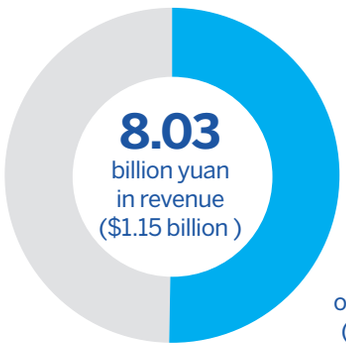
Wang Hanzhong, Wan Jianmin, Mei Xurong and Sun Tan, Vice Presidents of CAAS, attended 4 sub-forums of the Forum 2019 on Science and Technology for Agricultural and Rural Development in China

Support Capability

- Annual Budget
- Staff
- Domestic Cooperation
- International Cooperation
- Regional Strategic Development
- Research Facilities
- Field Stations
- Intellectual Property Achievements
- Graduate Education

Annual Budget

In 2019, CAAS generated a total revenue of about 8.03 billion yuan ($1.15 billion), which included more than 4.48 billion yuan ($640 million) of state funding.



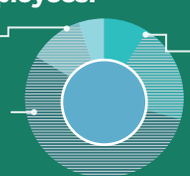
Staff

CAAS had 11,323 members of staff by the end of 2019, 6,933 permanent employees and 4,390 contract workers.

Among 6,933 permanent employees:

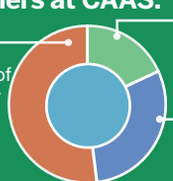
777 technicians and logistics workers, **11.21percent**

6,031 researchers (including **1,484** people who also hold managerial posts), **86.99percent**



1,609 were managerial staff, **23.21 percent**

Of all researchers at CAAS:



2,771 hold the title of research assistant or below **(45.95percent)**

1,295 were professors (**21.47percent)**

1,965 were associate professors **(29.84percent)**

77.65percent of all researchers held postgraduate degrees

2,964 researchers held doctorate degrees

1,719 researchers held master's degrees

Postgraduate degree holders account for **61.84** percent of the total managerial staff at CAAS. Of them, **539** have doctorates and **456** have master's degrees. A total of **746** managerial staff members are 45 years old or younger, accounting for **46.36** percent of CAAS management group.

Among technicians and logistics workers at CAAS, **12** are in first-class technical posts and **171** are in second-class technical posts; **147** technicians have college degrees and above, accounting for **18.92** percent of the total number of this group. There are **56** technicians and logistics workers aged 45 or younger at CAAS, accounting for **7.21** percent of the total.

Currently, 17 academicians of Chinese Academy of Sciences and Chinese Academy of Engineering work at CAAS. Of the CAAS staff, 25 have been honored as National Young and Middle-aged Experts with Outstanding Contributions to China, 124 have received special government allowances from the State Council, 67 have been listed in the National Hundred, Thousand and Ten Thousand Talents Program, 46 individuals and 11 teams have been ranked in the Innovative Talents Growth Program initiated by Ministry of Science and Technology, 14 have won the China Agricultural Elite Award presented by Ministry of Agriculture and Rural Affairs, and 81 have been included in the Outstanding Talents for Agricultural Scientific Research.

Domestic Cooperation

CAAS has enhanced cooperation with local governments. The academy has signed strategic cooperative agreements with provinces of Sichuan, Hunan and Hubei, and with cities including Shenzhen in Guangdong Province, Weifang in Shandong Province, Guang'an in Sichuan Province, Jinhua in Zhejiang Province and Bortala Mongol autonomous prefecture of Xinjiang Uygur autonomous region.

The joint cooperation focuses on strategic consultation, collaborative innovation, co-construction of pilot demonstration bases, technical training, and other sectors as efforts to promote the development of modern agriculture and rural revitalization and poverty alleviation.

CAAS sent experts to the production lines in the cities of Shenzhen, Ningbo, Jinhua, Guang'an, Jianyang, Pingliang and Bortala Mongol autonomous prefecture, where they provided technical guidance and advisory recommendations as well as made development plans. The efforts served to help the locals solve key technology problems restricting the development of regional modern agriculture.

The experts completed the development plans for Shenzhen International Food Valley, a food science center set up by CAAS and the Shenzhen government, and launched an international seminar. The construction of the valley has made significant progress.

