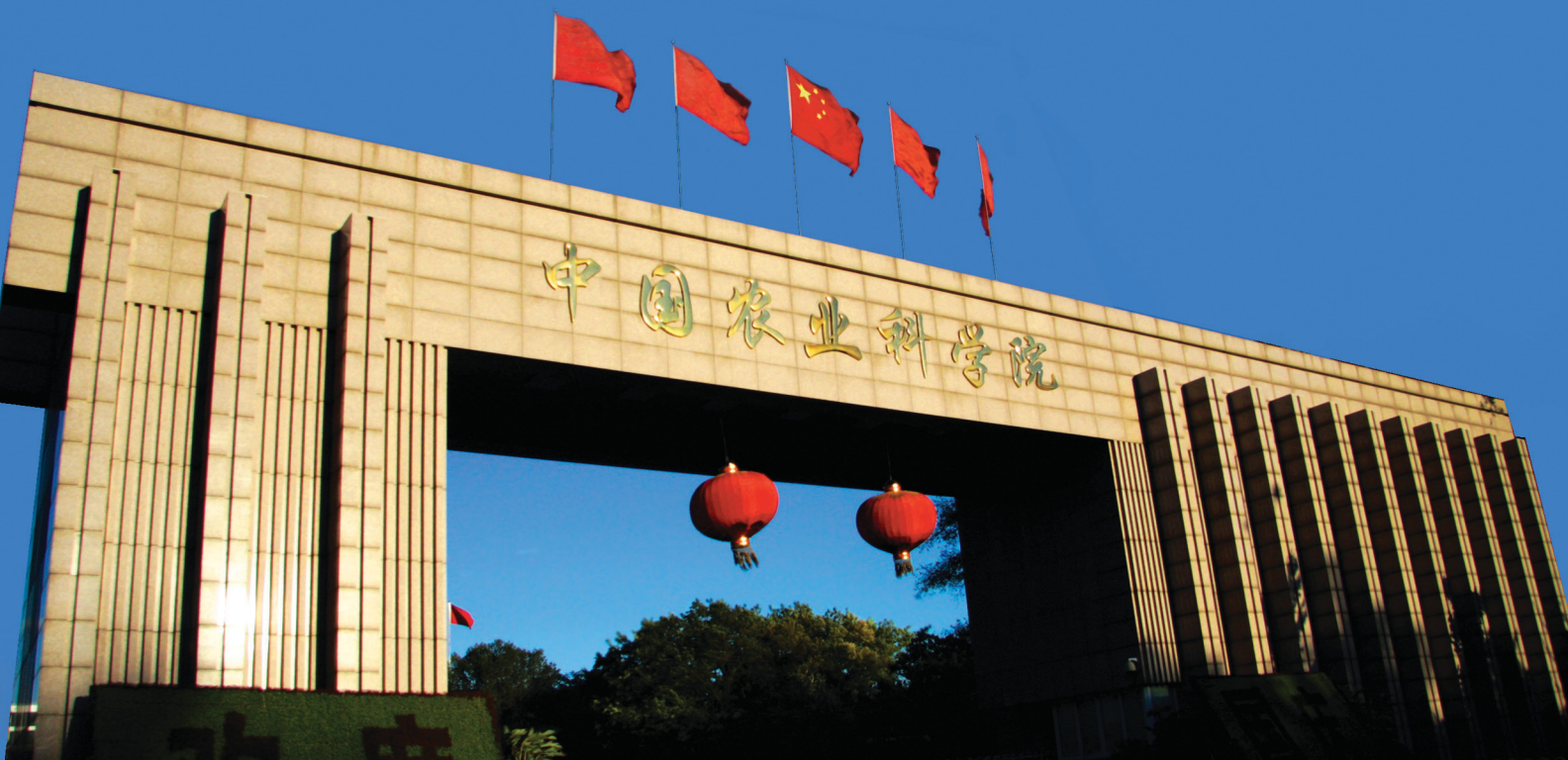




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# The Chinese Academy of Agricultural Sciences

*Envisioning an Innovative Future*



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## Enhancing the Role of Agricultural Science and Technology

This booklet, produced by the Custom Publishing Office of *Science/AAAS* and sponsored by the Chinese Academy of Agricultural Sciences (CAAS), highlights the latest developments at CAAS, including its new vision, research priorities, and strategic development plan and initiatives. It details past work and activities under way, with the aim of providing the international scientific community with a clear and comprehensive understanding of what the academy has achieved and what goals have been set for the future.

Food security and safety are critical issues that impact national economic development, social stability, and even national independence. As a developing country with the world's largest population, China must feed approximately 20% of the global population using only 9% of the world's arable land. In view of this, agriculture in China is not only important for the country, but is also a crucial factor in the stability of economic development worldwide.

It is well recognized that agricultural science and technology is of vital significance to the development of agriculture. Designating science and technology innovation as one of the key national development strategies indicates the Chinese government's ongoing commitment to supporting agricultural research, technology transfer, and capacity development. Each year since 2004, the so-called No.1 Document issued by the central Chinese government has focused on the "Three Rural Issues" of agriculture, the rural community, and farmers. Additionally, this first policy document released in 2012 emphasized the key role that agricultural science and technology plays in the future success and prosperity of the country. Over the past decade, China has endeavored to address these issues through dramatic improvements in agricultural innovation and development of a modern agriculture system.

CAAS, by virtue of its affiliation with the Ministry of Agriculture, is regarded as the leading national institution for agricultural research in China. The academy is mandated to conduct basic and applied research to address both technical and policy issues in agricultural production, sustainable development, and the welfare of farmers; to contribute directly to agricultural modernization, rural development,

and poverty elimination through technology transfer, partnerships, and support to agro-industries; and to conduct training and capacity development for the next generation of agricultural scientists and farmers.

Building on the strong foundation of the past five decades, but looking with purpose toward the future, CAAS has resolute plans to become a world-class agricultural institution. To achieve this objective, and thanks to steadfast support from the government, CAAS has initiated an ambitious research project, the Agricultural Science and Technology Innovation Program (ASTIP), starting in early 2013. ASTIP will no doubt significantly facilitate the overall development of scientific innovation at CAAS, impacting research, technology transfer, and capacity building, and hence enable CAAS to make meaningful contributions to food security and safety both within and outside China.

CAAS is dedicated to promoting international cooperation and would like to share its vision, progress, and knowledge with colleagues and friends worldwide, with an eye to achieving a common goal of building a hunger- and poverty-free world, assuring health and prosperity for all, and leaving future generations with a healthy environment and plentiful natural resource.

I would like to take this opportunity to thank *Science/AAAS* and my colleagues for their exemplary effort and contribution in the production and timely publication of this booklet, which I hope brings to the reader a deeper understanding of the culture and accomplishments of CAAS.

Professor Li Jiayang, Ph.D.  
President of CAAS  
Vice Minister of Agriculture





## Prioritizing and Globalizing Agriculture

China's brisk rise to prominence on the world economic stage is often associated with its growth as a product manufacturer. But focusing simply on goods means missing a critical factor: food safety and security.

Statistics show that China uses just 9% of the world's arable land to provide food for approximately 20% of the global population. Although not the whole story, these numbers point to a seemingly untenable position. For this reason, the Chinese government is putting its weight behind remodeling their agricultural system as a means to boost the economy, literally from the ground up. They plan to do this through the breeding of higher-producing, disease-resistant crops and animals, in concert with the development of advanced farming technologies. Apart from stimulating local rural economies, these advances aim to help China keep pace with the food needs of its growing urban population. Further, the rapid creation and dissemination of so-called agro-products, including vaccines against diseases like avian influenza, will positively affect the overall health of the population, even beyond its borders.

As the leading agricultural research organization in China, the Chinese Academy of Agricultural Sciences (CAAS) is at the forefront of this mission. With its over 5,000 professional employees and backing of the central government, CAAS works to support farmers, address countrywide agricultural problems, and provide policy guidance to the government in all agriculture-related matters. Translational research is integral to the culture of CAAS—every researcher understands that the endpoint of their work must somehow benefit agriculture, rural communities, and farmers (what the government terms the “Three Rural Issues”). This implies not only translating knowledge into practical skills through training, but also applying that

know-how to the development of more efficient farming equipment, improved varieties of crops and breeds of animals, and better monitoring systems to protect natural resources and reduce the impact of human activities on the environment.

A central driver in this change is the Agricultural Science and Technology Innovation Program, or ASTIP, initiated in 2013. The four central objectives of this ambitious 13-year program are to promote interdisciplinary research and expand research infrastructure, while building the talent pool and fostering greater international research cooperation and collaboration. Already a respected institution within China, it is CAAS President Li Jiayang's hope that ASTIP will fulfill the academy's overarching objective of broadening the reach of the academy and raising it the level of a world-class research institution.

The *Science*/AAAS Custom Publishing Office is pleased to publish this booklet, with support from CAAS, to share with our readers some of the work carried out by academy scientists, and outline future programs. We will be watching with interest as CAAS moves ahead with its new initiatives and look forward to seeing the academy play a greater role on the international scientific stage.

Alan Leshner, Ph.D.  
CEO, AAAS  
Executive Publisher, *Science*



# Overview of CAAS: Advancing Agricultural Science and Technology from Farm to Table

For more than five millennia, China has been a predominantly agricultural economy—industrialization arrived less than a century ago. Meanwhile, the security of the global food supply has become one of the most urgent concerns of our species. China, accounting for one-fifth of the world's growing population while supported by less than 10 percent of the global arable land, is especially impacted by this issue and the myriad of problems arising from intensive agriculture.

There are a multitude of agricultural challenges facing China today apart from a large population and limited resources. Until 1949, back-to-back wars had stalled education, research, and development, resulting in a big gap between China and the developed world in the study and application of agricultural science and technology. China is now in a race against time to catch up and at the forefront of this agricultural revolution is the Chinese Academy of Agricultural Sciences (CAAS).

Founded in 1957, CAAS is responsible for all aspects of agricultural science and technology research at the central government level in China. Today, there are 32 research institutes directly affiliated with CAAS (another nine are hosted jointly with universities and provincial governments). These institutes are located in Beijing and throughout the country, employing over 5,000 professional research staff. "The morale and teamwork spirit are very high right now," says CAAS President Li Jiayang, "and everyone is looking forward to the future

with confidence, hope, and enthusiasm." It is indeed an exciting time at CAAS. China's agricultural challenges and opportunities align seamlessly with the mission of the academy. A major endeavor, the Agricultural Science and Technology Innovation Program (ASTIP, see page 7), launched in early 2013, is aimed at elevating CAAS to become a global agricultural science and technology research powerhouse within the next decade.

## Achievements and Challenges

Throughout its 55-year history, CAAS has fulfilled its mission as the agricultural research leader and policy advisory in China. For example, as a result of successful breeding projects, the yields of major food crops—rice and wheat—have increased significantly. Similar breeding successes have also supported the domestic needs for cotton, ed-

ible oil, fruit, and fresh vegetables as well as important crops such as corn, millet, legumes, and soybeans. In veterinary medicine, several CAAS institutes have made groundbreaking contributions in vaccine development, and in disease control and monitoring. A highlight of CAAS's accomplishments is its vast resource of crop germplasm (some 420,000 accessions), indexed and preserved in the National Gene Bank. In addition, CAAS attaches great importance to food safety and nutrition, establishing specific institutes in those areas to meet national and international demands as well as fulfill the defined mission of CAAS.

Despite these significant achievements, CAAS faces a growing number of organizational hurdles. Without a dedicated R&D budget, "CAAS scientists spend a huge amount of time and energy securing competitive research grants instead of on actual research and innovation," says President Li. There is also a shortage of outstanding young scientists who are both well trained and innovative. And existing research facilities and experimental field stations, which are key to agricultural technology transfer, have struggled to meet the demands of CAAS researchers.

To break the headwind, CAAS has undertaken a series of reforms and new programs, starting in late 2011. Transformations are beginning to take shape in a new evaluation system for research performance, a more holistic approach to capacity building, an expansion of research facilities, and most importantly, ASTIP. Together with the traditional strengths of CAAS, these changes share the goal of advancing science and technology throughout the entire supply chain from farm to consumer.

## Modernizing Research Management

While many facets of Chinese society have undergone drastic transformations since the economic reform of the late 1980s, some of the old bureaucratic structures remain. Having played the role of national agricultural policy advisory for decades, CAAS is no exception when it comes to bureaucratic relics from a bygone era. A restructuring of the organization and management is therefore under way.

Modernization is taking place on several fronts. Since 2012, administrative restructuring has more clearly defined CAAS's mission. The goal: to reduce red tape and increase management efficiency. President Li believes that, "the role of administration should be to facilitate scientific research, not to micromanage the scientific process." The organizational reform has made CAAS a more nimble organization that is better able to support the latest agricultural science research.

The research focus of the academy is also undergoing strategic realignments to meet the redefined mission of CAAS. For example, there is a growing emphasis on environmental safety and sustainability, leaving behind the outdated singular goal of higher yields. Furthermore, new areas of research such as genomics and



**Li Jiayang, President of CAAS, Vice Minister of Agriculture**



**Chen Mengshan, Secretary of Party Leadership Group of CAAS**



molecular breeding are seen as requiring additional investment. Finally, taking into account both new trends and the established aptitudes of the academy, CAAS has reviewed and consolidated its vast array of research projects into eight disciplinary clusters, 134 focused fields, and 309 research focuses. This three-tier system will greatly improve the efficiency of resource allocation, eliminating redundancy and sowing the seeds for future breakthroughs.



**Tang Huajun, Vice President of CAAS**



**Liu Xu, Vice President of CAAS**

### Capacity Building

Human capital is another critical piece in building a world-class agricultural research institution. “CAAS is taking a holistic approach to build up research capacity,” President Li explains, “and we must do a good job in four areas: unlocking the full capacity of our existing talent, recruiting much-needed talent in all eight disciplinary clusters, retaining critical talent in today’s mobile society, and developing future talent through good education.”

“Recruiting young talent, especially those who trained abroad, is a top priority at CAAS, where the acquisition of the best scientists is believed to be the most direct route to generating top research and filling current knowledge gaps within institutes,” says Chen Mengshan, secretary of the Party Leadership Group at CAAS. CAAS has launched the Elite Youth Program (see page 49) to strengthen its research capacity for the long term; successful recipients receive generous funding covering project startup, equipment, housing, relocation, and benefits.

To retain top talent, CAAS implemented a new evaluation system in 2012, replacing an inconsistent and outdated scheme. “Our new evaluation system is based on research performance,” explains President Li, “and we are working hard to create an environment where talented scientists can develop a productive career at CAAS.”

The final element of capacity building is education. Since the 1980s, CAAS has been training graduate students from a variety of undergraduate majors. Currently about 220 Ph.D. and 700 Master’s students enroll annually in CAAS programs. “They are provided with the same opportunities available to graduate students in the United States, Europe, or Japan,” says President Li, who completed his Ph.D. degree at Brandeis University and his postdoctoral training at Cornell University. In his assessment, the laboratory skills of graduate students from CAAS are now on a par with those of students in the West or in Japan. However, he feels that CAAS students still lag behind in terms of creativity, systematic philosophy, and overall quality. “Thus, I encourage them to do post-doctoral training abroad, to learn new concepts from scientific leaders around the world, and to build their own international connections for future cooperation,” says Li.

### Unique Research Facilities and Infrastructure

Most agricultural scientific research has very real applications and implications, and laboratory results must be confirmed in the real world. Researchers also use real data collected in the field for modeling and simulation

studies. In China, the highly heterogeneous climate and terrain means that one region may face very different problems and require different solutions than those implemented in another region. To serve and support these unique requirements, CAAS has built an array of experimental field stations and observation stations throughout the country (for examples, see page 21).

Apart from these field stations, CAAS is also adding state-of-the-art equipment in its key laboratories in order to support cutting-edge research. Moreover, CAAS is the custodian for the second largest crop gene bank in the world—more than 420,000 accessions from over 1,100 species, which form the foundation of many breeding projects. In addition, there are seven national reference laboratories at CAAS, three of which are in the World Organisation for Animal Health (*Office International des Epizooties*, OIE) network. A growing array of food quality and safety monitoring centers are also under construction. “All CAAS research facilities receive continuous support at the national level, including from the Ministry of Agriculture [MOA] and the Ministry of Science and Technology [MOST],” explains Liu Xu, one of the CAAS vice presidents, while showing off a bag of seeds just harvested from a high-altitude test field in the Tibetan Plateau. “This quinoa may be the only grain that can support all human nutritional needs,” he explains, “and we want to see whether it can grow in other areas of China.”

### Translating Basic Research

Since its inception, CAAS has been entrusted with the mission of solving national agricultural problems. To tackle practical challenges, CAAS regularly provides scientific information and evidence-based policy advice to the central and local governments. What distinguishes CAAS from other national research organizations is its focus on challenges specific to China. In President Li’s view, “CAAS scientists must always bear in mind the needs of the nation when designing any research. We focus on important applied research, supported by fundamental breakthroughs in basic biology.”

An example of the effective transfer of basic research is Li’s own work on the molecular genetics of rice. The gene traits studied by his team directly impact the yield of rice crops. Li believes that “no researcher should be stuck inside the ivory tower of basic research,” but rather that the ultimate goals of their work should be to achieve “high yields, superb quality, high efficiency, good safety profiles, and environmental sustainability

Throughout its 55-year history, CAAS has fulfilled its mission as the agricultural research leader and policy advisory in China.





**Li Jinxiang, Vice President of CAAS**



**Shi Zhiguo, Senior Advisor, CAAS**

for their agricultural products and technologies.”

This application-oriented mentality is rooted deep in the design of every research project and support system at CAAS. Basic research findings become useful applications via different pathways, says Wu Kongming, a vice president of CAAS. When conceiving projects, priority is always given to research that can support the needs of agriculture, the rural community, and farmers—the so-called Three Rural Issues in China. At the local level, CAAS promotes bidirectional collaborations with provincial and county agricultural research bureaus. Such collaborations benefit local development as well as help fine-tune the research focus of CAAS.

CAAS is also equipped with technology transfer capabilities to capitalize on applied research findings in China's new market economy. A perfect example is the avian influenza vaccines from the Harbin Veterinary Research Institute, which generated approximately 1 billion Yuan (US\$161 million) in revenues during 2012. “The next step is to copy the success in veterinary vaccines to other research areas,” says Wu. With respect to intellectual property (IP) protection, CAAS is now expanding the focus from domestic to international IP in preparation for the export of several advanced products.