CAAS experts summarized the "rural revitalization model of Ningbo" and hosted a rural revitalization forum as well as two sessions of rural revitalization professional training. The experts also made development plans for Cow Valley in Bortala Mongol autonomous prefecture and drafted advisory reports on *Thoughts and Suggestions on Developing Industrial Cannabis Industry in Bortala Mongol autonomous prefecture*.

Since the CAAS training center was established in Guang'an, it organized over 30 experts to conduct research and launch technical training in the city, in order to expedite CAAS' advanced and applicable varieties, techniques and achievements to farmers.

▲ CAAS signs a strategic cooperation agreement with the Shenzhen municipal government

▲ Leading Initiative of the CAAS Technology Innovation Program (CAASTIP)

International Cooperation

In 2019, CAAS continued to optimize its agricultural science international cooperation layout and promote communication exchange with key agricultural scientific research institutions across the globe. The academy has thus played a role in promoting global science, technology, innovation, and sustainable development, while furthering its international influence.

Successfully Hosting the Sixth Global Forum of Leaders for Agricultural Science and Technology

The forum attracted more than 400 attendees from 39 countries and invited the following officials to deliver speeches there: Zhang Taolin, Vice Minister of Agriculture and Rural Affairs, FAO Director-General Qu Dongyu and leaders of Consultative Group on International Agricultural Research.

Themed with Science and Technology for Green Development of Agriculture and Rural Areas, the forum passed the Chengdu Declaration, which showcases China's achievements and experience of green development of agriculture and rural areas and CAAS' participation in the United Nations 2030 Sustainable Development Goals.

Leading Initiative of the CAAS Technology Innovation Program (CAASTIP)

CAASTIP plans to invest $10 million over 5 years to focus on advanced technologies, to connect with global comprehensive research plans, and to discuss hot and key issues of global agricultural technology. It also plans to promote the establishment of a stable international cooperation and coordination mechanism to effectively serve rural revitalization with science, technology, and

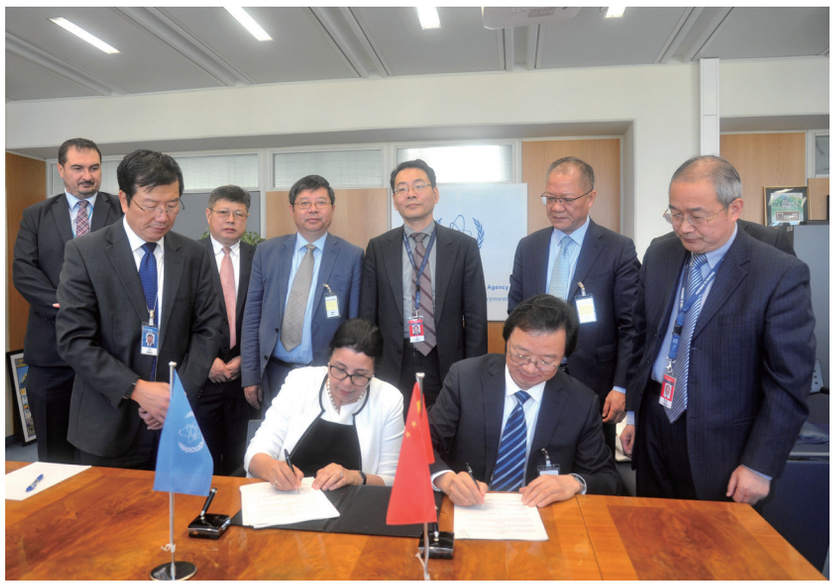
innovation, and to promote the UN's sustainable development. The program has received wide attention and positive responses from international partners.