### Connecting to the World

Technology transfer is just one example of the type of international cooperation that is of paramount importance on the road to creating a world-class agricultural research institution, and CAAS has made this a priority. “Cooperation with international partners has become routine amongst the new generation of scientists in China, rather than something rare, as it was just five to 10 years ago,” says Wang Ren, a former vice president of CAAS who served as the director of the Consultative Group on International Agricultural Research (CGIAR) from 2007 to 2009 and executive secretary of the CGIAR Fund Council and head of the Fund Office from 2010 to 2011. He took the position of assistant director general of the Food and Agriculture Organization of the United Nations (FAO) in February 2013. At the academic level, “China has entered into strategic cooperation programs with key international partner organizations, going from predominantly learning about



**Wu Kongming, Vice President of CAAS**

technologies from other nations, to actively producing output to aid developing countries,” he says.

CAAS's partners range from geographic neighbors that share common interests in environmental protection or pest control to international organizations and strategic national partners such as CGIAR and the Brazilian Agricultural Research Corporation (*Empresa Brasileira de Pesquisa Agropecuária*, EMBRAPA). CAAS is also responsible for providing statistics from China to the international food safety network maintained by FAO. From basic research to international policy coordination, these projects all contribute to the inclusion of CAAS in the global community.

However, “there remains much work to be done,” says Wang. CAAS is ready to address the challenges by finding smart solutions through international IP sharing and breaking residual isolationist restrictions, by investing in IP research and standardization, and by making international cooperation a central objective for the future.

### Heaven and Earth

After 55 years of advising the government on agricultural research, technology, and policy, CAAS is at a critical turning point. Major changes are needed for China to face the challenges of the 21st century. “The government understands the need to proactively tackle the upcoming challenges,” says Zhang Lubiao, director general of the Department of International Cooperation at CAAS, “and has tasked CAAS with finding the best solutions through research and innovation.”

Through the process of transformation and modernization, the hope is that CAAS can build upon its strengths and achievements, while opening up new areas of research. In 10 to 15 years, President Li is hopeful that CAAS will be a world-class agricultural research institution. Using a Chinese idiom “顶天立地,” Li illustrates his vision for success: “Our goal is to reach the heavens while keeping our feet on the ground. We are rapidly catching up to the West and will soon be able to produce research of the highest quality; yet we should remember that our mission is to solve the everyday problems faced by the Chinese farming community.”



**Zhang Lubiao, Director General of Department of International Cooperation, CAAS**

# The Agricultural Science and Technology Innovation Program

The Agricultural Science and Technology Innovation Program (ASTIP), launched in early 2013, is directly supported by the Chinese central government. At the center of ASTIP is a new funding paradigm dedicated to supporting four specific objectives (see below) over the next 13 years. “In alignment with President Li’s vision of building a world-class agricultural research institution, these objectives aim to promote novel innovations and leverage research results to solve specific agricultural problems in China,” says Tang Huajun, a vice president of CAAS.

Similar innovation programs have been implemented in the past to advance other areas of importance in China. A notable example is the Knowledge Innovation Program (KIP), which began at the Chinese Academy of Sciences in 1998 with the aim of boosting research and education capacity in the natural sciences. On the humanities side, the Philosophy and Social Science Innovation Program was initiated in 2011 at the Chinese Academy of Social Sciences to more deeply investigate social and economic issues. What sets ASTIP apart from these two programs is its goal to produce science- and technology-based applications that can be rapidly applied to solving real-world problems.

## Supporting Long-Term and Interdisciplinary Research

Before the advent of ASTIP, several factors hindered the competitiveness of CAAS. The amount of effort spent applying for grants significantly reduced the time and energy available for actual research work by CAAS scientists, a situation that has been improved through dedicated funding. Continuity of research was also a problem. The absence of consistent funding has hindered many opportunities to solve big problems through long-term experiments, especially since “crop breeding typically takes five to eight years to complete, and for livestock, at least 15 to 20 years is necessary to see any result,” Tang explains. “Therefore, the first objective of ASTIP,” says Tang, “is to support long-term and interdisciplinary research by providing stable and continuous funding.”

## Capacity Building

ASTIP will also help other aspects of the transformation happening at CAAS, including the recruitment of top talent. Hence, the second objective of ASTIP is to revamp the recruitment system by injecting new funds so that “every research project will be carried out by a team of the most brilliant scientists led by experts on the subject,” says Tang. The retention of talent—through mechanisms such as performance-based evaluation and promotion—will also be put in place through ASTIP.

## Expanding Research Support Facilities and Infrastructure

The third objective of ASTIP is to speed up the expansion of critical research facilities and infrastructure. Agricultural research requires validation in experimental facilities and field stations. Currently, the utilization of existing CAAS experimental stations is near saturation, making the need for new and multipurpose field stations critical. ASTIP will facilitate cooperation between CAAS and local government and agricultural research institutions to make the most of available sites as well as develop new ones.

## Fostering International Cooperation

The final objective of ASTIP is to foster more international cooperation, which can often lead to fruitful research collaborations. From the global perspective, international cooperation is pivotal to global food security. Tang explains: “The annual global food trade is about 200 million tons, but the consumption within China alone is 500 million tons. Any disruption to the stability of the food supply in China would wreak havoc with global food security.” The importance of international cooperation on agricultural research, monitoring, and policy cannot be overstated. ASTIP will provide the funding and framework for both new and ongoing international cooperation projects.

## Three Phases of ASTIP

Currently, three phases are planned for ASTIP, paralleling China’s 12th, 13th, and 14th Five-Year Plans between now and 2025. Such coordination with the central Five-Year Plans indicates the importance of ASTIP in the nation’s strategic planning. From 2013 to 2015, the first phase of ASTIP focuses on the exploration of a new and more efficient organization to support agricultural innovation. The second phase, from 2016 to 2020, will be the review and adjustment period in which lessons learned in the first phase will be applied to fine-tune priorities. Additionally, international cooperation, capacity building, and the enhancement of research facilities and infrastructure will reach their peak. Finally, from 2021 to 2025, the final phase will be to continue the expansion of all parts of the program.





## A Brief Introduction to CAAS

CAAS,  
established  
in 1957 and  
headquartered in  
Beijing, oversees  
41 institutes, of  
which 32 are  
direct affiliates.

The Chinese Academy of Agricultural Sciences (CAAS) is a national, integrative agricultural scientific research organization with responsibility for carrying out both basic and applied research as well as research into new technologies impacting agriculture. CAAS is dedicated to overcoming a broad range of challenges impacting agricultural development and support of the local rural economy. Importantly, CAAS promotes sustainable agriculture within and outside China, extending its reach through technology exchange and cooperative research agreements with agricultural research institutions/universities domestically and internationally, and global non-governmental organizations.

CAAS, established in 1957 and headquartered in Beijing, oversees 41 institutes, of which 32 are direct affiliates. The remaining nine institutes are co-hosted together with local governments or universities. CAAS also incorporates a graduate school and a publishing house. Research and policy work at the academy cover a broad range of topics, which have been categorized as eight disciplinary clusters, 134 focused fields, and 309 research focuses. The eight disciplinary clusters include crop science, horticulture science, animal science, veterinary medicine, agricultural resources and environment, agricultural mechanization and engineering, agro-product quality, safety and processing, and agricultural information and economics.

CAAS aligns its research priorities with the so-called Three Rural Issues in China: agriculture, the rural community, and farmers. The academy has generated thousands of scientific and

technological advances, with almost 3,000 of these winning national or provincial awards. Additionally, more than 1,000 new varieties of crops, livestock, and poultry have been developed. Advances with broad economic impact include the creation of super rice and dwarf sterile wheat, advances in the prevention and control of wheat stripe rust, development of transgenic insect-resistant cotton, production of vaccines against avian influenza and foot-and-mouth disease, and the generation of double-low (low erucic acid, low sulfuric glucoside) rapeseed, high-oil soybeans, and transgenic phytase corn.

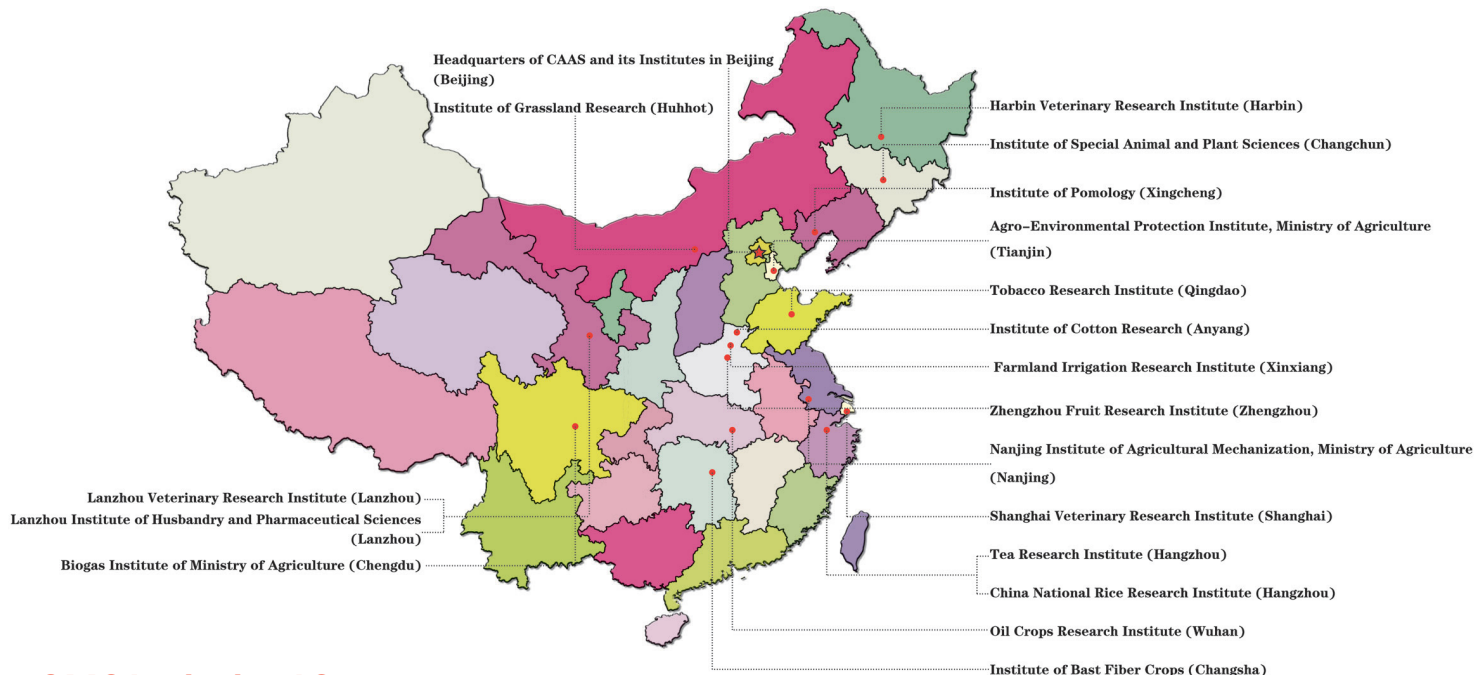
The success of CAAS can be attributed to an ideal combination of science, technology, and economic incentive. The active transfer of technology for the betterment of all is a primary driver. Thousands of researchers at the front line of agricultural production aid in transforming the latest technological achievements into applications for farmers through technical training and onsite demonstrations. CAAS cooperates closely with local governments to promote local economic development through technology transfer and has been instrumental in establishing over 100 companies, particularly in the fields of crop seeds and seedlings, agricultural chemistry, veterinary products and drugs, animal feed, and special agricultural products.

CAAS is the largest employer of scientific talent in agricultural science and technology in China, with over 5,000 professional employees. Twenty-five members of the Chinese Academy of Sciences and the Chinese Academy of Engineering are past employees of CAAS, and 11 of them are still actively involved in research. The Graduate School of CAAS (GSCAAS) cultivates exceptional research talent in the agricultural sciences, many of whom feed directly into the academy. The school currently enrolls more than 4,300 students in its 65 Master's, 53 Ph.D., and nine postdoctoral research programs.

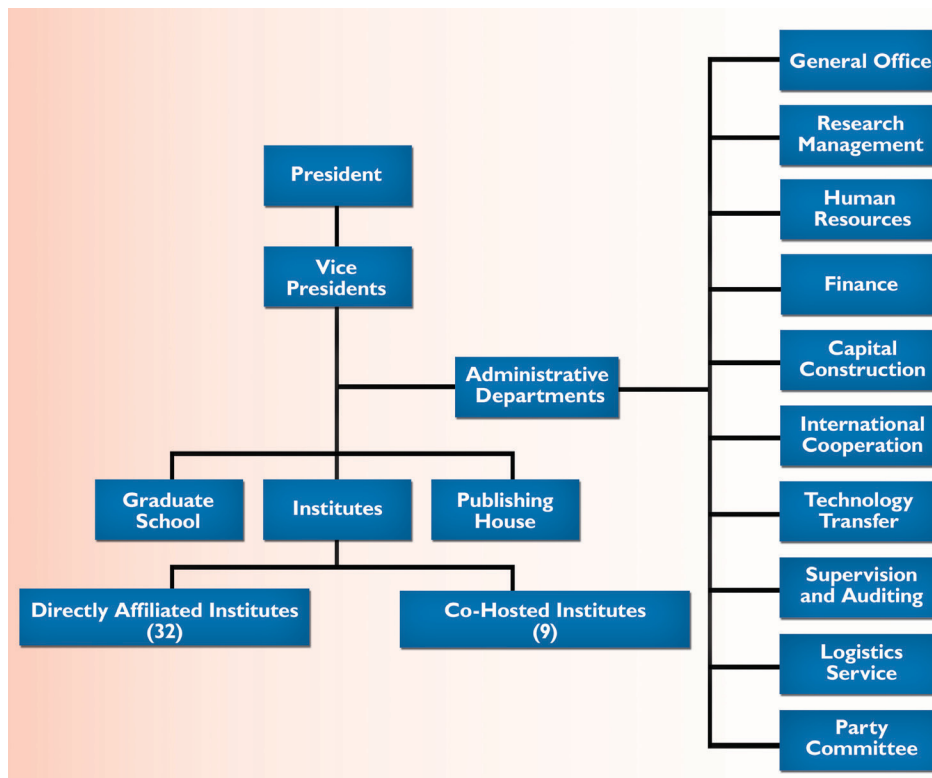
International cooperation is an essential part of the mission of CAAS. It has set up successful cooperative agreements or memoranda of understanding with numerous international institutions, organizations, and companies as well as non-governmental organizations, civil societies, and international foundations. Presently, there are 27 joint laboratories and research centers set up in cooperation with various countries and international organizations (see page 30), and 13 international organizations and foreign agricultural institutions have established liaison offices within the academy.

The research infrastructure at CAAS is cutting edge, and includes two national key scientific facilities (the National Key Facility for Crop Gene Resources and Genetic Improvement, and the National Agricultural Biological Security Science Center) as well as key laboratories, centers, and experimental field stations. CAAS also has one

## Distribution of CAAS Institutes



## CAAS Institutional Structure



agriculture-related fields.

The overarching goal of the academy is to be, in the words of CAAS President Li Jiayang, “a world-class agricultural research institution.” To achieve this, CAAS is building up its technological and knowledge capacity, empowering it to be a primary source of expertise and innovation in agricultural science and technology in China. To address the “Three Rural Issues,” CAAS aims to cultivate exceptional talent and be a base for agricultural innovation and entrepreneurship.

The Agricultural Science and Technology Innovation Program (ASTIP), launched in early 2013, will significantly improve CAAS’s innovative capacity by enabling further acquisition of top scientists, improving research infrastructure, and overcoming technical bottlenecks that have limited agricultural development in China. CAAS will continue to lead and promote modern agricultural development in China, with an eye to becoming one of the top agricultural

long-term and 10 medium-term national gene banks for the storage of crop germplasm resources, together with 12 national crop germplasm nurseries. Overall, more than 420,000 accessions are conserved. The Agricultural Library at CAAS headquarters archives numerous domestic and international journals and books, while CAAS itself publishes 68 scientific and technological journals in numerous

scientific and technological institutions in the world by 2025.

As CAAS plays a greater role in the global scientific family, it is seeking to establish further international collaboration and large-scale cooperation in agricultural research in an effort to accelerate the pace of innovation and make significant contributions to eliminating poverty and hunger in the world.



# Disciplinary Clusters at CAAS

Disciplinary Cluster	Disciplines (not comprehensive)	Associated Institutes
<b>Crop Science</b>	crop germplasm resources crop genetics and breeding crop molecular biology crop cultivation and physiology crop molecular breeding crop functional genomics crop proteomics crop metabolomics bioinformatics, and 14 others	Institute of Crop Sciences Biotechnology Research Institute China National Rice Research Institute Institute of Cotton Research Oil Crops Research Institute Institute of Bast Fiber Crops Tobacco Research Institute
<b>Horticulture Science</b>	vegetable germplasm resources and breeding vegetable molecular biology vegetable cultivation and ecophysiology flower germplasm resources and genetic breeding fruit germplasm resources and breeding fruit cultivation and ecophysiology tea germplasm resources and genetic breeding tea cultivation and ecophysiology special and economically important crops, and two others	Institute of Vegetables and Flowers Institute of Pomology Zhengzhou Fruit Research Institute Tea Research Institute Institute of Special Animal and Plant Sciences Institute of Bast Fiber Crops
<b>Animals Science</b>	animal resources and genetic breeding animal biotechnology and reproduction animal nutrition feed and feed additives forage resources and breeding feed biotechnology genetic resources and breeding of special animals pollinator biology insect pollination and ecology, and four others	Institute of Animal Science Feed Research Institute Bee Research Institute Lanzhou Institute of Husbandry and Pharmaceutical Sciences Institute of Grassland Research Institute of Special Animal and Plant Sciences
<b>Veterinary Medicine</b>	animal immunobiology animal influenza swine infectious diseases poultry infectious diseases foot-and-mouth disease amphixenosis exotic diseases and fulminating infectious diseases parasitic diseases pet diseases and veterinary public health traditional Chinese veterinary medicine veterinary medicine engineering, and six others	Institute of Animal Science Harbin Veterinary Research Institute Lanzhou Veterinary Research Institute Lanzhou Institute of Husbandry and Pharmaceutical Sciences Shanghai Veterinary Research Institute Institute of Special Animal and Plant Sciences
<b>Agricultural Resources and Environment</b>	plant diseases insect pests weeds and rodents pesticides crop biosafety microbial resources and utilization agricultural meteorology dry land and water-efficient agriculture agricultural water resource safety and utilization soil sciences plant nutrition and fertilizer agricultural ecology agricultural environmental engineering agricultural environmental control and remediation agricultural environmental monitoring and evaluation nanometer agricultural technology agricultural region planning, and 11 others	Institute of Plant Protection Institute of Vegetables and Flowers Institute of Environment and Sustainable Development in Agriculture Biotechnology Research Institute Institute of Agricultural Resources and Regional Planning Farmland Irrigation Research Institute China National Rice Research Institute Institute of Cotton Research Institute of Bast Fiber Crops Agro-Environmental Protection Institute of the Ministry of Agriculture Institute of Grassland Research Biogas Institute of the Ministry of Agriculture Tobacco Research Institute
<b>Agricultural Mechanization and Engineering</b>	irrigation techniques and engineering farmland drainage techniques and engineering agricultural and forestry biomass transformation engineering biogas engineering cultivation machinery harvest machinery agro-product processing machinery plant protection and resource utilization machinery grassland machinery	Farmland Irrigation Research Institute Institute of Grassland Research Biogas Institute of the Ministry of Agriculture Nanjing Institute of Agriculture Mechanization of the Ministry of Agriculture
<b>Agro-Product Quality, Safety, and Processing</b>	agro-product quality and safety monitoring and evaluation agro-product risk precaution and evaluation process control of agro-product quality and safety agro-product quality and safety management food nutrition and safety quality and safety of agro-product processing agro-product preservation and logistics agro-product processing, and 16 others	Institute of Crop Sciences Institute of Vegetables and Flowers Institute of Animal Science Bee Research Institute Feed Research Institute Institute of Agro-Products Processing Science and Technology Institute of Quality Standards and Testing Technology for Agro-Products Institute of Food and Nutrition Development of the Ministry of Agriculture China National Rice Research Institute Oil Crops Research Institute Institute of Bast Fiber Crops Institute of Pomology Zhengzhou Fruit Research Institute Tea Research Institute Tobacco Research Institute
<b>Agricultural Information and Economics</b>	agricultural information management agricultural information techniques agricultural information analysis agricultural remote sensing and information industrial economy and policies technical economics and policies agricultural product market and trade rural development and policies food nutrition strategies and policies	Institute of Agricultural Economics and Development Institute of Agricultural Resources and Regional Planning Agricultural Information Institute Institute of Food and Nutrition Development of the Ministry of Agriculture

## Research Development and Advances

**A**gricultural research at CAAS spans eight disciplinary clusters, with many noteworthy achievements in each cluster. Just a few of these research achievements are outlined here, highlighting the high level of science being performed throughout the academy.



Cheng Shihua

### Breeding of Key Crops

#### *Late-Stage Vigor Super Rice*

The two major varieties of *Oryza sativa* rice grown in Asia, *japonica* and *indica*, are believed to have been domesticated near the Yangtze River Valley in China about 12,000 years ago. Since then, rice has become the staple food crop in China and throughout Asia. Facing the dual threat of growing populations and limited land space, China is being pressed to find ways to increase the unit yield of rice in order to ensure food security in the region.

In the mid-1960s, the International Rice Research Institute (IRRI) in the Philippines released the first high-yield, dwarf rice variety. In the 1970s, Chinese scientists successfully developed *indica* hybrid rice, further increasing the yield to six tons per hectare. In 1996 Chinese scientists started their own super rice breeding program by crossing the *indica* and *japonica* strains. To date, the cultivation of super rice varieties has spread to more than a quarter of the rice-growing areas in China, yielding more than 8.6 tons per hectare. However, these varieties suffer from certain physical weaknesses that cause the yield to drop rapidly in suboptimal growth environments.

Cheng Shihua, director general of the China National Rice Research Institute (CNRRI), CAAS in Hangzhou, has been working on rice breeding for over 30 years. He was the first to pinpoint the source of the problems in super hybrid rice as a decline in photosynthesis and a shallow root system. "These deficiencies lead to premature growth retardation and empty seeds. You need strong roots to support a healthy plant above ground," Cheng explains. Taking advantage of IRRI's and CAAS's genetic resources and new molecular markers identified at CNRRI, Cheng successfully bred several so-called late-stage vigor super rice varieties that had deep, strong root systems and a longer photosynthesis period. These

varieties not only represented enormous economic value, but also established an important theoretical foundation for future rice breeding.

#### *The Right Wheat for Chinese Food*

In northern China, wheat is a major food crop, used to make noodles and steamed bread. "However, the quality requirements in wheat flour are different for Chinese food compared with those for bread, pastry, or pasta," says He Zhonghu of the CAAS Institute of Crop Science and National Wheat Improvement Center, who spent years setting up the quality evaluation standards for Chinese wheat-based food. Through collaborations with the Agricultural Research Service of the United States Department of Agriculture, Murdoch University in Australia, and the International Maize and Wheat Improvement Center (*Centro Internacional de Mejoramiento de Maíz y Trigo*, CIMMYT), he undertook a comparative genomic approach to identify more than 100 functional markers controlling key wheat flour qualities, such as color and gluten subunit composition. Guided by these markers, He's team developed 12 improved varieties. "We are now the global leader in understanding the role of functional molecular markers in improving wheat quality," says He.

#### *A Very Oily Double-Low Rapeseed*

Another important crop is rapeseed (*Brassica napus*), which is the source of the majority of the cooking oil used in China. Farmers still follow the ancient tradition of growing rapeseed during the gap between staple food crop seasons. Wang Hanzhong, director general of the CAAS Oil Crops Research Institute (OCRI) in Wuhan, describes the superior oil content of rapeseed line YN171 developed at OCRI: "We employed modern biological methods to achieve the highest oil content in rapeseed in the world—64.8%—while maintaining the desirable 'double low' characteristics of low erucic acid and low glucosinolates."

### Livestock and Veterinary Science

#### *The Datong Yak*

The domestic yak (*Bos grunniens*) is the most important animal economically for inhabitants of the Tibetan Plateau, providing food, transportation, clothing, and even fuel (from dried dung). It is smaller than the wild yak (*Bos mutus*), which roams the alpine meadows up to 6,000 m on the Tibetan Plateau.

"The wild yak is an amazing animal, the males can weigh up to 1,000 kg," says Yan Ping, deputy director general of the CAAS Lanzhou Institute of Husbandry and Pharmaceutical Science (LIHPS). "It is a unique genetic resource for China," she adds.

Yan is the third generation of LIHPS scientists to



He Zhonghu



Wang Hanzhong

To date, the cultivation of super rice varieties has spread to more than a quarter of the rice-growing areas in China.



Yan Ping





Li Guangyu

work in the harsh high-altitude environment of the plateau, with the single-minded mission to preserve the yak's genetic heritage. Decades of work has finally resulted in the first offspring from the artificial breeding of wild and domestic yak, named the Datong yak. The Datong yak is bigger and stronger than the domestic yak and therefore popular among the plateau dwellers. Yan's team is now distributing frozen Datong yak semen for breeding, thereby boosting the economy in the region.

#### *The Three Treasures of the Northeast*

The northeast region of China is famous for the so-called three treasures: ginseng, marten fur, and velvet antlers. In Jilin, the CAAS Institute of Special Animal and Plant Sciences (ISAPS) is doing research aimed at boosting the economic value of these resources. "Our top three research achievements are the breeding of sika deer, the creation of new ginseng varieties, and the development of vaccines for high-economic value animals. We have bred three new varieties of ginseng, created the "Jilin" sika deer, and effectively controlled disease in fur animals using vaccines," says Li Guangyu, deputy director general of ISAPS. Domesticated wild ginseng can now be planted in mountainous regions, bringing in greater profits for farmers. Additionally, because martens and sika deer are endangered species, the collection of fur and velvet antlers is possible only from farmed animals. However, diseases spread quickly when wild animals are domesticated and crowded into a small area. Therefore, vaccines and diagnostic tests for diseases are in high demand. ISAPS has successfully commercialized several products, generating 120 million Yuan (US\$19.3 million) in revenues per year from vaccines alone. The institute also conducts research into the epidemiology of animal diseases and educates local farmers about cage conditions and disease monitoring. The fur industry in northeast China produces 30 billion Yuan (US\$4.8 billion) of economic activity each year, second only to Scandinavian fur producers, making the research at ISAPS of great economic importance.

many powerful applications," Tang says, "such as food production monitoring, pest and disaster control, and studying the long-term effects of climate change on agriculture."

#### *The Ecological Impact of Bt Cotton*

China is the world's largest cotton producer. Before the introduction of genetically modified Bt cotton, the resistance of insect pests to chemical pesticides was a huge problem in the country, resulting in serious financial losses to the cotton industry. Bt cotton has greatly reduced these losses, but the ecological impact is unclear. Understanding these environmental effects is essential, because the Bt toxin kills only a fraction of insects and may upset the delicate ecological balance between species. CAAS Vice President Wu Kongming is a leading expert on the impact of Bt cotton cultivation, his work having been published in *Science* and *Nature*. "We have conducted long-term ecological monitoring since the mid-1990s at the Langfang experimental station," Wu says, "and have demonstrated the wide impact of Bt cotton cultivation not only on the cotton bollworm, but also on multiple non-target insects in the agro-ecosystem."

#### *Urban Protected Horticulture*

The economic boom in China has led to rapid urbanization and loss of traditional agricultural land in peri-urban areas. As in other developed countries, city dwellers in China are intent on bringing green back to the concrete jungle. Yang Qichang, professor at the CAAS Institute of Environment and Sustainable Development in Agriculture, has spent the last seven years working on 3-D horticulture techniques that are uniquely suited to an urban environment. His innovative methods incorporate different soilless growing techniques for fruit and vegetables as well as energy-efficient LED lighting. "This 3-D 'plant factory' technology can increase the productivity of many plants," says Yang, adding that it is particularly applicable "where land is limited, such as in China and Western Europe, and is an important step toward sustainable urban agriculture." Disney has purchased the rights to exhibit the 3-D plant factory in its theme parks.

#### *Efficient Fertilization*

Scientists at CAAS have made notable progress in reducing stress on the environment through the study of efficient fertilization techniques. "Without knowledge of optimal fertilization, farmers generally believe that more is better, leading to heavy runoff of fertilizer into the local environment," says He Ping, professor at the CAAS Institute of Agricultural Resources and Regional Planning. Her team aims to measure the nutrients naturally found in soil and the response of crops to the application of fertilizer. The understanding gained will lead to the establishment of tools for determining optimal nutrient application levels for intensive agricultural production systems, improving efficiency of nutrient use and reducing negative environmental effects due to over-application of fertilizer. "We work very closely with farmers and do a lot of educational work to promote the efficient use of fertilizer," she says.



Yang Qichang



He Ping

### **Environment and Sustainable Agriculture**

#### *Monitoring Agriculture from the Air*

Remote sensing and monitoring systems are widely used to quickly collect timely and accurate agricultural information in large food-producing countries such as the United States, Brazil, Russia, and Australia. The information collected can help to optimize resource allocation, trade balance, and environmental protection. "However, in China, the use of remote sensing technology in operational agriculture monitoring faces unique challenges, including complex terrain, complicated planting patterns, and higher costs," says Tang Hua-jun, a vice president of CAAS and a remote sensing expert. Tang's team of geographers, ecologists, and engineers are tackling this challenge by combining multiplatform, multisensor, and multiscale data together to develop an integrated system (the China Agriculture Remote Sensing Monitoring System, or CHARMS), suited for monitoring the small, mixed-plot planting modalities in China. All the data collected are instantly stored and analyzed in a central system. "There are

# Achievements in Science and Technology at CAAS

Although CAAS has always had an agricultural focus, the range of disciplines it encompasses is astonishingly broad. The academy is committed to generating the best basic and applied research possible, something it achieves through the acquisition of top talent and the provision of exceptional infrastructural and knowledge support to its researchers.

Some of the most outstanding achievements that have come out of CAAS in the 56 years since its founding are presented here.



Rice Germplasm Gene Bank

## Biological Resources

Since its inception, CAAS has been vigorously engaged in the collection, preservation, identification, and evaluation of indigenous and exotic landraces, breeds, lines, genetic materials, and wild species, which have enriched China's resources of plant and animal germplasm and laid a solid genetic basis for the breeding of new varieties.

**Crop Germplasm Resources Preservation:** CAAS possesses one national long-term gene bank and 10 medium-term gene banks as well as 12 national crop germplasm nurseries. Preserved genetic resources include the most important grain and cash crops, such as rice, wheat, maize, coarse cereals, legumes, cotton, oil crops, bast fiber crops, tea, forage, vegetables, and staple fruits. An integrated system for the conservation of national crop germplasm resources was established by CAAS in 2003, and currently has over 420,000 accessions. CAAS has also established the Chinese Crop Germplasm Resources Information System ([www.cgris.net](http://www.cgris.net)) to acquire, analyze, and manage germplasm information.

Looking to the future, a new long-term gene bank is being built to meet the needs of Chinese agricultural development over the next 50 years, with a storage capacity of 1,500,000 accessions.

## Domestic Animal Genetic Resources

**Conservation:** A conservation system for domestic animal genetic resources has been established at CAAS that includes livestock, poultry, and economically important animal breeds, representing 15 animal species. Detailed, standardized information on all domestic animals has been well documented, which is helpful in research and utilization of these resources.

Free and open online access to the Chinese Domestic Animal Genetic Resource Information System ([www.cdad-is.org.cn](http://www.cdad-is.org.cn)) and the Chinese Special Animal Genetic Resource Information System ([www.spanimal.cn](http://www.spanimal.cn)) has been provided by CAAS. From 2002 to present, these websites have been visited over three million times.

## Agricultural Microorganisms Collection and Conservation

**Collection and Conservation:** Established in 1979, the Agricultural Culture Collection of China (ACCC) preserves more than 18,000 strains of microorganisms, predominantly pathogenic and beneficial bacteria, actinomycetes, yeast, and filamentous fungi. ACCC distributes about 3,000 strains annually and has become an agricultural microorganism resource center in China.

CAAS has made breakthroughs in the preservation of crop germplasm resources and their innovative utilization. They include the following:

## Collection, Conservation, Evaluation, and Utilization of Chinese Crop Germplasm Resources

**A germplasm preservation system integrating a redundant long-term gene bank plus multiple medium-term gene banks has been established, holding more than 420,000 crop germplasm accessions. Additionally, a**

Looking to the future, a new long-term gene bank is being built to meet the needs of Chinese agricultural development over the next 50 years, with a storage capacity of 1,500,000 accessions.



Transgenic Bt Cotton





"Double-Low" Rapeseed

Development of new animal and plant varieties is an important part of the central research focus of CAAS.

comprehensive reproduction and regeneration system to ensure the genetic integrity of preserved germplasm resources was developed to facilitate germplasm evaluation, genetic diversity assessment, gene discovery, and germplasm enhancement.

#### Diversity and Descriptor Lists for Crop Germplasm Resources and Their Application:

The careful study of the genetic diversity of 110 crops has resulted in the generation of 512 maps showing the geographical density distributions of these resources, together with descriptor lists (lists of specific plant attributes) and data standards for these crop germplasm resources. More than 110 volumes of descriptor lists were compiled and disseminated, greatly improving the efficiency and benefits of the crop germplasm database.

**Derivation and Use of ID-Type Cytoplasmic Male Sterility Rice:** The derivation of a new cytoplasmic male sterility (CMS) variant from Indonesian native rice germplasms allowed for the creation of three ID-type CMS lines with a high out-crossing rate. More than 200 ID-type hybrid rice combinations have been released and planted accumulatively over an area of more than 30 million hectares.

**Genetic Analysis of Important Rice Germplasms:** Genetic material was isolated and analyzed from a series of rice strains with differing morphological, physiological, chemical, and biological



New Capsicum Variety of Chili Pepper

characteristics. Almost 50,000 genetic differences were mapped and entered into a biomarker database. This analysis established the world's first collection of morphological markers for isogenic lines from the *indica* strain, information that is now widely used. Additionally, in-depth genetic information from insect- and disease-resistant genes from wild rice, landraces, and specially bred species was collected and stored in a searchable database. This resource allows for the identification of key functional genes and ultimately the creation of new and innovative rice varieties.

**Conservation and Utilization of Wild Cotton Germplasm:** More than 6,000 economically and agriculturally important cotton germplasm as well as threatened varieties have been collected and stored at the Wild Cotton Nursery in Sanya, Hainan Province. Over 700 elite cotton parent materials were created from those germplasms, while over 7,000 accessions (some reused frequently) have been provided to cotton breeders around the world. Moreover, 172 novel cultivars have been developed in China that come directly or indirectly from these parent materials. The overall area planted with new varieties is accumulatively more than 37 million hectares.

#### Agricultural Microorganisms Collection and Conservation



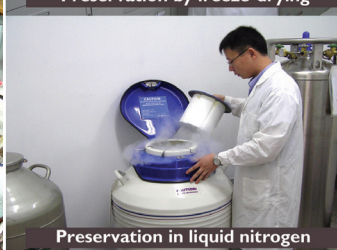
Preservation in liquid paraffin



Preservation by freeze-drying



Freeze-drying technique



Preservation in liquid nitrogen

#### New Plant and Animal Varieties

Development of new animal and plant varieties is an important part of the central research focus of CAAS. The major plants studied include rice, wheat, corn, cotton, oil crops, vegetables, fruit trees, bast fiber crops, and tea, amongst others. Pigs, cattle, sheep, chicken, ducks, other large livestock, and economically important animals are also studied. The new plant and animal varieties developed by scientists at the academy are used widely in agricultural production, and a number of grain, cotton, and oil crops have become the predominant crops planted in certain agricultural areas in China. These crops have

made important contributions to ensuring national food security, promoting the development of modern agriculture, and increasing the financial stability of farmers. In 2011 and 2012 alone, 181 new varieties were released, some of which are detailed below.

**Application of Dwarf Male-Sterile Wheat in Breeding:** Breeding methods based on dwarf male-sterile wheat, now widely used in China, have significantly improved wheat breeding efficiency. Utilizing these methods, 42 new varieties have been developed including “Lunxuan 987,” which produced a record yield of 10.73 tons per hectare. From 2001 to 2010, new varieties have covered accumulatively 12.3 million hectares and have boosted grain output by 5.6 million tons in total. A number of elite lines developed using the dwarf male-sterile wheat method are in regional trials and the results so far have been very positive.

**Breeding System for Super Hybrid Rice:** To improve the vigor of rice crops, cutting-edge molecular analysis and screening techniques have been developed to combine the best physical characteristics (root strength, photosynthesis capacity, disease resistance) of *japonica* and *indica* rice through introgression crossing. Application of this methodology resulted in the creation of a series of high-vigor super hybrid rice varieties, including “Guodao 1” and “Guodao 6,” which have been widely cultivated in Yangtze River Region in China.

**Phytase Genetically Modified Maize:** Genetically modified (GM) phytase maize, when used as animal feed, will abolish the need for industrially produced phytase as an additive (phytase is needed to aid phosphorus absorption by animals), thereby reducing feedstuff costs dramatically. It will also reduce the need to supplement feed with phosphorus by 80–120 tons annually, saving precious phosphorus resources. This GM phytase maize was issued with a GM organism production application safety certificate in 2009 by the Ministry of Agriculture.