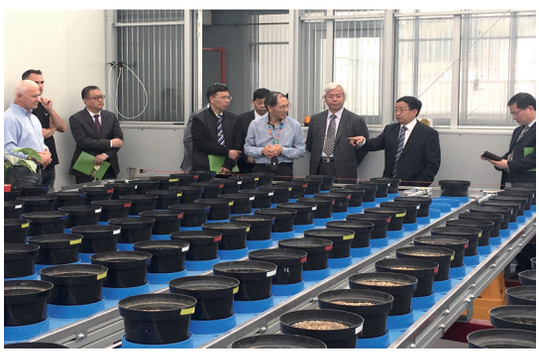
Enhancing Supporting Ability of Scientific and Technological Innovation

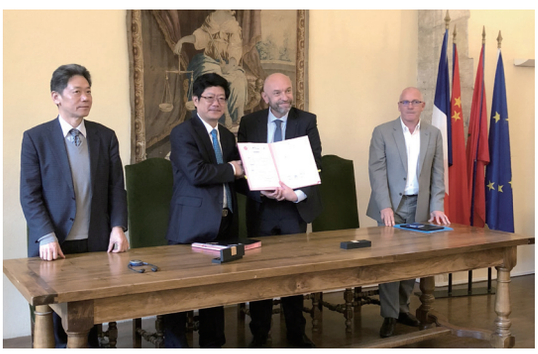
In 2019, CAAS signed 107 international cooperation projects with an investment of 109 million yuan ($15.71 million), hosted 40 international academic conferences, and signed 128 cooperative agreements and memorandums. CAAS also set up 17 new international cooperation platforms, including joint laboratories at home and abroad. Among them, China-Romania Joint Laboratory of Agricultural Cooperative Belt and Road and China-Kazakhstan Joint Laboratory of Agricultural Science Belt and Road were approved by Ministry of Science and Technology of China. The academy encourages personnel exchanges with international cooperative partners. For example, more than 3,000 professionals had either gone from CAAS to foreign countries or from abroad to CAAS. Jointly, CAAS' staff members and its international cooperative partners published over 80 high-quality papers.

Promoting Shared Agricultural Science and Technology

CAAS launched science and technology demonstration cooperation projects of 7 crops, including rice and cotton, and 6 new varieties of vegetables in countries of Southeast Asia, Central Asia and Africa, as well as integrated 6 sets of technical models to enhance production. In addition, the academy began production and sales of poultry vaccines in Indonesia and set up early warning mechanisms for animal and plant diseases for the purpose of joint preventing and controlling of these diseases across international borders.







Participating in Global Agricultural Science and Technology Governance

CAAS took part in G20 Agricultural Chief Scientists Initiative and promoted the establishment of agricultural technology and knowledge sharing platforms. The academy participated in the director-general election of Food and Agriculture Organization. As initiator of the action plan for sustainable food development known as Food Forever, CAAS contributes to the conservation and utilization of agricultural biodiversity. It also hosted the 23rd ATCWG annual meeting of APEC, and it worked closely with CGIAR to promote cooperation between the two entities in researching and controlling animal and plant diseases, such as African swine fever and fall armyworm. In addition, the academy hosted the ninth meeting of the CGIAR System Council.

Regional Strategic Development

CAAS intends to build a world-class agricultural research academy by focusing on implementing Agricultural Science and Technology Innovation Projects. In 2019, CAAS made phased progress in major scientific research areas.

▲ Liu Xianwu, Vice President of CAAS, inspects construction of core areas of National (Chengdu) Agricultural Science and Technology Center

National (Chengdu) Agricultural Science and Technology Center

National (Chengdu) Agricultural Science and Technology Center was built by CAAS and the Chengdu government to launch agricultural, scientific, and technological innovation projects with local characteristics, which is an important strategy for CAAS in China's southwestern regions. By the end of 2019, construction of the first phase was 60 percent complete. The first phase is expected to be finished by October 2020. Simultaneously, the center made plans for construction of the second phase and the key projects to promote the integrated development of technological innovation, result transformation, start-ups, and industry cultivation.

▲ Planning map of Western China Agricultural Research Center

Western China Agricultural Research Center

The Western China Agricultural Research Center is being built by CAAS and the Xinjiang Uygur autonomous region in Xinjiang Changji National Agricultural Sci-Tech Park. The center will provide services to West China and Central Asia and focus on innovation and the Belt and Road Initiative. In August 2019, the main structure of the comprehensive service building was finished and it is expected to be completed by the end of September 2020.

▲ Planning map of North China Rice Research Center

North China Rice Research Center

The center is the first national rice research platform of CAAS in China's northern regions. It will focus on national food safety strategy and research in 6 major areas: North China's rice germplasm resources innovation, breeding of new varieties, physiological and ecological research, cultivation technology innovation, soil fertilization, and remediation research. The center will also promote the development of common and key technologies of the rice industry in northern China. Construction began in June 2020.

Research Facilities

Major Science and Technology Facilities
CAAS has 3 major national scientific facilities, 6 state key laboratories, 1 state key laboratory jointly built with provincial governments, 22 comprehensive key laboratories under Ministry of Agriculture and Rural Affairs, 40 professional key laboratories under Ministry of Agriculture and Rural Affairs, 30 agro-products quality safety risk evaluation laboratories under Ministry of Agriculture and Rural Affairs, and 52 academy-level key laboratories.

Major Technology Innovation Platforms
CAAS has 5 national engineering technology research centers, 5 national engineering laboratories, 1 engineering laboratory jointly built by national and local organizations, 2 national engineering research centers, 22 national centers (sub-centers) for the improvement of varieties, 18 national agricultural industry technology research and development centers, and 32 academy-level engineering technology research centers.

Major Supporting 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 510,000 accessions of crop germplasm resources under long-term preservation, which ranks second in the world. It also has 5 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 the third in the world.

▲ The National Agricultural Library of CAAS

Field Stations

The CAAS field station network consists of 3 basic systems: experiment demonstration, observation and monitoring, and pilot projects and conversion. There are 118 field stations in 27 provinces, municipalities and autonomous regions except for Chongqing, Guizhou, Shaanxi and Ningxia. The stations cover a total area of 6,080 hm^2, including 2,980 hm^2 of land owned by CAAS and 386.8 hm^2 of land used for construction. A total of 1,078 staff members work at the field stations, of whom 514 work full time or part time, and 564 have signed long-term employment contracts.

In 2019, CAAS spent 574 million yuan ($81.97 million) and launched 54 projects for the construction, maintenance, and purchase for the field stations. The area of newly added buildings reached 36,600 m^2. The academy also improved 120.73 hm^2 of experimental fields and purchased 142 pieces of agricultural implements and 2963 sets of instruments and equipment. Based on data of the field stations, CAAS received 56 provincial-level scientific and technological awards, published 1,405 high-level papers, examined and approved 182 new varieties, and was also granted 465 patents.

The academy held 606 on-site meetings and demonstrations in its field stations, attracting 49,000 visits, and 615 opening days, welcoming 27,000 visits. It also organized 847 training classes, which attracted 50,000 visits from farmers and agricultural technicians. It promoted 1,054 new varieties and planted them in an area of 3.16 million hm^2. It promoted 178 new agricultural techniques and adopted them on 5.95 million hm^2 of land. It also promoted 66 new products and applied them to 145,000 livestock and poultry.

Intellectual Property Achievements

To achieve the best possible IP quality, CAAS held a session for ideas and suggestions on improvement of patent quality at its innovation team training program designed for chief scientists. Five of the academy's affiliated institutes rolled out a series of training sessions on a lecture circuit, providing IP services to front-line researchers. CAAS also offered training in-patent data analysis software via online videos.

The academy encourages its faculty and students to apply for the WIPO-CNIPA Awards for Outstanding Chinese Patented Inventions and Industrial Designs. Last year 1 of them won a silver award, and another 5 won excellence awards.

To expand channels of commercializing and industrializing its research achievements, CAAS hosted a series of research results display and business matchmaking events, including the China Agricultural Technology Transfer Fair 2019. CAAS also helps innovators resolve pressing issues, such as meeting requirements for pilot tests and business incubation. It also helps enhance their capacities of industrializing and utilizing IP.

▲ The first China Agricultural Technology Transfer Fair was held in Chengdu, Sichuan Province in 2019

◀ CAAS' base for nano-pharmaceutical research achievements industrialization is in Beijing's Pinggu District

Graduate Education

The Graduate School of CAAS is working to become China's top graduate school with top disciplines in all areas and offering quality education and efficient school operations. To mark its 40th anniversary, GSCAAS hosted a seminar on reform and development of graduate education, a symposium on graduate education from a global perspective, and an achievement show in celebration of its 40th anniversary.