**Transgenic Cotton:** Utilizing elite germplasm and new breeding technologies, a number of novel transgenic cotton varieties have been developed. These include CCRI 24, with a short growth period and high fiber quality; CCRI 29 with improved yield, high quality, resistance to multiple diseases, and improved adaptability; and CCRI 41, carrying two insect-resistance genes and showing superior growth efficiency and a broad growing area. New transgenic lines created in 2012 that show improved fiber quality and boll size will provide parental stock for a second generation of transgenic cotton in China.

**Soybeans:** A novel high-yield, high-protein, and adaptable soybean variety, “Zhonghuang 13,” was developed in China using a special breeding system. This superior variety has the largest geographical growth range in the country, now standing at over 4.8 million hectares. It was intentionally developed to be planted across 14 provinces and has held the record for the largest soybean growth area since 2007.

**Rapeseed:** Dozens of high-yield (up to 64.8% oil), double-low (low erucic acid, low sulfuric glucoside) varieties of rapeseed have been developed over the past few decades, including a series of open-pollinated “Zhongshuang” varieties and a raft of hybrid “Zhongyouza” varieties. The planting area for these particular crops currently covers one-third of the total national acreage of rapeseed.

**Peaches and Nectarines:** A breeding system for high-quality, adaptable peaches and nectarines has been established and utilized to create 25 new nectarine, peach, and ornamental varieties by taking advantage



**Datong Yak, the First Improved Yak Breed in the World**

of high-quality germplasms. Among them, five new nectarine varieties, including “Zhong Youtao 4,” hold the top five spots for acreage of trees in nectarine cultivation areas. The planting of some of these new cultivars around the country has reinvigorated peach cultivation in China.

**Capsicum:** Extensive work has been carried out to develop sweet peppers and chili peppers that have resistance to viruses and other diseases, particularly phytophthora blight. In addition, the genetic loci controlling cytoplasmic male sterility in pepper were identified and analyzed. This information was used to create 11 elite inbred lines, from which five hybrid offspring have been successfully generated and released. These new varieties are now major cultivars, covering large growing areas in pepper-producing regions of China.

**Datong Yak:** CAAS scientists have created the Datong yak, the first improved yak breed in the world, developed by crossing large wild yak males with smaller, domestic yak females. The new breed is genetically stable, has relatively strong disease resistance, and shows good environmental adaptability. Meat production from the Datong yak is 20% higher, hair and fur production is 19% higher, and the reproductive rate is improved by 15% to 20%. About 300,000 vials of frozen Datong yak semen were distributed throughout the yak rearing areas in China and have improved the productivity of domestic yaks dramatically.

**Peking Ducks:** Numerous advances in breeding techniques and molecular marker-assisted selection have improved the productivity of Peking duck significantly over the past three decades. Two specialized strains of Peking duck have been successfully bred: the rapidly growing Z-type ducks with a high percentage of lean meat and good feed efficiency, and Nankou-I ducks with high skin fat content. Every year, over 100 million commercial birds are produced from these two strains, with annual economic benefits of above 3 billion Yuan (US\$485 million).

### Applied Agricultural Technologies

In the area of applying new agricultural technologies in China, CAAS has a solid focus on innovation. This includes not just new ideas, but the integration and full application of those ideas to make a real difference in guaranteeing national food security and ecological security.

Through intensive research and development, breakthroughs have





Protected Horticulture—Mobile Pipeline Cultivation

As China transforms itself into a modern agricultural nation there is a growing urgency for new and better agricultural technologies and products.

been made in a number of key areas, for instance in the improvement of agricultural products, more efficient use of resources, and the application of agricultural biotechnology for the prevention and control of major animal and plant diseases, as well as the prevention and control of agricultural pollution, and enhancement of soil fertility.

Some specific achievements in these areas are outlined below.

**Quality Testing Protocols for Chinese Wheat Products:** Noodles and steamed bread are important staples in the Chinese diet. CAAS has established standardized testing and evaluation methodologies for these and other traditional Chinese products. Key factors responsible for noodle quality have been identified and comparative genomics has been employed to characterize how genetic variations impact food quality. Over 40 gene-specific markers have been validated and used to characterize germplasms in China and at the International Maize and Wheat Improvement Center (CIMMYT) in Mexico. Three improved varieties developed by CAAS, with excellent pan bread or noodle quality, have become leading varieties in northern China.

**Integrated Management of Wheat Stripe Rust:** The virulent fungus *Puccinia striiformis* Westend causes stripe rust on wheat in many areas around China. At CAAS, technology has been developed that can forecast regional epidemics of

stripe rust early and with an accuracy of close to 100% based on an analysis of the variation in the inoculum from the source of the outbreak. Studies have elucidated the genetic basis for an evolution of virulence in pathogens as well as the reasons for the failure of plant resistance in wheat cultivars. A strategy of ‘headstream’ management to identify the sources of pathogens and quickly control their spread has been widely implemented across the country, resulting in a significant reduction in crop losses and saving 9.3 billion Yuan (US\$1.5 billion) from 2009 to 2011.

**High-Yield and High-Efficiency Maize Production:** Researchers investigated the key factors and technological requirements for the most efficient production of maize. Thirteen different systematic approaches were developed, each suited to different ecological regions or niches in China, such as the southwest, the north, or the Huang-huai-hai Plain. These models have proven highly successful at boosting maize production, consistently generating record high yields in many different ecological regions.

**In Vitro Culturing of Cotton:** A new methodology has been developed that uses explants of petioles (the stalk attaching leaf to stem) or hypocotyls (part of the plant seedling) to more easily create cotton seedlings in vitro. Utilizing an *Agrobacterium tumefaciens*-mediated transformation protocol, the transformation ratios can be increased 1.9- to 3.5-fold over wild type. Transformation cycles are therefore greatly shortened and the efficiency of tests for validation of gene function significantly increased.

**Innovations in Urban Horticulture:** The cultivation of food in an urban setting has grown in importance as more people move to large cities, which has given new impetus to CAAS’s urban horticulture program. One example is a novel cultivation technique for sweet potatoes in which the above-ground tuberous root can be continuously harvested, while leaving the below-ground root system untouched to allow the absorption of nutrients.

In addition, a number of three-dimensional soilless cultivation systems have also been developed, including wall, column, and mobile pipeline cultivation. These techniques have greatly improved the efficient utilization of both space and light, and facilitated the promotion of urban agriculture.



High-Yield and High-Efficiency Maize Production

**Monitoring System Driven by Remote Sensing:** Crops in China are grown in complex and diverse landscapes and commonly mixed with other vegetation. To effectively and efficiently monitor crop conditions at a regional level, an integrated crop monitoring system has been built that combines remote sensors, in situ observation stations, and wireless sensor networks. Using data generated by this system, discriminative crop diagnostic techniques incorporating complex quantitative inversion algorithms were developed and deployed nationwide to gather data on major crop and agro-environmental variables for assessment and analysis. The system has now been running for a decade, providing rapid and reliable information to support important decisions regarding the management of crops throughout China.

### Agricultural Products

As China transforms itself into a modern agricultural nation—balancing the needs of the industrial sector with a drive to innovate—there is a growing urgency for new and better agricultural technologies and products. These cover a broad swath of areas, from vaccines and detection reagents for infectious diseases, to better agricultural machinery and improved fertilizers. CAAS has successfully developed many such items, producing them on a large scale for standardized application across the country. Additionally, work done at CAAS has significantly increased the productivity of arable land, improved the utilization of limited natural resources, boosted labor productivity, and increased the income of farmers. From 2006 to 2010, CAAS was awarded 36 national certificates for new veterinary drugs, pesticides, and fertilizers; in 2011 and 2012, another 14 such certificates were added.

Just a few of the representative successes are described below.

**H5N1 Avian Influenza:** China is a leader in avian influenza vaccine development and distribution. CAAS established a platform for H5N1 vaccine development using plasmid-based reverse genetics (RG). H5N1 RG vaccines have been widely used in China, Vietnam, Indonesia, and Egypt, and have played an important role in the control of H5N1 avian influenza in domestic poultry. CAAS has also developed a live attenuated Newcastle disease virus (NDV) vectored H5N1 influenza vaccine, which provides protection against both Newcastle disease and H5N1 in chickens. This is the first widely used RNA virus vectored vaccine in the world.

**Foot-and-Mouth Disease:** Researchers at CAAS have been instrumental in the surveillance, diagnosis, prevention, and control of foot-and-mouth disease (FMD) in China. Their work on the origin of the virus and pathways of transmission have enabled the creation of effective diagnostic techniques and the generation of vaccines against type O, A, and Asia I FMD strains, thereby reducing the occurrence of outbreaks and limiting the spread of FMD.

**Quinocetone:** Quinocetone, an animal growth promoter, is the first such novel drug certificated in China. The compound took more than 20 years to develop, but now demonstrates high yield, good stability, and significant growth promotion, with apparently no toxicity, no side effects, and no environmental pollution. Quinocetone has been widely used in China to promote growth in pigs, broiler chickens, ducks, and fish.

**Fertility of Upland Red Soil Areas in Southern China:** Since 1982, long-term fertility experiments have been carried out in the red soil areas of southern China. Comprehensive fertility improvement methodologies



Diagnostic Reagents and Vaccines Developed for Animal Diseases

have been established that have enhanced productivity through the use of eight compound fertilizers (specifically for upland crops), four multi-function conditioning compound fertilizers, and four upland red soil conditioners. These fertilizers and soil conditioners are now manufactured by 10 fertilizer companies in Hunan, Jiangxi, Guangxi, and Guangdong provinces, with an annual production of more than 320,000 tons. The methodologies have been successfully applied over approximately 3.5 million hectares in southern China.

**Health and Nutrition in Piglets:** Research into various aspects of piglet health has been undertaken at CAAS, including piglet rearing and feeding patterns, physiological stress induced by weaning, the nutritional and anti-nutritional effects of components in feedstuff, nutritional requirements, and the importance of the gut microbial balance for intestinal health. Through this research, over 240 feed additives, premixes, and concentrated and specially formulated feeds that can enhance piglet health have been developed.

**Multitarget Insecticides:** As a means to manage insect pests that have developed resistance to multiple different insecticides, a series of effective, new multitarget pesticides have been developed. These include 20% abamectin-monosultap microemulsion, 3% beta cypermethrin-emamectin microemulsion, 20% fenvalerate-malathion emulsifiable concentrates, and 15% abamectin-chlorpyrifos emulsifiable concentrates. These insecticides demonstrate high co-toxicity efficacy in laboratory assays and are effective at controlling pests such as *Helicoverpa armigera*, *Cnaphalocrocis medinalis*, *Liriomyza sativae*, and *Nilaparvata lugens* in the field. The use of multitarget insecticides significantly delayed the development of pesticide resistance under laboratory conditions when compared with insecticides containing a single active ingredient. Over two million tons of these insecticides have been deployed in the field to control insecticide-resistant pests.

### Advancing Basic Agricultural Research

CAAS attaches great importance to continuously pushing the boundaries of basic agricultural research and developing new paradigms through both theoretical analysis and practical experimentation. In this vein, CAAS has made a number of theoretical and methodological breakthroughs in





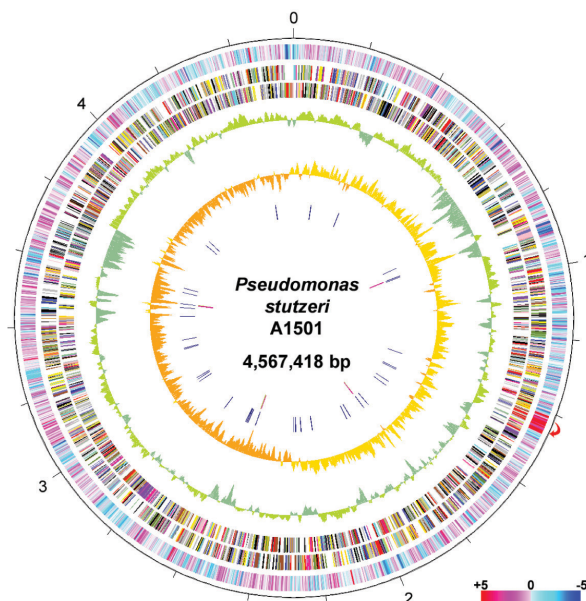
CAAS attaches great importance to continuously pushing the boundaries of basic agricultural research and developing new paradigms through both theoretical analysis and practical experimentation.

the study of the genomics of important crops, the process of molecular breeding, the molecular basis of certain important agronomic traits, agricultural pest control, and the ecological and environmental security of genetically modified crops. From an academic perspective, CAAS scientists have excelled, increasing the number of published papers from 11,000 in the years 2001 to 2005, to over 20,000 from 2006 to 2010. Importantly, the number of papers indexed by the Thomson Reuters Science Citation Index and the Engineering Index rose fivefold from 514 to over 2,500 in the same period. The years 2011 and 2012 saw further dramatic improvement, with 10,000 publications, of which 2,620 were indexed, indicating increasing momentum for quality basic research and theoretical innovation at CAAS. CAAS scientists continue to publish influential papers in a range of fields in prestigious journals such as *Science*, *Nature*, *Nature Genetics*, *Proceedings of the National Academy of Sciences, U.S.A.*, and *The Plant Cell*.

Some recent achievements from CAAS include:

**Study of Important Functional Genes in Rice:** In cooperation with researchers at the Chinese Academy of Sciences, *OsSPL14/IPA1*, a key gene in rice that promotes higher grain yield, was cloned, characterized, and then introduced into conventional rice varieties, increasing grain yields in recipient strains by ~10%. Candidate quantitative trait loci associated with 14 agronomically important phenotypic traits of Chinese rice varieties were identified through genome-wide association studies; these are currently being studied further. Additionally, the role of epigenetic modifications in the determination of plant height and flower development was reported, and a key gene related to rice fertility, *pss1*, was discovered.

**Nitrogen Fixation in Rice:** The complete genome sequence of the nitrogen-fixing bacterium *Pseudomonas stutzeri* A1501 was determined, leading to the identification of a 49-kb genomic island carrying the nitrogen fixation (*nif*) gene cluster. New genes required for the



Genome Sequence of *Pseudomonas stutzeri*

nitrogen fixation process have since been identified within this cluster. Knowledge of the genome sequence allows for further study of *nif* gene evolution and identification of rhizosphere traits needed for robust interaction between bacterium and host plant root. Moreover, it opens up new opportunities for the broader application of root-associated, nitrogen-fixing microorganisms in sustainable agriculture.

**Sequencing of Important Crops Genomes:** Using state-of-the-art next generation sequencing technology, CAAS scientists determined the complete sequence of the cucumber, potato, Chinese cabbage, and cotton genomes, all of which are economically important crops. Careful analysis and annotation of these data yielded a goldmine of genetic information that can be practically applied in the breeding and management of these crops.

**Assessment and Management of Transgenic Bt Cotton:** CAAS scientists have been conducting long-term studies into how the cotton bollworm develops resistance to transgenic Bt cotton. Elucidation of resistance pathways has engendered new management strategies based on a multicrop system (utilizing non-Bt host crops as a natural refuge) as well as techniques to control and delay the acquisition of resistance. Studies of the ecological impact of Bt cotton on target and non-target organisms (including insect pests and their natural enemies) has provided the necessary knowledge for the establishment of new systems for insect pest management in areas where transgenic Bt cotton is grown.

**Evolution of H5N1 Viruses:** Important research carried out at CAAS revealed the pathways by which H5N1 influenza viruses gradually acquired the ability to infect and kill mammalian hosts. This work uncovered some of the critical molecular components responsible for interspecies infection and transmission of H5N1 viruses in mammals, and revealed that the *NS1* gene is a key determinant for the virulence of these viruses. Analysis of the *NS1* gene sequence revealed functional information regarding virulence pathways.



# Supporting Agricultural Research in the 21st Century

All research projects at CAAS are supported by an array of state-of-the-art core facilities, experimental field stations, and other shared technology resources. Additional support is provided by information services, germplasm resources, food quality control services, and product commercialization support. Below, we examine in more detail some of the core facilities that underpin the research at CAAS.



Meng Xianxue

## National Agricultural Library

The central library of CAAS will be renamed the National Agricultural Library (NAL) in 2013. NAL is one of the four arms of the Chinese National Science and Technology Library (NSTL) system, which also includes the national science, engineering, and medical libraries. "The NAL serves all agricultural researchers at CAAS and throughout China," says Meng Xianxue, deputy director general of the Agricultural Information Institute of CAAS. Besides providing all the basic services of a modern science library—electronic access to the full text of almost 10,000 journals, for example—NAL also has a special role in preserving ancient texts. Among the 2.1 million volumes of books in the NAL, there are some 15,000 ancient Chinese agricultural handbooks, statistics books, and almanacs dating back to the Song Dynasty (960–1279 A.D.). Says Meng: "There is a plan to digitize the ancient literature so that scholars around the world can access these historic documents." By participating as a partner in the European Union's 7th Framework Programme, which aims to boost research and development through information services, NAL is dedicated to joining the world's information service network and making a unique contribution.

## Crop Germplasm Resources

The National Key Facility of Crop Gene Resources and Genetic Improvement, affiliated to the CAAS Institute of Crop Sciences (ICS), is responsible for preserving the 420,000 accessions of crop germplasm. "This collection is the second largest in the world, and unlike the seed collections in the United States, most lines in our collection are native," says Wan Jianmin, director

general of ICS. In addition to a redundant backup system for seed and plant preservation, the facility also provides more than 352 pieces of equipment for 'omics studies, predominantly genomics, proteomics, metabolomics, and transcriptomics. It also operates more than 10,000 m<sup>2</sup> of fully automated greenhouse space for experiments. The services are open 24 hours a day, seven days a week, and all year round. Many of the scientists with breeding success stories at CAAS (or even nationwide) have used this particular facility, which is maintained by more than 100 staff scientists. Going forward, "the challenges we face include funding stability and a shortage of expertise in certain disciplines, particularly bioinformatics," says Wan. The funding issue will be addressed by the Agricultural Science and Technology Innovation Program (see page 7), and regarding the latter, bioinformaticians are currently being recruited to analyze the vast amount of 'omics data being generated.

## Control of Plant Diseases and Insect Pests

A day before the opening ceremony for the 2008 Beijing Olympics, monitoring systems outside of the capital city picked up the radar image of a swarm of meadow moths headed for the festivities. Top scientists at the State Key Laboratory for Biology of Plant Diseases and Insect Pests (SKLBPI) were tasked with intercepting these uninvited "guests" before they reached the city. Just hours before the opening night events, integrated measures—including powerful searchlight traps, ultraviolet light traps, and biopesticides—were set up to catch the invaders en route, the majority of which were successfully intercepted. "We were all staring at the TV screen nervously to see if any moths landed on the suits of the VIP guests; we would have been in a big trouble if that had happened," jokes Zhang Jie, deputy director of SKLBPI and professor at the CAAS Institute of Plant Protection.

SKLBPI is responsible for setting up these types of monitoring systems throughout the country, to detect the early warning signs of plant diseases and insect pest outbreaks. SKLBPI also carries out research to create strategies to mitigate the impacts of such epidemics and of invasive organisms. The core facilities of SKLBPI support broad basic research, for example the use of functional genomics analysis and genetic monitoring to study transgenic species. The laboratory's experimental field stations, on the other hand, are located in different climate zones throughout China for more defined uses. "Each field station has its own specific focus," says Zhang. "For example,



Wan Jianmin

All research projects at CAAS are supported by an array of state-of-the-art core facilities.



Zhang Jie



Zhang Huimin

the Guilin Field Station, deep in the hilly region in southwest China, specializes in insect monitoring due to its location in the seasonal wind corridor that brings insect pests from Southeast Asia,” he explains, adding: “The station is also the test site for evaluating the safety of genetically modified crops because of its isolated location.”

### Long-Term Soil Experiments

Located deep in the hills of southern China is the Qiyang Red Soil Experimental Station, which boasts the record for the longest continuous monitoring of soil fertility in China. The station was established in the 1960s under extremely difficult conditions due to its remote location. It became a national field station in 2000. Since 1975, long-term studies on the impact of fertilization on the soil environment and crop yield have been carried out continuously at the station. “These kinds of long-term data are invaluable, especially in the research of sustainable agriculture,” says Zhang Huimin, head of Qiyang Station and professor of the CAAS Institute of Agricultural Resources and Regional Planning. After being subdivided many times throughout the decades to accommodate new research projects, there are still six long-term field experiments at Qiyang Station that have more than 20 years of soil and plant samples available for analysis. Says Zhang: “We have collaborated with researchers in Australia, the United States, England, Japan, and Korea to study environmentally friendly fertilization in the hilly terrain. Our long-term data are also very valuable for the study of carbon sequestration and climate change.”

### Quality Control of Agro-Products

Facing increasing problems of food safety in the Chinese market, the Ministry of Agriculture and CAAS established a new institute dedicated to food safety issues in 2003. The general mission of the institute is to carry out research on testing technologies, risk assessment, cultivation process control methods, development of standards, certification, and traceability systems for the safety and quality of agro-products. “Food safety is an emerging issue, which is highly correlated with, and originating mostly from, agro-products,” says Ye Zhihua,



Ye Zhihua

director general of the CAAS Institute of Quality Standards and Testing Technology for Agro-Products, “and we were obliged to hit the ground running from the beginning.” Researchers in Ye’s institute have done an impressive job, despite having to work in temporary laboratories until the construction of institute’s permanent building was finished in 2008. Using state-of-the-art physiochemical analytical instruments, they have developed many standard-testing protocols tailored for Chinese agro-products. They have also developed risk analysis models and tracing/tracking systems for food authentication and, if necessary, the recall of agro-products. “Application of the technologies and implementation of the systems developed in our institute will greatly improve the overall food safety in China,” says Ye.

### An Incubator for Veterinary Biotechnology

Building on decades of the successful development and production of veterinary vaccines at CAAS’s Harbin Veterinary Research Institute (HVRI), and the lessons learned from the commercialization process, a new Na-



Wang Xiaomei

tional Engineering Research Center for Veterinary Biologics (NECVB) was established in 2010 to facilitate the transfer of technology from basic laboratory research to commercial products. “We are pretty good at basic research and at the subsequent large-scale production of research products. However, the technologies for industrialization still need to be greatly improved,” says Wang Xiaomei, the deputy director general of HVRI. The new research center has been structured as a state-owned enterprise, with stakeholders from HVRI, several other national research institutes, and some biotechnology firms as well. Through the startups in biotech incubators, NECVB has conducted collaborations with some Chinese and American companies. “The goal of NECVB is to act as a technology incubator and biotechnology transfer platform for the industrialization of bio-products for animal health,” says Wang. Currently, NECVB’s mandates include vaccines, diagnostic reagents, and other veterinary products as well as experimental animal models. According to Wang, NECVB serves not only HVRI and institutions around Harbin, but also all research institutions and scientists nationwide. Being the first veterinary biotech incubator in China, the establishment of NECVB will promote the transformation and industrialization of research accomplishments in the animal and veterinary sciences generated within CAAS institutions and beyond.



# Establishing Premier Research Facilities

Great science cannot be done without a solid infrastructure. To support its focus on building strong interdisciplinary teams and generating world-class research, CAAS has established comprehensive science and technology research facilities, which can be broadly categorized as follows:

**Technological Innovation Facilities:** Housed at its various affiliated institutes, CAAS has built six state key laboratories, 18 national centers (and sub-centers) for plant and animal variety improvement, five national engineering research centers, 19 comprehensive key laboratories of the Ministry of Agriculture (MOA), and 23 specialized key laboratories of MOA. In addition, 13 MOA laboratories undertake quality and safety risk assessment of agro-products.

**Scientific Support Facilities:** CAAS has constructed two national key facilities, one national long-term gene bank, 10 medium-term gene banks for crop germplasm storage, five national experimental field stations, and 24 MOA experimental field stations. All of these facilities provide data and infrastructure support for ongoing research at CAAS.

**Technology Service Facilities:** To support technology development, CAAS has built 38 quality, supervision, and inspection centers (at both the national and ministerial level), three national reference laboratories, and three reference laboratories of the World Organisation for Animal Health (*Office International des Epizooties*, OIE) and one reference laboratory of the Food and Agriculture Organization of the United Nations (FAO).

To boost its scientific research competence, CAAS continues to invest in research infrastructure, and in recent years has successfully built advanced biosafety laboratories, remote sensing application laboratories, bioreactors, modern plant factories, a microorganism culture collection center, and environmentally controlled chambers for animal nutrition research, amongst others. In addition, a national foot-and-mouth disease reference laboratory, a specialized biosafety laboratory for the study of animal-disease prevention and control, and a dioxin research laboratory are all currently under construction.

## Major Research Facilities at CAAS

### National Key Facilities

The construction of national key facilities is funded by the central government. These facilities are generally large-scale research installations or networked systems and, besides their scientific function, they also serve as a benchmark indicating the level of commitment of the country to national scientific and technological development.

**National Key Facility for Crop Gene Resources and Genetic Improvement:** As China's first national key facility covering agriculture, this center embodies the significant progress that has been made in

China in the area of agricultural science. Research at this facility centers on three major areas: basic research and technological innovation in the genetics and genomics of staple crops, understanding the molecular basis of important crop traits, and the theory and practice of genetic manipulation of economically important crops. Work performed includes identification of genetic resources, investigation of new genes that confer important physical traits, functional genomics research, and innovations in techniques for breeding new varieties of rice, wheat, corn, cotton, soybean, and other crops. Additionally, world-class modern facilities have been created for large-scale, high throughput genetic analysis, gene cloning, and the generation of novel transgenic plants as well as a system for preservation of unique crop germplasms.

**National Agricultural Biological Security Science Center:** This national center houses a high-risk plant pathogen laboratory, a high-risk insect laboratory, a high-risk plant laboratory, as well as other research facilities for the analysis of agricultural biosafety data, and the early detection and quarantine of dangerous plants, insects, and pathogens. As an internationally recognized agricultural biosecurity facility, the center provides a foundation for agricultural biosafety research in China, providing reliable scientific and technological support for national agricultural biosafety research.

### State Key Laboratories

State key laboratories, established and constructed under the auspices of the Ministry of Science and Technology (MOST), are important bases from which high-level basic research and applied research is or

To support its focus on building strong interdisciplinary teams and generating world-class research, CAAS has established comprehensive science and technology research facilities.



DNA Sequencing Instrument



**A Pilot Base for Feed Research in Nankou, Beijing**



Similarly to the national key facilities and state key laboratories, MOA laboratories form an important part of the nation's agricultural technology innovation infrastructure.

ganized. They also hire and foster top talent, and conduct high-level academic exchanges. By making advanced equipment and machinery available to researchers, they also play an essential role in scientific and technological innovation in China.

**State Key Laboratory for Biology of Plant Diseases and Insect Pests:** Affiliated with the CAAS Institute of Plant Protection, this is one of China's preeminent laboratories in the field of plant protection, with projects under way both at home and abroad. It focuses on the basic biology of plant diseases and insect pests, including modes and pathways of outbreaks, and the prevention and control of pathogens and insect pests. It also carries out cutting-edge, creative, and forward-looking research that provides a foundation for the sustainable development of agriculture, food security, and ecological security—and thereby economic security—in China.

**State Key Laboratory of Animal Nutrition:** This key laboratory is co-hosted by the CAAS Institute of Animal Sciences and the China Agricultural University. It is oriented toward supporting the nation's strategic needs for economic development as well as carrying out research work on basic, critical scientific, and technological issues faced by China's animal husbandry and feed industries. Further, it undertakes research that provides a theoretical basis as well as practical approaches for addressing resource shortages, safety of livestock and poultry, product quality, and other issues that may impact China's economy.

**State Key Laboratory of Rice Biology:** This laboratory was jointly established by the China National Rice Research Institute of CAAS and Zhejiang University. Focusing on rice germplasm and molecular breeding techniques, it carries out research into rice biology and cultivation technologies, providing state-of-the-art research facilities. A gene bank of rice mutants has been established by the laboratory that is open to researchers and farmers around the country. This storage bank for mutant rice plants has become a valuable national resource in China.

**State Key Laboratory of Veterinary Biotechnology:** This key laboratory is located at the CAAS Harbin Veterinary Research Institute. It is China's first state key laboratory in the veterinary sciences, carrying out research focused on infectious animal diseases and amphi xenosis. Researchers investigate the effect of genetic variation on disease pathogenicity, mechanisms of pathogenicity and induced immunity, and the prevention, diagnosis, and treatment of various diseases affecting economically important animals. Scientists have access to state-of-the-art equipment and use the latest molecular biology and genetic engineering techniques, making important contributions to animal-disease prevention and control across the country.

**State Key Laboratory of Veterinary Etiological Biology:** Affiliated with the CAAS Lanzhou Veterinary Research Institute, this state key laboratory investigates major epidemics that endanger livestock health and the etiology of these diseases as a pathway to prevention and control. Research into pathogen functional genomics, pathogen ecology, and mechanisms of infection, pathogenicity, and immunity, are all primary areas of focus. The laboratory's overarching mission is to support the country's strategic needs for a robust livestock industry.

**State Key Laboratory of Cotton Biology:** Co-hosted by the CAAS Institute of Cotton Research and Henan University, this laboratory is predominantly engaged in basic cotton biology research and application, including understanding cotton genetic diversity and the genetic underpinnings of fiber quality, stress resistance, and other physical traits. Work is also undertaken to create new cotton varieties. Additionally, the laboratory plays a role in the studies of environmental modulation as it relates to cotton crops.

### **Key Laboratories of the Ministry of Agriculture**

Similarly to the national key facilities and state key laboratories, MOA laboratories form an important part of the nation's agricultural technology innovation infrastructure. They participate in nurturing outstanding scientific minds, carrying out domestic and international academic exchanges, and creating innovative scientific and technological agriculture products. They are tasked with carrying out both basic and applied research related to agriculture in an attempt to solve technological problems that might be constraining the development of related industries. Key laboratories of MOA are established based on industry needs, the specialized characteristics of a particular region, and the specific disciplines that align with national science priorities. There are two types of laboratories: comprehensive key laboratories and specialized (regional) key laboratories.

**Comprehensive Laboratories:** Based on-site at the relevant CAAS institutes, there are 19 comprehensive key laboratories of MOA that cover a wide range of disciplines, including genetic resource storage, the biology of various crops, and the integrated management of crop pests. In addition to focusing on both basic and applied research, and in line with national needs, these laboratories also take the lead in coordinating scientific cooperation (within and outside China, including hosting visiting academics), resource sharing, performance assessments, and also in overseeing work carried out within the specialized key laboratories and at the observation and experimental field stations. They also influence the choice of which disciplines are regarded as nationally important.

**Specialized Laboratories:** There are 23 specialized key laboratories

of MOA, also housed within CAAS institutes, covering areas of study such as crop physiology and ecology, crop biology, and water conservation in the cultivation of rain-fed crops. These laboratories receive operational guidance from the comprehensive laboratories and carry out specialized basic and applied research in accordance with national and regional priorities.

### National Engineering Technology Research Centers

The primary purpose of the national engineering technology research centers—all constructed under the auspices of MOST—is to strengthen the bridge between scientific and technological research and the actual application of this work in the field, thereby promoting industrialization of new technologies. The centers focus on nurturing industrial-scale production of new products and technologies, the translation of new discoveries to the relevant industries, and stimulating and supporting the creation of new industries while concurrently improving and upgrading traditional industries.

**National Comprehensive Agricultural Engineering Research Center (Changping):** Located in a suburb of Beijing, this center focuses on the cultivation of new varieties of grain crops, vegetables and flowers, and livestock and poultry as well as on technological research and the industrial development of animal feed and new feed additives. Furthermore, the center carries out pilot studies that allow for the smoother transition of new discoveries and technologies into the industrial marketplace.

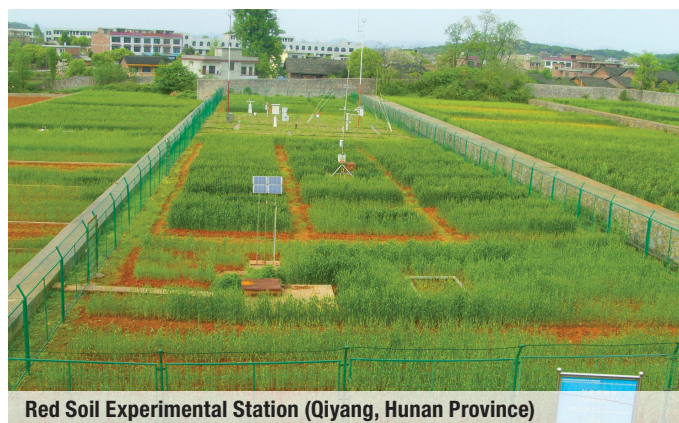
**National Feed Engineering Technology Research Center:** Co-hosted by the CAAS Feed Research Institute and China Agricultural University, this center serves China's feed industry and is tasked with researching and developing relevant new high-tech products as well as distributing up-to-date information about the industry. It also works to review and integrate domestic and international research advances, including advanced technologies imported from outside the country.

**National Engineering and Technology Research Center for Rapeseed:** This center, a collaboration between the CAAS Oil Crops Research Institute and Huazhong Agricultural University, has the goal of improving crop quality and productivity in rapeseed production as well as reducing costs and simplifying the cultivation process. The center engages in research into the breeding, cultivation, and processing of rapeseed as well as facilitates the integration of new technologies into relevant industries. It has developed and introduced a number of new rapeseed varieties, together with more efficient, high-yield cultivation techniques and technologies for plant processing and utilization.

**National Engineering and Technology Research Center for the Tea Industry:** Based at the CAAS Tea Research Institute, this center supports the industrial objectives of efficiently producing high-quality, safe, and ecologically sustainable tea crops as well as conducting research and development to generate technologies that benefit the tea industry. Applied research from bench experiments up to small-scale pilot studies can be carried out in the well-appointed laboratory facilities, providing a clear path from discovery to industrialization.

### National Facilities for Crop and Animal Improvement and Germplasm Resource Preservation

The creation, safe storage, and preservation of genetic resources are



Red Soil Experimental Station (Qiyang, Hunan Province)

important considerations in agricultural research, particularly as underutilized or genetically modified varieties are more frequently seen as economically valuable commodities. The national facilities for crop improvement and germplasm preservation engage in basic and applied research to genetically improve plants and animals through modern breeding and transgenic techniques. New varieties and breeds have been developed and are stored for research and industrial use both inside and outside China.

**National Facilities for Crop and Animal Improvement:** Through collaborations with related institutes, CAAS has successfully built 14 national crop improvement centers and one sub-center, covering rice, wheat, oil crops, soybean, cotton, bast fiber crops, vegetables, tea, tobacco, citrus, sericulture, and forage. In addition, CAAS constructed the National Livestock and Poultry Molecular Breeding Center, the National Milk Quality Improvement Center, and the National Experimental Animal Resource Center for Poultry. Infrastructure and equipment at these centers have recently been updated, providing state-of-the-art laboratories for the genetic modification and improvement of agricultural plants and animals, and for the creation of new, economically important varieties.

**National Facilities for Crop Germplasm Preservation:** CAAS has constructed a national long-term storage gene bank for crop germplasm, 10 medium-term storage gene banks for cereal crops, vegetables, cotton, oil crops, bast fiber crops, melon, forage crops, and tobacco.

### Experimental Field Stations

The testing of new, experimental crops requires, by its nature, large tracts of land and relatively stable environmental conditions. Experimental stations dotted around China form the foundation for numerous field experiments as well as providing monitored environments suitable for “real-world” crop trials.

In addition to five national-level and 24 ministerial-level experimental field stations, CAAS has set up another 93 research and test bases across China located in 25 provinces, municipalities, and autonomous regions. They form an academy-wide network of test sites that cover all of the major agricultural areas in the country. These bases have played important roles in many of the major scientific accomplishments of CAAS in recent years, including the creation of super rice, transgenic insect-resistant cotton, “double-low” rapeseed, dwarf sterile wheat, and transgenic phytase corn.





In Vivo Imaging of Small Animals

The national reference laboratories established at CAAS engage in basic and applied research over a broad range of topics related to preventing and controlling animal diseases in China.

The five national-level experimental stations are described below.

**National Crop Germplasm Resources Field Observation and Research Nursery Network:** Based at the Institute of Crop Sciences, 32 field observation nurseries have been built in 21 provinces, municipalities, and autonomous regions across China. The network covers five different climate zones, namely (from north to south): cold temperate, temperate, warm temperate, subtropical, and tropical. The nurseries encompass complex and diverse ecosystems with rich germplasm resources and, for nearly 30 years, have formed a network of systematic, unified research bases that have provided a valuable source of observational field data.

**National Soil Fertility and Fertilizer Efficiency Monitoring Network:** This network carries out research on long-term changes in soil fertility, fertilizer utilization rates, and fertilizer agronomy as well as the ecological and environmental effects of fertilizers on different soil types in different geographical regions. Other topics of study include the evolution of soil quality across different climate zones, determination of optimal fertilization systems, and the environmental effects of intensive farming waste recycling.