The school was authorized to confer the veterinarian doctorate degree and its College of Veterinary Medicine for the first time employed an "application-examination" mechanism in its admissions. GSCAAS enrolled its first group of PhD candidates without master's degrees. It was among the first group of higher-learning schools in China that won the certification for international education and management quality. A CAAS alumni office called Alumni Home was inaugurated at GSCAAS.

There are 2,251 supervisors at GSCAAS, including 17 academicians of the Chinese Academy of Sciences and the Chinese Academy of Engineering, 849 supervisors for doctoral programs, and 566 teachers working full-time or part-time. They teach 173 courses in Chinese and 39 courses in English.

A total of 5,453 postgraduates studied at GSCAAS last year: 2,038 were PhD candidates, 1,523 sought academic master's degrees and 1,892 sought professional master's degrees. Of that total, 1,716 students joined GSCAAS in 2019, 538 of them for doctorate degrees, 511 for academic master's degrees and 667 for professional master's degrees.

A total of 995 students, including 355 PhD holders and 916 master's degree holders, graduated from GSCAAS last year. The school's overall employment rate for graduates was 95.56 percent.

▲ Overseas students from CAAS recited ancient Chinese poems during a reading promotional event in 2019

GSCAAS ranked second nationwide by the number of PhD candidates benefiting from higher education cooperation programs, where different schools at home and abroad contributed to students' progress in schooling. CAAS led all other Chinese universities and colleges in terms of school enrollment related to agricultural and forestry sciences.

In 2019, GSCAAS enrolled 118 international students — 104 for doctorate degrees, 13 for master's degrees and 1 participant in an advanced program.

Currently, 522 students from overseas are studying at GSCAAS — 466 for doctorate degrees, 51 for master's degrees and 5 participating in advanced programs. Of them, 306 were awarded the Chinese Government Scholarships. They hail from 58 countries and their studies cover 42 majors. The number of international students for doctorate degrees caused GSCAAS to rank sixth among Chinese universities and colleges and first in higher-learning schools related to agricultural and forestry sciences.

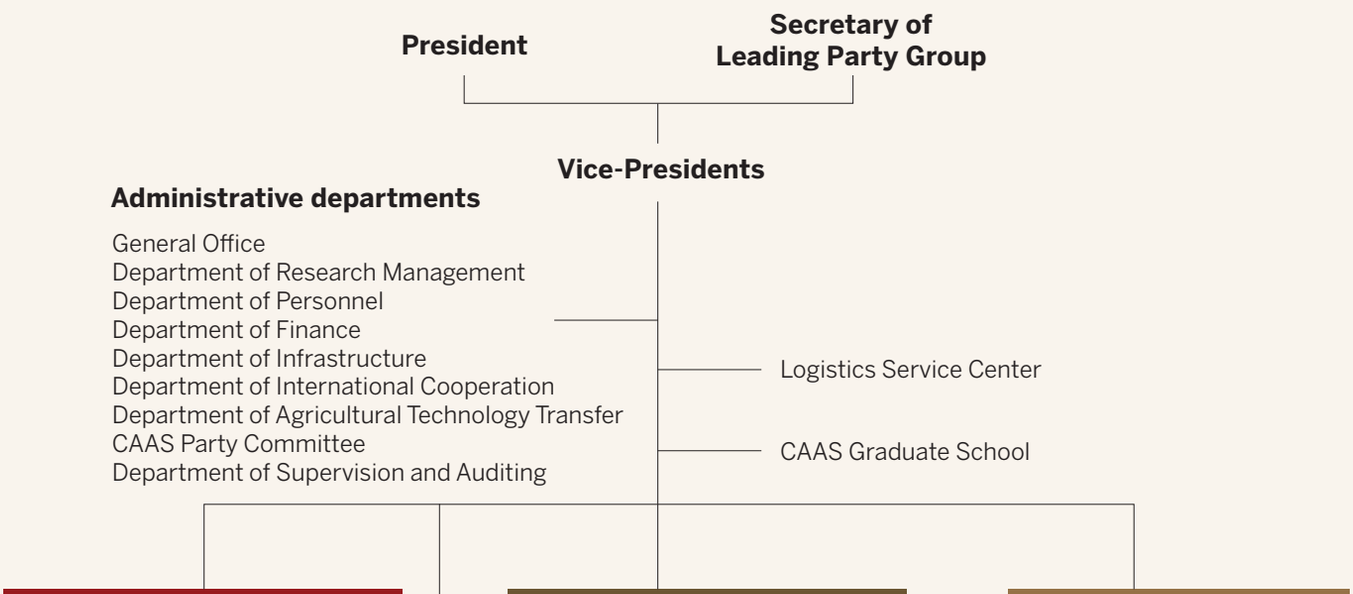
Of 100 international graduates from GSCAAS last year, 92 were PhD holders and 8 were master's degree holders. Five of the doctorate degree holders won GSCAAS' 2018-2019 premier academic paper awards. The international graduates' published papers per capita, single paper impact factor, and papers winning the graduate school's premier academic paper awards all set record highs in the history of GSCAAS.