**Red Soil Experimental Station (Qiyang, Hunan Province):** This field station focuses on long-term variation in the ecology of the red soil hilly regions of mid-south China, and how human agricultural activities impact the environment over time. These studies are important in understanding how best to preserve the sustainable development of agriculture and prevent degradation of the farmland ecosystem. Experiments are also carried out to determine the most effective and efficient technology for use in red soil and assess the best models for sustainable agriculture in the region.

**National Grassland Ecosystem Observation and Research Station (Hulunber, Inner Mongolia):** The main mission of this station is to engage in research on various natural processes and the effect of human activities on the grassland ecosystem. Experiments are performed to de-

velop theories and technology that enable active agricultural production with minimal impact on grassland ecology. Three main research areas include long-term grassland ecology, remote sensing of grassland ecology, and the development of technology for regional agriculture and animal husbandry.

**National Scientific Observation Station for Farmland Ecosystem (Shangqiu, Henan Province):** Work at this station mainly focuses on systematic allocation, optimization, and regulation of farmland and agricultural ecosystem resources. In particular, long-term studies are carried out on optimizing irrigation water use and on changes in the farmland ecosystem on the Huanghuai Plain. This research reveals those human and environmental factors impacting farmland ecosystems, and enables the establishment of systems for evaluating how best to make use of the land for production, while maintaining a healthy ecosystem.

### National Reference Laboratories

The national reference laboratories established at CAAS engage in basic and applied research over a broad range of topics related to preventing and controlling animal diseases in China, including addressing major technical hurdles in dealing with animal epidemics and providing a scientific basis for developing strategies for handling major disease outbreaks as well as offering technical and material support for the diagnosis, prevention, control, and eradication of disease.

**National Reference Laboratory for Avian Influenza:** This laboratory undertakes epidemiological investigations of animal influenza, viral strain monitoring, influenza virus collection and long-term storage, development and optimization of diagnostic protocols, development and standardization of related diagnostic reagents, development of new vaccines and immunization program formulation, studies of viral pathogenesis and acquired immunity, and research into food safety.

**National Reference Laboratory for Foot-and-Mouth Disease:** Research undertaken at this laboratory includes the diagnosis, quarantine, epidemiological monitoring, immune prevention, and pathogen biology study of foot-and-mouth disease and swine vesicular disease as well as the development of relevant products. Housed within this laboratory are a virus bank and a serum bank—plus associated databases—that provide the biological samples and information needed for research into the prevention of foot-and-mouth disease.

**National Reference Laboratory for Contagious Bovine Pleuropneumonia:** Epidemiological investigation of contagious bovine pleuropneumonia (CBPP) is carried out at this reference laboratory, including research and development of diagnostic techniques for CBPP, and the formulation and regular revision of diagnostic standards. This work has helped enable China to apply for the status of a “CBPP-free country.”

In addition to those mentioned above, another four reference laboratories at CAAS have been recognized by OIE and FAO. They are the OIE Reference Laboratory for Avian Influenza, the OIE Reference Laboratory for Equine Infectious Anemia, the OIE Reference Laboratory for Foot-and-Mouth Disease, and FAO Reference Center for Animal Influenza.

### National Service Facilities for Risk Assessment and Testing of Agro-Product Quality and Safety

These national service facilities were established to help ensure the

quality and safety of agro-products produced in China.

**Risk Assessment Laboratories of MOA for Quality and Safety of Agro-Products:** A total of 13 risk assessment laboratories engage in research and analysis related to the monitoring of risks associated with agro-product quality and safety as well as the optimization of early warning systems. Those products covered include cereals crops, oil crops, dairy products, vegetables, fruit, and bee products, amongst others. Associated tasks such as setting up agricultural quality, safety, and testing standards, as well as evaluating and handling national agricultural emergencies, are also under the purview of these laboratories.

**National and Ministerial Product Quality Supervision, Inspection, and Testing Centers:** CAAS has established three national product

quality supervision, inspection, and testing centers for feed, fertilizer, and plant protection equipment, respectively, as well as 27 ministerial centers for crops, animal products, and agricultural machinery covering cereals crops, oil crops, vegetables, milk, and biogas equipment. These centers are involved in overseeing countrywide production and testing of product quality, as well as routine monitoring of agricultural production on a local level, including the performance of spot testing and general inspection of quality and safety of agro-products, risk monitoring, product quality certification, and market access. Other tasks assigned to these centers include the exchange of technical information between centers, training of inspectors, policy guidance, and providing consultation services related to quality and safety testing of agro-produce grown domestically and abroad.

## Technology Transfer

As a national non-profit research academy, CAAS is committed to supporting the development of modern agriculture in China. A significant part of this mission involves the dissemination of scientific information and new technologies across China, particularly to the rural farming regions. These outreach and knowledge transfer efforts extend to supporting the technical training of personnel and building up the domestic agricultural industry in cooperation with local governments, agricultural research institutions, and universities.

Since the start of the 11th Five-Year Plan in 2006, CAAS scientists have performed over 15,000 on-site training and education sessions in rural areas to demonstrate and consult on agricultural technologies, while approximately four million people have received basic training as technicians and farmers. More than 300 new crop varieties have been released, and the accumulated planting area has reached over 200 million hectares. This includes 23 million hectares of transgenic Bt cotton (accounting for 90% of the total transgenic insect-resistant cotton planted in China, with output valued at over 50 billion Yuan [US\$8 billion]); 4.7 million hectares of the “Zhonghuang 13” soybean (the first such variety to be awarded international intellectual property protection); and 16 varieties of “double-low” (low erucic acid, low sulfuric glucoside) rapeseed—of which 1.6 million hectares is planted annually, accounting for fully one-third of rapeseed planted in the country. In addition, CAAS scientists have bred new and improved varieties of animals, which now number over two bil-



On-Site Demonstration of Biogas Digester Construction

lion fowl and 88 million livestock. The avian influenza vaccine developed at CAAS was distributed countrywide, totaling 100 billion doses with a value of 9 billion Yuan (US\$1.45 billion).

Cooperation between CAAS and other domestic agricultural research and education organizations, as well as local governments, is important to facilitate technology transfer. CAAS has signed cooperation agreements with 23 provinces, and 40 cities and local agricultural research institutions. These agreements set out terms for establishing pilot testing sites to demonstrate key techniques and products, and how the participants will collaborate on science and technology projects coming out of local governments. Guidelines are also put in place for interactions with national agricultural high-tech development parks, aimed at providing technical support for the development of modern agricultural methodologies. In particular, CAAS attaches great importance to bringing advanced techniques and products to remote and previously neglected regions. To do this effectively, there is a concerted effort led by CAAS to establish joint research projects in these areas to build sustainable capacity for ongoing, independent innovation in science and technology.

The transfer of mature technology and products to farmers is the ultimate goal of the agricultural research carried out by CAAS. The academy, as the leading agricultural research institution in China, is mandated to not only be research-focused, but also, perhaps more importantly, to orient its work to the needs and concerns of Chinese farmers, and to produce sound products that can improve productivity and thereby income for rural communities across the country.



CAAS Scientist Conducting Farmer Field School



# Capacity Building and Development at CAAS

**C**apacity building—the recruitment of talent—is a top priority in CAAS's plan for the next decade. To address the multifaceted problems in agriculture, the academy is assembling interdisciplinary teams made up of diverse expertise. A number of successful examples in breeding and veterinary medicine are highlighted below.



Chen Hualan

## Frontiers in Veterinary Medicine

In China, CAAS is the front line of defense for the detection and control of two global diseases: avian influenza and foot-and-mouth disease (FMD). These diseases threaten a large population of poultry and livestock throughout the country; effectively controlling outbreaks could have tremendous benefits for both the agricultural trade and human health.

## Avian Influenza

Since 2003, the global spread of the H5N1 strain of avian influenza virus (avian flu) has grabbed media attention because of the high mortality rate in humans. This highly pathogenic strain also poses a threat to the poultry industry in China as well as Southeast Asia, where domestic fowl are typically housed in crowded conditions.

At CAAS's Harbin Veterinary Research Institute (HVRI) in northeastern China, Chen Hualan, a renowned H5N1 expert, leads a team of 80 of virologists, epidemiologists, veterinarians, and graduate students who develop vaccines and rapid diagnostics for this deadly strain. "On the basic research side, we have contributed to the fundamental understanding of the host switching mechanism [from fowl to humans], the mechanism of transmission, and the epidemiology of the H5N1 virus," says Chen, citing work published in *Science*, the *Journal of Virology*, and other major journals.

Vaccines and diagnostics developed by Chen's team are widely used in China, and the technologies have been exported to other countries, including Vietnam, Mongolia, Indonesia, and Egypt. Chen also runs the World Organisation for Animal Health (*Office International des Epizooties*, OIE) Reference Laboratory for avian influenza and the newly established Food and Agriculture Organization of the United Nations (FAO) Reference Center for Animal Influenza, both as part of the global disease monitoring network.



Qian Qian



Liu Xiangtao



Li Lihui

## Foot-and-Mouth Disease

"China is one of the biggest breeders of livestock in the world, but also has a very long border with neighboring countries. Domestic livestock have therefore long been threatened by exotic animal diseases, of which foot-and-mouth disease is one of the most important, with the potential to cause large economic losses," says Liu Xiangtao, deputy director general of the CAAS Lanzhou Veterinary Research Institute (LVRI) in Gansu Province. "Today, China is playing an increasingly important role in the global prevention and control of this diseases," he adds.

Liu's team of more than 65 researchers works on diagnostics, vaccines, epidemiology, monitoring, pathology, and virology of the FMD virus. "We were delighted to have become an OIE Reference Laboratory for FMD in 2011," says Liu, who is currently developing a third-generation FMD vaccine. His institute, established in 1957, is one of the most well-known in FMD research, on par with the Pirbright Institute in the United Kingdom and the Plum Island Animal Disease Center in the United States.

## Genetic Resources in the Genomic Era

At the Institute of Crop Sciences (ICS), Li Lihui leads a team of more than 35 scientists with the mission to preserve the National Gene Bank, which includes 420,000 accessions from 1,135 crop species. In addition to traditional preservation of seeds and plants, the institute launched an ambitious plan in 2011 to digitize this huge genetic resource, creating a database of genomes, gene expression profiles, and phenotypic traits. "Aided by new technologies, we are generating an enormous amount of data that will unveil hidden insights into this vast collection," says Li. An interesting early finding from the data reveals how local customs or flavor preferences shape the genetic selection of traits in food crops. Li's team also collaborates with anthropologists to understand the evolution of crop diversity in China.

## Super Rice and Green Super Rice

Of the species included in the national collection, rice has received the most attention in China. At the China National Rice Research Institute (CNRRI) in Hangzhou, decades of molecular genetics research—on more than 50,000 rice accessions—has led to the discovery of 42 genes that control the most important agronomic traits, including *Gn1*, which controls grain number, and *DEP1*, which influences the density and erectness of panicles. "These achievements were the fruit of the collaborative efforts of many experts," says Qian Qian of CNRRI. In 2010, his team cloned the *IPA1* (Ideal Plant Architecture 1) gene, bringing them one step closer to defining the agronomic traits needed to create an optimal "super rice" variety.

In Beijing, a team at the ICS is working to improve rice crops for resource-poor regions of the world. The project, supported in part by the Bill and Melinda Gates Foundation, is led by Li Zhikang, who spent six years at the International Rice Research Institute in the Philippines before joining ICS in 2003. "Our goal is to breed 'Green Super Rice' [GSR] cultivars that not only produce high and

stable yields, but also require less water, fertilizer, and pesticides,” explains Li. Currently, Li’s team includes nine professor-level researchers with expertise in genetics, plant breeding, informatics, genomics, plant physiology/metabolomics, and plant pathology.

From 2008 to 2012, the first phase of the project focused on testing more than 370 rice varieties from China in 15 countries of Southeast Asia, South Asia, and sub-Saharan Africa. In phase two, China will continue to scale up the most promising Chinese rice varieties optimized for African and Asian countries as well as train scientists from these countries in breeding techniques and technologies, enabling them to develop their own new GSR varieties.

One of the objectives in phase two—which began in 2013—is to establish the world’s largest functional genomic databases for rice by sequencing 3,000 accessions from the rice core germplasm collections, representing an estimated 90% of the total diversity in rice. The database will focus on the genomic and genetic underpinnings of complex agronomic traits, such as drought-, pest-, and salt-resistance, amongst others.

### Cotton

China is the largest cotton producer in the world and yet still needs cotton imports to support its enormous textile industry. The widely cultivated New World upland cotton species was introduced to China in the 1950s and, since then, the average lint yield has increased more than eightfold, to 1,305 kg per hectare in 2011. “This achievement was made possible by bringing together a ‘cotton team’ to improve both the quantity and quality from multiple angles,” says Li Fuguang, director general of the CAAS Institute of Cotton Research (ICR) in Anyang.

In 1992, ICR scientists developed a transgenic variety of cotton carrying an anti-pest protein from the microbe *Bacillus thuringiensis* (referred to as Bt cotton), followed by the pest-resistant Bt/CpTI line (carrying Bt and the cowpea trypsin inhibitor gene) three years later. An additional 83 cotton varieties, with optimized agronomic traits for various growing conditions, have been developed at IRC. Going forward, Li’s interdisciplinary team at IRC will continue searching for new cotton lines suited for the arid region of western China and for mechanized harvesting.

### The Golden Cucumber

Food crop breeding is rapidly evolving at CAAS. The focus is not only on staple foods, but also on fruits and vegetables—including Chinese favorites such as cabbage and cucumber—and new genomics-based approaches are replacing the a priori process of traditional breeding. At the frontier of this transformation is Huang Sanwen, professor at the CAAS Institute of Vegetables and Flowers (IVF). “Breeding used to be an art,” says Huang, “but we wanted to change it to a rationale-based system, using all the information available to us, including genome sequences.”

Huang studied pathogen resistance in potatoes for his Ph.D. degree at Wageningen University in the Netherlands. Since returning to CAAS in 2005, he has participated (twice in a co-leading role) in five genome sequencing projects, for the cucumber, potato, Chinese cabbage, tomato, and watermelon. He proposed to CAAS leadership that they establish the CAAS Genome



Li Zhikang



Li Fuguang

Center, which will be inaugurated in 2013. The center aims to accelerate sequencing efforts for vegetables and other food crops and to enable researchers to more accurately map genetic variants important for creating improved plant lines.

Huang is applying this new rationale-based breeding paradigm to cucumbers and to that end he has sequenced a core set of 115 lines. These projects have not only shed light on the domestication history of the cucumber, but have also revealed beneficial mutations. For example, comparative analysis of the genomes from these lines uncovered a gene mutation that causes increased accumulation of  $\beta$ -carotene in an exotic line from southwest China. “This discovery provides a path for breeding a ‘golden cucumber’ with improved nutritional value,” says Huang.

### Swine

China boasts a broad variety of animal lines, too. In fact, “China has the largest collection of swine breeds in the world,” says Li Kui of the CAAS Institute of Animal Science (IAS). “However, because most of the indigenous pigs are small and produce meat at a low efficiency,” he explains, “almost all farms now use strains imported from Europe and the United States.”

Li’s team, of four professors and more than 50 other scientists and graduate students, is working to improve the utility of pigs through molecular breeding. First, they are working to characterize the genes and pathways that control pig development and muscle growth. These findings are then used to produce new pig lines through molecular-marker-assisted breeding or a direct transgenic approach. Says Li: “One of our goals is to breed the good genes from the indigenous Chinese pigs, such as stress resistance, into the widely used Western lines.” Finally, Li’s team is generating transgenic mini-pig lines for medical uses, such as disease modeling and xenotransplantation.



Huang Sanwen



Li Kui

One of the objectives in phase two—which began in 2013—is to establish the world’s largest functional genomic databases for rice.





## Attracting and Retaining Top Talent

The mission of CAAS is to become a “world-class agricultural research institution,” taking a leading role in advancing the science and technology of agriculture in China.

As an internationally recognized institution, CAAS attracts some of the top scientists from within China and around the globe. There are currently 5,306 technical professionals at CAAS, 2,319 of whom are at a senior level. CAAS is also home to two scientists who serve as members of the Chinese Academy of Sciences and nine who serve in the Chinese Academy of Engineering. Additionally, five CAAS scientists have been elected as members of international academies, namely the U.S. National Academy of Sciences, the German National Academy of Sciences, the Belgian Royal Academy for Overseas Sciences, the Russian Academy of Agricultural Sciences, the Indian National Academy of Agricultural Sciences, and the Academy of Sciences for the Developing World.

Viewing CAAS from a governmental perspective, there are 24 national-level early and mid-career experts designated for their outstanding contribution to China’s agricultural development, as well as 947 experts who have been granted Special Government Allowances of the State Council. Further, 43 researchers have been selected for the prestigious New Century Talents Project, one has been awarded a grant from the Science Fund for Creative Research Groups set up by

the National Natural Science Foundation of China (NSFC), 14 were awarded funding from the National Science Fund for Distinguished Young Scholars from NSFC, and two won grants from the Excellent Young Scientist Fund, also from NSFC. The “Shennong Program” of the Ministry of Agriculture (MOA) has seen

fit to honor 25 CAAS scientists, while 40 CAAS scientists/research teams have been recognized for their excellent research by MOA. The National Outstanding Agricultural Talents Prize has been awarded to seven scientists, 12 have received the Chinese Youth Science & Technology Prize, and 11 have been presented with the Scientific and Technological Progress Award from the Ho Leung Ho Lee Foundation.

CAAS has a strong academic foundation with respect to postgraduate education and postdoctoral research. The academy currently offers nine postdoctoral programs and continues to increase its annual postgraduate enrollment (112 students were enrolled in 2012, with the total number of postdoctoral students exceeding 300 for the first time). The CAAS Graduate School boasts 4,268 postgraduates, 1,144 Master’s student advisors, and 462 Ph.D. student advisors.

The mission of CAAS is to become a “world-class agricultural research institution,” taking a leading role in advancing the science and technology of agriculture in China. To fulfill this goal, the development of outstanding talent, together with excellent training and team building, is of vital importance. In view of this, a series of “talent programs” will be initiated, including an Elite Youth Program (see page 49), an Overseas Intelligence Recruitment Program, and a Postdoctoral Promotion Program, which will provide a means for CAAS to increase its personnel capacity building through the recruitment and training of exceptional scientists both from China and abroad. There will be four main areas of focus for talent training and development: scientific research, technical support, technology development and transfer, and management.

To ensure the success of the above-mentioned programs, significant effort is being made to provide an attractive work environment for training and development, together with an enticing compensation package. The employment and evaluation system for CAAS employees is currently being reformed, providing the basis for developing newly structured talent programs. CAAS intends to build an engaged, vital, and modern workforce that will sustain its research goals into the future.

The 12th Five-Year Plan for Talent Team Development at CAAS states that, by 2015, the number of researchers in science and technology must increase to 7,000, or 80% of the total academy staff. To achieve this, there will be an increase of over 2,000 professionals and interdisciplinary researchers in various understaffed research areas (including basic research, new technologies, and emerging disciplines). Additionally, CAAS plans to recruit top researchers under a number of different national-level talent acquisition programs, including 10 researchers within the Recruitment Program of Global Experts (Thousand Talents Program), an additional 10 under the Recruitment Program of Foreign Experts (Thousand Foreign Experts Program), 20 under the Thousand Youth Program, as



Dr. Yu Shuxun (front) with Graduate Students

well as 100 researchers under the CAAS Elite Youth Program.

Research teams tackling high-level science and technology problems are a key element in the success of research at CAAS. With this in mind, plans are in place to create an additional 300 “innovation teams” at CAAS made up of three levels of personnel: one or two chief scientists, 10 to 15 topic experts, and eight to 10 supporting research assistants.

As the most important of the talent programs, the Elite Youth Program will be launched first, running from 2013 to 2020. After a one-year probationary period, recipients may be invited to stay on as full-

time employees—following a strict evaluation—receiving startup fund of no less than 1 million Yuan (approximately US\$161,000). Support provided includes research funds, monies for apparatus and equipment, and a housing allowance (for more information, see page 49).

CAAS will also revamp the way that the internal hierarchy is structured to create a more modern and equitable system, particularly with respect to professional titles, research discipline breakdown, and regional distribution of scientific personnel.

## The CAAS Graduate School

CAAS is committed to providing strong support for academic research and practice, particularly for graduate students. One example of this is the Graduate School of CAAS (GSCAAS), which was founded in 1979 and approved by the State Council of China in 1981 as one of the country's first Master's and doctoral degree-conferring institutions. Besides the excellent research facilities and equipment, the school has a top team of graduate advisors and a wide range of research projects for students. Coupled with stable research funding, excellent literature resources, and numerous international cooperation arrangements and exchanges, GSCAAS is regarded as a sought-after destination for up-and-coming young scientists.

Relying on 41 research institutes located in 16 provinces, municipalities, and autonomous regions across the country, graduate education at CAAS adheres to the educational philosophy of “research-based, quality-oriented, scientific education that invigorates agriculture.” The combination of the school's educational prowess with the wealth of knowledge held at the institutes provides a rich and fulfilling graduate experience for GSCAAS scholars. GSCAAS is responsible for enrollment, teaching, and granting of degrees as well as overall course management during the academic teaching period. The specific institutes take over management of the scholars during the graduate research period, until the completion of their theses.

GSCAAS awards Master's and doctoral degrees, as well as other professional degrees, to Chinese and foreign students. The scale of enrollment has increased dramatically since 2003—currently, 4,300 graduates are enrolled in the school's postgraduate program. Approximately 7,500 students have graduated from GSCAAS and are now making important contributions to China's agricultural science and technological development.

Two GSCAAS professors are members of the Chinese Academy of Sciences and nine are members of the Chinese Academy of Engineering. In total, the school has 1,144 advisors, including 462 doctoral advisors.

GSCAAS provides a wide range of graduate education options, broadly classified under agriculture, science, engineering, and management science disciplinary groups. Under these groupings, doctoral and Master's degrees are offered in 17 disciplines: crop science, horticulture, agricultural resources and the environment, plant protection, animal science, veterinary science, grass science, ecology, agricultural



International Graduate Students



Field Visit Organized by GSCAAS

and forestry economic management, biology, atmospheric science, agricultural engineering, environmental science and engineering, food science and engineering, forestry, management science and engineering, and information and documentation. Doctoral degrees are bestowed in 10 of these disciplines, within 53 subdisciplines. Master's degrees are awarded in 12 of these disciplines, within 65 subdisciplines. GSCAAS also offers two professional Master's degrees, namely Master of Agricultural Extension and Master of Veterinary Science.

GSCAAS is authorized by the Ministry of Education (MOE) to accept foreign students. It currently accommodates over 130 foreign students from 35 countries in Asia, Africa, Europe, and the Americas. Approximately 80% of the foreign students are doctoral students. More than 97% of the foreign students have received study grants from governments, institutions, and organizations at home and abroad. GSCAAS also undertakes programs for cooperative graduate education together with universities in the United States, Italy, Canada, the Netherlands, and Belgium.

In 1999, GSCAAS was honored with the title of National Outstanding Organization for Academic Degrees and Graduate Education Management awarded by MOE and the Academic Degrees Committee of the State Council. It was also more recently (2008) named as an Outstanding Organization for Academic Degrees and Graduate Education Management by the Beijing Government. The exemplary performance of the school has resulted in it being ranked as China's top graduate school in agricultural science each year since 2002 as well as being ranked in the top 30 graduate schools nationally.

Embodying its motto of “wisdom, virtue, erudition, and discretion,” GSCAAS has grown into an exceptional, internationally renowned base for cultivating and fostering outstanding scientists in the agricultural fields and for pursuing high-level, research-based, international graduate education.



# Connecting CAAS with Global Communities

As part of its strategy for becoming a world-class agricultural research institution, CAAS is broadening its global presence by nurturing a network of international collaborations. Six specific examples of such efforts at the research institute level are detailed below. These projects represent the extensive scope and geographical diversity of international cooperation at CAAS.



Gong Xifeng

## Brazil-China Joint Laboratory

Brazil and China have much in common—both are facing similar population, resource, and environmental challenges and both belong to the BRICS (Brazil, Russia, India, China, and South Africa) quintet of emerging economies.

One of the key areas identified for cooperation between these nations is agriculture. In 2010, CAAS and the Brazilian Agricultural Research Corporation (*Empresa Brasileira de Pesquisa Agropecuária, EMBRAPA*) entered into an agreement to facilitate cooperation in four areas: biotechnology, renewable energy, genetic resource sharing, and personnel exchange. A Brazilian laboratory (Labex China) was opened at the CAAS headquarters in April 2011, and CAAS did the same at EMBRAPA in August 2012. This was the first official joint agricultural research laboratory that China had ever set up abroad.

"Brazil has a well-developed biotechnology industry and rich biodiversity resources," says Gong Xifeng, deputy director general of the Department of International Cooperation at CAAS. And in

return, Chinese researchers bring their knowledge and expertise of breeding and other agricultural technologies—tailored to use in small plots in developing countries—to the collaboration. "This cooperation is expected to be complementary and mutually beneficial," Gong says. Though it is still early there is already much excitement for future collaborations that will bring increased cooperation for the development of crop plants and livestock products. "We look forward to boosting the impact scientists have in both countries, to creating a number of flagship projects, and to expanding the cooperation to other Latin American partners," explains Gong.

## Joining the Global Food Security Network

China is the world's leading agricultural producer and consumer of many staple foods. To ensure glob-

al food security, there is therefore an urgent need to synchronize the agro-economic metrics from China with the rest of the world. "FAO [Food and Agricultural Organization of the United Nations] sees the focus of global food security shifting to Asia and supports China's endeavor to join the FAO Technical Cooperation Program [TCP]," explains Xu Shiwei, director general of the CAAS's Agricultural Information Institute. "Accurate agricultural market data from China is essential to the predictability of the FAO model," says Xu.

This FAO-TCP cooperation with CAAS began in 2011, with the first phase focused on training and exchange of statistical methodologies used by FAO and China. This was followed by a second phase that involved learning the medium-term projection model (Aglink-Cosimo), jointly developed by FAO and the Organization for Economic Cooperation and Development, and the building of a Chinese sub-model into the framework. This year, more workshops are being held on the use of short-term market monitoring and early-warning indicators as well as long-term projection methods. "Through these cooperative activities, we have made significant progress in connecting China's own Chinese Agricultural Monitoring and Early-Warning System with the FAO system," says Xu. Going forward, Xu sees some areas where China is still behind the curve, including making historical data compatible with the FAO model and improving data cleanup. The ultimate goal is to ensure food security in China and around the world.

## Cooperating for Sustainable Agriculture

China is becoming increasingly aware of the need to control for environmental damage that results from demanding agricultural practices. "China only owns 9% of the world's arable land and 6% of the world's fresh water resources; yet, we are producing 21% of the world's grains, using 34% of the fertilizer, 40% of chemical pesticides, and consuming 30% of the world's animal protein output," says Mei Xurong, director general of the CAAS Institute of Environment and Sustainable Development in Agriculture. "China can learn from Japan's experience and avoid making the same mistakes," says Mei. With limited land and a high population density, Japan has extensive experience dealing with environmental problems resulting from intensive agricultural development, and it has good reason to share its experience with China since environmental damage can easily spread across borders.

The R&D Program for China's Sustainable Agriculture, jointly sponsored by the Chinese and the Japanese governments, launched in 2002. For the first five years, the focus was to transfer sustainable practices for rice, wheat, and soybeans to



Xu Shiwei



Mei Xurong

China; new varieties and technologies were developed and successfully adopted by Chinese farmers. The ongoing second phase, from 2009 to 2014, emphasizes the management of surface pollution and agricultural waste. More than 90 scientists, from 20 agricultural science institutes in both countries, are now working at multiple sites in China to help the country promote sustainable agriculture.

### Cooperating for Plant Protection

Like pollution, agricultural runoff, plant pathogens, and pests are not restricted by international borders. Each year, seasonal winds blow insect pests up and down the Mekong River valley between China and its neighbors in Southeast Asia. In 2008, guided by the principle of 'South-South Cooperation' between developing countries, the Chinese Ministry of Agriculture (MOA) began a program of cooperation with the CABI, an international, non-profit organization with roots in scientific publishing, applied research, and agricultural development in both developing and developed countries around the world.

The Institute of Plant Protection (IPP) at CAAS is responsible for leading the program of cooperation through the MOA-CABI Joint Laboratory for Biosafety and there are currently five ongoing projects in southwest China, Laos, Myanmar, the Democratic People's Republic of Korea, Afghanistan, and Mongolia. "We receive financial support from the European Union [EU] for two of the projects, which promote the export of our plant protection technologies to Laos and Myanmar," says Chen Julian, director of the International Cooperation Department at IPP. The projects for maize and rice receive €2.5 million (US\$3.3 million) and €1.8 million (US\$2.4 million) in support from the EU, respectively. In 2012, Ulrich Kuhlmann, CABI chief of the joint laboratory, received a special 'Friendship Award' from the Chinese government to signify the success of the cooperation.

### HarvestPlus-China

Launched in 2004, HarvestPlus is an international non-profit program that combats micronutrient deficiency in developing countries through bio-fortification—fortifying food crops by breeding or transgenic technology—as opposed to the more common method of adding micronutrients to processed food products. In 2005, Fan Yunliu, academician and professor at CAAS and a pioneer in the field of biotechnology in China initiated a local program called HarvestPlus-China (HPC) to fight the micronutrient deficiency problem in rural areas of the country.

In the proof-of-concept phase (2005–2009), HPC successfully developed a number of new rice, wheat, maize, and sweet potato varieties rich in iron, zinc, and vitamin A. "HarvestPlus is an integrated research program that brings together conventional crop breeders, nutritionists, genetic engineers, and other experts to solve a common problem," says Zhang Chunyi, deputy director general at the CAAS Biotechnology Research Institute and deputy director of HPC. "For researchers participating in HPC, there are auxiliary benefits, including increased scientific output and experience with interdisciplinary collaboration," says Zhang.

Since 2009, HPC has selected 16 additional lines with high micronutrient content; four have been approved for dissemination to poor rural regions across China. Says

Zhang: "The next goal is to improve the quality of these bio-fortified lines. Despite preliminary successes with HPC, more governmental support is needed to continue to improve the health status and quality of life of the Chinese population, especially the poor."

### International Biogas Training Course

Biogas technology is another example of how China can serve as a critical intermediate for technology transfer from developed countries to the third world. "Large biogas plant and biofuel production are well developed in the West; however, the advanced equipment and fermentation processes used are not fully compatible with the present state of biogas development in China and other developing nations," explains Li Qian, director general of the Biogas Institute of the Ministry of Agriculture (BIOMA) in Chengdu, Sichuan Province.

Working with villages and households over the years, BIOMA has adjusted the biogas production systems to meet the special requirements of small-scale production in rural settings. The adjustments include building innovative facilities and equipment, using different waste treatment methods, and developing special microorganism species suitable for small-scale biogas production.

Since 1981, BIOMA has organized 52 international training courses on biogas technology. To date, more than 1,200 trainees have passed through the course. "Many of our trainees come to play a leading role in bioenergy in their countries," says Li. He adds that "it is always a wonderful experience to run into our participants at major, international conferences on agriculture and renewable energy, as it demonstrates the success of these programs at improving biogas technology in developing countries."



Chen Julian



Li Qian

China is the world's leading agricultural producer and consumer of many staple foods.



Zhang Chunyi



# International Cooperation at CAAS



**Memorandum of Understanding Signing Ceremony between CAAS and Agriculture and Agri-Food Canada**

Through increased international collaboration, CAAS has become more community minded, placing greater emphasis on reducing poverty and increasing food security in China and around the world.

CAAS is a nationally and internationally recognized institution that offers an abundance of international collaborative learning and research opportunities in the field of agricultural science and technology innovation. Over the past five decades, CAAS has led or been involved in an increasing number of collaborative projects, enabled by significant increases in funding from various governmental and international resources. Since the start of China's 11th Five-Year Plan in 2006, more than 830 joint projects have been funded, totaling over to 634 million Yuan (US\$102 million).

Collaboration areas that have seen the most growth include crop and animal sciences, agricultural biotechnology, agricultural information, agricultural resources and environment, and food quality and safety. The number of research partners continues to increase annually. CAAS currently boasts partnerships with 81 countries, 33 international organizations, seven multinational companies as well as many non-governmental organizations and research foundations. To date, CAAS has signed more than 70 agreements or memorandums of understanding with international partners. Collaborative research exchanges continue to be established, with 13 foreign institutions having set up liaison offices at CAAS in addition to the 27 joint laboratories and research centers. Scientific exchange is strongly encouraged and promoted at CAAS, which has led to thousands of exchange visits between CAAS and foreign scientists, who develop joint research projects, attend scientific meetings and forums, and engage in reciprocal training.

International cooperation has contributed significantly to science and technol-

ogy innovation at CAAS, providing direct and indirect benefits to China's agricultural development. Through cooperative exchanges, genetic resources have been improved, novel technologies have been shared, and scientific knowledge has been greatly enhanced. Additionally, a large number of personnel in both research and management have developed important new skills through collaborative training opportunities, providing significant economic and social benefits to the country.

Through increased international collaboration, CAAS has become more community minded, placing greater emphasis on reducing poverty and increasing food security in China and around the world. Some specific examples include:

- Proactively organizing international events, such as the Global Forum of Leaders for Agricultural Science and Technology (GLAST), cosponsored by CAAS, the Food and Agriculture Organization of the United Nations (FAO), and the Consultative Group on International Agricultural Research (CGIAR). This event has been held three times in China, in 2006, 2007, and 2010, with great success. The GLAST meetings have catalyzed action through the sharing of information and experience, promoting partnerships between national agricultural research institutions in China as well as with foreign agricultural research institutions and international organizations.
- Voluntarily providing technical assistance to developing countries. CAAS has been actively involved in "South-South," trilateral, and multilateral cooperation to introduce advanced agricultural technologies to developing countries in Africa, Latin America, and South Asia. For example, since the 1980s, 52 international biogas training courses have been organized by the CAAS Biogas Institute both inside and outside China, and more than 1,200 people around the world have been trained.
- Intensively participating in global initiatives, such as CGIAR Research Programs, the European Union Framework Programmes and EuropeAid projects, the G20 Action Plan in Agriculture, and the Tropical Agricultural Platform, in which CAAS has played important roles in implementation and management.

International cooperation continues to be of vital importance to the development of the academy, and forms one of the core principles of the newly initiated Agricultural Science and Technology Innovation Program (see page 7). This program will assist CAAS in reaching its primary strategic development goal of being a world-class agricultural research institution.

## The CAAS Institutes

CAAS, headquartered in Beijing, has 41 institutes, of which 14 are located in Beijing and the rest distributed in 16 provinces across the country. Thirty-two of the institutes are direct affiliates, while the remaining nine are co-hosted together with local governments or universities. A graduate school and a publishing house are also located in the CAAS headquarters, together with the administrative departments, including the General Office, and the departments of Research Management, Human Resources, Finance, Capital Construction, International Cooperation, Technology Transfer, and Supervision and Auditing, amongst others. In this section, the 32 directly affiliated institutes are briefly described.

### Institute of Crop Sciences

With the goal of resolving basic, critical, and prospective key problems for the development of crop science and technology, the Institute of Crop Sciences (ICS)

focuses on germplasm resource investigation, gene discovery, breeding of new varieties, and crop cultivation. The major directions of the institute are collection, conservation, evaluation, and utilization of crop germplasm resources, as well as driving new germplasm and material innovations. In addition, ICS researchers investigate the genetics and breeding of *japonica* rice, wheat, corn, soybean, and coarse cereal; crop gene discovery and utilization; functional gene evaluation and utilization; molecular breeding; crop bioinformatics; crop cultivation and physiology; tillage and ecology; informatization of production; and grain quality and risk evaluation.

The scientific research premises encompass 70,000 m<sup>2</sup>, which includes a 10,000 m<sup>2</sup> automated greenhouse and a 1,000 m<sup>2</sup> automated drought-resistance identification facility. The pilot station system, which emulates the major ecological zones in China, covers an area of 300 hectares.

ICS's research units include the Crop Germplasm Resource Protection and Research Center, the Crop Genetics and Breeding Department, the Crop Molecular Biology Department, and the Crop Cultivation and Physiology Department.

A number of research facilities are available at ICS, including the National Gene Bank; the National Key Facility for Crop Gene Resources and Genetic Improvement; the National Engineering Laboratory of Crop Molecular Breeding; the National Plant Transgenic Technology Research Center; the National Wheat Improvement Center; the Key Laboratory of the Ministry of Agriculture (MOA) for Crop Genetic Resources and Germplasm Innovation; the Quality Supervision, Inspection, and Testing Cen-



ter of MOA for Grain; and the Key Laboratory of MOA for Wheat Biology and Genetic Breeding.

ICS has built preliminary technology platforms for high throughput genomics, proteomics, and cytomics, and has established

phenotype identification facilities to test crop resistance to disease, insects, and abiotic stress.

Since 2003, ICS has built the national crop germplasm resource protection and utilization system to safely house all 420,000 crop germplasm resources. Moreover, the establishment of genetic resources and a gene modification science and technology platform has led to the discovery of 1,200 genes that can be manipulated to improve crops. Through the ICS conventional and molecular breeding technology systems, ICS researchers have produced 960 new elite and multi-resistant breeding materials and have released 105 new crop varieties. In addition, ICS has developed high-yield and high-efficient cultivation technologies.