GSCAAS had 40 new students registered for joint doctorates in international cooperation programs, and 16 participants in the joint PhD programs graduated last year. At present, 164 students are enrolled in the programs, covering 32 disciplines across 28 CAAS institutes. GSCAAS signed 3 memorandums of understanding for cooperation on postgraduate education with foreign universities and research institutions.

Appendix

- Organizational Structure of CAAS
- Key Laboratories and Centers

Organizational Structure of CAAS



INSTITUTES IN BEIJING

- Institute of Crop Sciences
- Institute of Plant Protection
- Institute of Vegetables and Flowers
- Institute of Environment and Sustainable Development in Agriculture
- Institute of Animal Sciences
- Institute of Apicultural Research
- Feed Research Institute
- Institute of Food Science and Technology
- Biotechnology Research Institute
- Institute of Agricultural Economics and Development
- Institute of Agricultural Resources and Regional Planning
- Agricultural Information Institute
- Institute of Quality Standards and Testing Technology for Agro-Products
- Institute of Food and Nutrition Development of MARA

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INSTITUTES OUTSIDE BEIJING

- Farmland Irrigation Research Institute (Xinxiang, Henan)
- China National Rice Research Institute (Hangzhou, Zhejiang)
- Institute of Cotton Research (Anyang, Henan)
- Oil Crops Research Institute (Wuhan, Hubei)
- Institute of Bast Fiber Crops (Changsha, Hunan)
- Institute of Pomology (Xingcheng, Liaoning)
- Zhengzhou Fruit Research Institute
- Tea Research Institute (Hangzhou, Zhejiang)
- Harbin Veterinary Research Institute
- Lanzhou Veterinary Research Institute
- Lanzhou Institute of Husbandry and Pharmaceutical Sciences
- Shanghai Veterinary Research Institute
- Institute of Grassland Research (Hohhot, Inner Mongolia)
- Institute of Special Animal and Plant Sciences (Changchun, Jilin)
- Agro-Environmental Protection Institute of MARA (Tianjin)
- Biogas Institute of MARA (Chengdu, Sichuan)
- Nanjing Research Institute of Agricultural Mechanization of MARA
- Institute of Tobacco Research (Qingdao, Shandong)
- Agricultural Genomes Institute (Shenzhen, Guangdong)
- Institute of Urban Agriculture (Chengdu, Sichuan)

CO-HOSTED INSTITUTES

- Citrus Research Institute (Chongqing)
- Institute of Sugar Beet (Hulan, Heilongjiang)
- Sericultural Research Institute (Zhenjiang, Jiangsu)
- Institute of Chinese Agricultural Heritage Research (Nanjing, Jiangsu)
- Buffalo Research Institute (Nanning, Guangxi)
- Grassland Ecological Research Institute (Lanzhou, Gansu)
- Poultry Institute (Yangzhou, Jiangsu)
- Sweet Potato Research Institute (Xuzhou, Jiangsu)
- Changchun Veterinary Research Institute
- Shenzhen Biological Breeding Innovation Institute

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

High Containment Facilities

No.	Facilities	Research	Institutes
1	National High Containment Facilities for Animal Diseases Control and Prevention	To meet the demands of the national biosafety strategy and public health. To carry out related basic and applied research of major zoonoses and severe exotic diseases.	Harbin Veterinary Research Institute

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