**Contact:** Zhang Hui (zhanghui06@caas.cn)

### The Institute of Plant Protection

The Institute of Plant Protection (IPP) is a national non-profit scientific research institute that specializes in crop pest research, prevention, and control. IPP has 10 departments, including plant pathology, agricultural entomology, pesticide science, molecular plant pathology, pest natural enemies, monitoring and forecasting of plant disease and insect pests, biological invasion, biological pesticides, weed and rodent science, and functional genomics and gene safety. IPP is also the host institute for the China Society of Plant Protection and the China Plant Protection Herbarium. In addition, IPP is responsible for editing and publishing two academic journals entitled the *Chinese Journal of Biological Control* and *Plant Protection*.

Based on the developing trends in international plant protection, on

#### ABBREVIATIONS USED:

MOA - Ministry of Agriculture  
MOE - Ministry of Education  
MOST - Ministry of Science and Technology  
OIE - World Organisation for Animal Health  
FAO - Food and Agriculture Organization of the United Nations





China's agricultural production needs, and on which areas of research have garnering the most interest worldwide, IPP has identified five major disciplines: plant diseases (fungal diseases, bacterial diseases, viral diseases, and nematodes); plant pests (food crop pests, cash crop pests, and natural enemy insects); pesticides (chemical pesticides and biological pesticides); weeds and rodents (farmland weeds and farmland rodents); and crop biosafety (prevention and control of alien invasive species and genetically modified organism safety).

IPP has robust research facilities. It has several national or ministerial key laboratories; including the State Key Laboratory for the Biology of Plant Diseases and Insect Pests; the National Agricultural Biological Security Science Center; the Key Laboratory of MOA for Crop Integrated Pest Management; the Management of Alien Invasive Species Center of MOA, the Supervision, Inspection, and Testing Center of MOA for Environmental Safety of Transgenic Crops; the Supervision, Inspection, and Testing Center of MOA for Disease and Insect Pest Resistance in Plants; the MOA-CABI Joint Laboratory for Biosafety; and the Sino-American Biological Control Laboratory as well as eight field stations around the country.

For many years, IPP has actively encouraged multidisciplinary coordination by hosting and undertaking large, national and international plant protection science and research projects. Together, IPP researchers have published more than 100 books and 4,000 scientific research papers and have won more than 270 scientific research awards.

**Contact: Chen Julian (jlchen@ippcaas.cn)**

## Institute of Vegetables and Flowers

The Institute of Vegetables and Flowers (IVF) is the only national non-profit research institute devoted to the application of basic research for the developmental demands of the vegetable and flower industry, and its related disciplines, in China.

The institute focuses on three broad disciplinary clusters: horticulture; agricultural resources and environment; and agro-product quality, safety, and processing. In addition, IVF covers six fields within these disciplines: vegetable germplasm and breeding, vegetable molecular biology, vegetable cultivation and physiological ecology, flower germplasm and breeding, integrated vegetable pest management, and vegetable quality and safety.

The institute's scientific and research premises encompass a total of 18,000 m<sup>2</sup>, with six pilot farms located across 79 hectares (of which

100,000 m<sup>2</sup> are protected cultivation). IVF also owns a national medium-term vegetable gene bank, which holds 38,500 accessions.

IVF now has a number of research facilities, including: the National Vegetable Improvement Center; the National Engineering Laboratory for Crop Cell Breeding; the Key Laboratory of MOA for Horticultural Crop Biology and Germplasm Innovation; the Key Laboratory of MOA for Tuberous Crop Biology and Genetic Breeding; the Risk Evaluation Laboratory of MOA for Vegetable Quality and Safety (Beijing); the Vegetable and Flowers Sub-Center of the National Comprehensive Agricultural Engineering Research Center (Changping); and the Quality Supervision, Inspection, and Testing Center of MOA for Vegetables (Beijing).

IVF has coordinated and participated in a great number of national, provincial, and ministerial scientific research projects and has developed more than 200 new vegetable varieties. Further, IVF researchers have created many practical production technologies, which have promoted the development of the vegetable and flower industry in China. By 2011, IVF scientists had won over 170 science and technology achievement awards, of which 16 were national prizes. The institute has also initiated and finished genome sequencing projects for cucumber, potato, and Chinese cabbage, which have been published in *Nature* and *Nature Genetics*, journals that impact research worldwide.

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## Institute of Environment and Sustainable Development in Agriculture

The Institute of Environment and Sustainable Development in Agriculture (IEDA) is a non-profit organization that, through scientific discovery and technical innovation, aims to maintain and restore the health of the agricultural environment and reinforce the sustainability



**State Key Laboratory for Animal Nutrition Sciences, IAS**

of agricultural development in China. IEDA carries out mission-oriented research in response to emerging challenges such as climate change, frequent meteorological disasters, water scarcity, and a degraded agro-ecosystem. IEDA has built up a 60-year history of excellence in research, training, consulting, and outreach programs.

IEDA's research covers five main disciplines: agro-meteorology (climate change and climate resource utilization, agricultural responses to climate change and carbon sequestration, and agriculture disaster prevention and mitigation); dryland and water-efficient agriculture (biological mechanisms for reducing water use, dryland agriculture, and optimized management of regional water resources); agro-environmental control and restoration (agricultural stereoscopic pollution control, clean production, and ecological restoration of degraded environments); agro-environmental engineering (animal environment facilities and engineering, and protected horticulture); and nano-agriculture technology (multifunctional nanomaterials and their application in agriculture).

IEDA has developed excellent facilities for science and technology innovation as well as technology transfer. The institute has two national centers—the China-Japan Research and Development Center for Agricultural Technology, and the National Engineering Laboratory for Crop High Efficient Water Use and Disaster Mitigation—as well as six ministerial laboratories including the Key Laboratory of MOA for Agro-Environment, the Key Laboratory of MOA for Dryland Agriculture, and the Key Laboratory of MOA for Energy Conservation and Waste Management of Agricultural Structures. In addition, the institute has a number of international cooperation laboratories, such as the Sino-U.S. Agricultural Environment Center, and nine academic observation and experimental field stations in locations such as Naqu County, Tibet, and Shunyi District, Beijing are also affiliated with IEDA.

Since the initiation of the national 11th Five-Year Plan, IEDA has hosted and undertaken more than 400 science and technology projects with grant funding totaling 480 million Yuan (US\$77.2 million). The institution holds 121 patents (42 patents specifically for inventions) and has extensively promoted the development of agro-environment-related disciplines.

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## Institute of Animal Sciences

The Institute of Animal Sciences (IAS) is a national comprehensive science and research institute for animal and veterinary science. The

editorial offices of two national academic journals are affiliated with IAS, namely the *Chinese Journal of Animal and Veterinary Sciences* and *China Animal Husbandry and Veterinary Medicine* (formerly *Animal Science Abroad*).

With research focuses on swine, poultry, cattle, and sheep, IAS is dedicated to studying a wide range of issues pertinent to the entire country. The institute aims to study and solve major issues related to animal husbandry in China and to organize collaborative efforts among national programs. Moreover, IAS is committed to promoting its science and technology achievements, advancing scientific technologies, fostering high-level talent, and carrying out academic collaborations in China and abroad. IAS has six set scientific disciplines, namely animal nutrition and feed science, animal biotechnology and propagation, animal genetic resources and breeding, pratacultural (grassland) science, veterinary medicine, and quality and safety of animal products.

IAS has a number of research facilities, including the State Key Laboratory for Animal Nutrition Science; the Key Laboratory of MOA for Animal Nutrition and Feed Science; the Animal Husbandry Sub-Center of the National Comprehensive Agricultural Engineering Research Center (Changping); the Quality Supervision, Inspection, and Testing Center of MOA for Milk and Dairy Products (Beijing); and the Supervision, Inspection, and Testing Center of MOA for Transgenic Animal and Feed Safety (Beijing). The institute also encompasses four experimental field stations, which are located in Beijing, Inner Mongolia, and Hebei.

Since its establishment over 50 years ago, IAS has undertaken nearly 1,000 research projects and has received 226 science and research achievements, of which 116 have been awarded at the national and provincial level. IAS has developed 22 new breeds and cultivars, registered 57 software copyrights, and holds 89 patents (54 of which are specifically related to inventions).

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## Bee Research Institute

The Bee Research Institute (BRI) is the national comprehensive research institute in China for apicultural science. The institute is dedicated to applied and basic research and explores the application of new technologies to apicultural science. BRI aims to improve the economic and social benefits of apiculture, and to promote the modernization of apiculture science and technology. It comprises several laboratories that are dedicated to bee resources and genetic breeding; bee pathology and biosafety; beekeeping and biotechnology; insect pollination and ecology; quality, safety, and evaluation of bee products; and apiculture economy management and information. The editorial office for the scientific journal *Apiculture of China* is located in the institute. The Apicultural Science Association of China is also affiliated with BRI.

BRI's research covers all aspects of apicultural science, including insect pollination and ecology, pollinator biology, bee product processing, and bee product quality and safety. The institute has seven research laboratories, including the Key Laboratory of MOA for Pollinator Biology; the Quality Supervision, Inspection, and Testing Center of MOA for Bee





**Bee Research Institute**

Products (Beijing); the Risk Evaluation Laboratory for Bee Product Quality and Safety (Beijing); the National Apiculture Technology Research and Development Center; the National Bee Germplasm Resource Conservation Center; and the Key Laboratory of CAAS for Pollinator Biology.

BRI has been presented with 97 scientific achievement awards, including 69 at the national and provincial level. It has also been awarded 53 patents.

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## Feed Research Institute

The Feed Research Institute (FRI) is a national research institute devoted to feed sciences with a focus on feed resource development and utilization, feed and animal product safety, ecological environment safety, and animal product quality. Researchers at FRI investigate all facets of the feed industry, but mainly focus on feed biotechnology, biochemical engineering and extraction, animal nutrition and feed science, feed processing technology, feed testing and safety evaluation, and feed economy and information.

FRI has developed many high-tech products with independent intellectual property rights and actively promotes new scientific technologies in its main research areas. It has established a research and development platform for feed enzymes and has developed environmentally friendly feed additives. Moreover, the institute has made cutting-edge breakthroughs in calf and lamb early weaning technology, technology for healthy feeding of egg layers and more efficient egg production, the efficient use of alternative protein ingredients in aquatic feeds, healthy feeding technology for broilers, and starter feed formulation technology. Researchers have also made significant progress in aquatic animal micro-diet feed manufacturing, feed processing code, and quality tracing systems as well as early warning and rapid testing technology for animal feed quality.

The institute has more than 10 national or ministerial scientific technology innovation laboratories, including the National Engineering Research Center of Bio-Feed Development and the National Feed Engineering Technology Research Center. FRI is the leading institute for the National Feed Industry Technology Innovation Strategic Alliance. FRI has a pilot base in a suburb of Beijing which covers an area of nearly 6.6 hectares.

FRI has received four national and 27 provincial/ministerial awards. The institute has also developed three new national class-II veterinary drugs and holds over 80 patents. In addition, FRI researchers have pub-



**National Base for Safety Evaluation of Aquatic Feed, FRI**

lished more than 230 papers that are listed in the Science Citation Index, and have published 80 books.

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## Institute of Agro-Products Processing Science and Technology

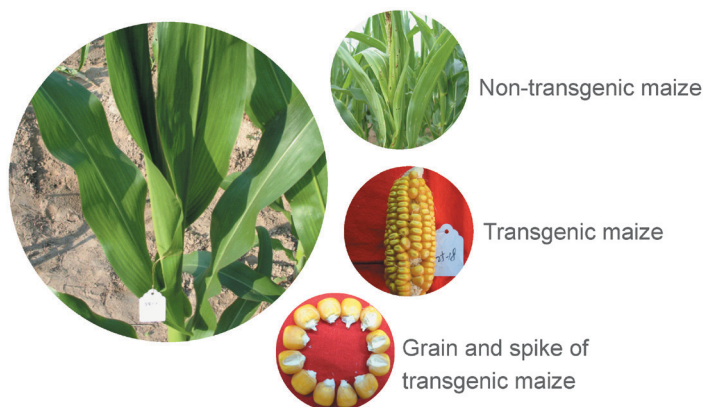
The Institute of Agro-Products Processing Science and Technology (IAPPST) is the only national non-profit scientific research institute in the field of agro-products processing science and technology. IAPPST is devoted to solving critical science- and technology-related issues to support the agro-products processing industry. With 127 employees, IAPPST conducts basic and applied research to develop new technology and novel products.

At IAPPST, the main scientific disciplines include agro-products processing, preservation and logistics, quality and biosafety, nutrition and health, and functional foods. IAPPST has seven research departments related to these disciplines and three science and research laboratories at the ministerial level, including the Key Laboratory of MOA for Agro-Products Processing, the National Pilot Plant of MOA on Agro-Products Processing, and the National Risk Assessment Laboratory of MOA for Agro-Products Processing, Quality, and Safety. In addition, the institute has established seven international joint laboratories with institutions from Argentina, the United States, Canada, the United Kingdom, Germany, Italy, and Japan.

Since the initiation of the national 12th Five-Year Plan, IAPPST has



**Institute of Agro-Products Processing Science and Technology**



### Transgenic Insect-Resistant Maize, BRI

been involved in more than 180 science and technology projects and received research funding totaling 180 million Yuan (US\$29 million). IAPPST researchers have accepted more than 50 awards at the provincial or ministerial level and have been granted 56 patents. Moreover, IAPPST scientists have published 685 articles (87 of which were in Science Citation Index journals) and have been involved in the editing of over 60 books.

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## Biotechnology Research Institute

The Biotechnology Research Institute (BRI) is a unique, public, national non-profit institution focusing on basic and applied research for agro-biotechnology in China. BRI comprises a relatively young and robust scientific community. The institute houses the Chinese Society for Agricultural Biotechnology (CSAB), as well as an editorial office for two major journal publications, the *Journal of Agricultural Science and Technology* and *Current Biotechnology*.

The institute's mission is to address fundamental questions in agricultural biotechnology and meet strategic needs that enable the sustainable development of agriculture throughout the country. BRI's strategy targets research frontiers in the life sciences and biotechnology, and focuses on improving crop productivity and quality as well as integrating plant metabolic and microbial enzymatic engineering. Researchers investigate crop functional genomics, crop proteomes, crop nutrition and metabolism, bioreactor techniques, crop biotech breeding, agricultural microbes, and animal engineering products.

BRI has six productive research departments, focusing on crop genomics and genetic improvement, plant molecular biology, crop molecular breeding, microbial enzyme engineering, special microbial resources, and the biosafety of agricultural genetically modified

organisms. Several research facilities are also affiliated with the institute, such as the Key Laboratory of MOA for Agricultural Genomics (Beijing) and the Supervision, Inspection, and Testing Center of MOA for Environment Risk Assessment of Genetically Modified Plant-Related Microorganisms (Beijing). In addition, the Beijing Key Laboratory for Agricultural Gene Resource and Biotechnology is being built in collaboration with the Beijing Agro-Biotechnology Research Center.

Between 2006 and 2012, BRI researchers received more than 220 major grants from various funding agencies, including MOA, the Ministry of Science and Technology (MOST), the National Natural Science Foundation of China (NSFC) as well as international organizations and collaborative partners. Scientists within the institute have published more than 800 papers and 20 books, and have patented over 100 inventions. Among BRI's remarkable achievements are the development of transgenic Bt cotton and transgenic phytase corn—two key agricultural biotechnology accomplishments that have helped industrialization development throughout China.

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## Institute of Agricultural Economics and Development

The Institute of Agricultural Economics and Development (IAED) has several research divisions, covering modern agriculture, agricultural resources, environmental economics, agro-technical economics, agricultural policy, agriculture industrial economics of farming and animal husbandry, rural development, and international agricultural economics and trade.

Based on the demands of the agricultural industry in China, and on the analysis of cutting-edge and international agricultural economics research, IAED has dedicated its research focus to the following four disciplinary fields: industrial economics and policy (economics and policy on crop production and livestock), technical economics and policy (technological economics, science and technology policy, and modern agriculture development), agro-products market and trade (domestic agro-product market and circulation, foreign agricultural economics, and international trade), and rural development and policy (new countryside development and poverty reduction, rural finance and banking, and rural resource and environmental policy).

IAED has built the Open Laboratory of National Agricultural Policy Analysis and Decision Support System in order to conduct cutting-edge research on domestic and foreign agricultural economics and science and technology policy, to carry out agricultural policy analysis and provide policy advice to the government, to attract and cultivate high-level talent, and to promote academic exchanges.

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Books and Journals Published by IAED



## Institute of Agricultural Resources and Regional Planning

The Institute of Agricultural Resources and Regional Planning (IARRP) is a non-profit national agricultural science and technology institute that focuses on finding ways to efficiently use agricultural resources, and on advancing regional agricultural development. IARRP comprises 13 departments carrying out research on a broad range of topics, namely plant nutrition, fertilizers, remote sensing and digital agriculture, soil sciences, agricultural microbiology, agricultural water resources, modern farming systems, agricultural ecology and environment, grassland sciences, resources management and utilization, agricultural allocation and regional development, edible mushrooms, and agricultural information technology. IARRP is also the host institute for the Chinese Plant Nutrition and Fertilizer Society and the China Society of Agricultural Resources and Regional Planning.

The research facilities at IARRP play an important role in facilitating institutional development. These include the National Engineering Laboratory for Improving Quality of Arable Land, the Key Laboratory of MOA for Plant Nutrition and Fertilizer, the Key Laboratory of MOA for Agro-Informatics, the Key Laboratory of MOA for Nonpoint Source Pollution Control, and the Key Laboratory of MOA for Microbial Resources. IARRP has also established three national and six ministerial pilot experiment sites, including the Qiyang Red Soil Experimental Station, the National Hulunber Grassland Ecosystem Observation and Research Station, and the National Soil Fertility and Fertilizer Efficiency Long-Term Monitoring Network.

IARRP researchers have overseen many outstanding scientific and technological achievements, such as the design of sustainable, highly efficient fertilization theories, methods, and technologies as well as significant breakthroughs in understanding the nutrition needs of major crops. Moreover, IARRP scientists have developed a national monitoring system for crop growth that integrates remote sensing information, field observation data, and wireless sensor networks. The system has been used by the Group on Earth Observations (GEO) as a prime example of global- to regional-agricultural monitoring systems. In addition, IARRP scientists have systematically described the evolutionary features of dry land fertility in red soil regions and elucidated that decreases in acidification and organic matter are major indicators of dry land degradation, and

that the overuse of fertilizer, especially nitrogenous fertilizer, is a major cause of soil acidification. Based on their observations, scientists have systematically developed theories and methodologies for agricultural regional planning and development.

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**Information Platform of Agricultural Technology Extension, All**

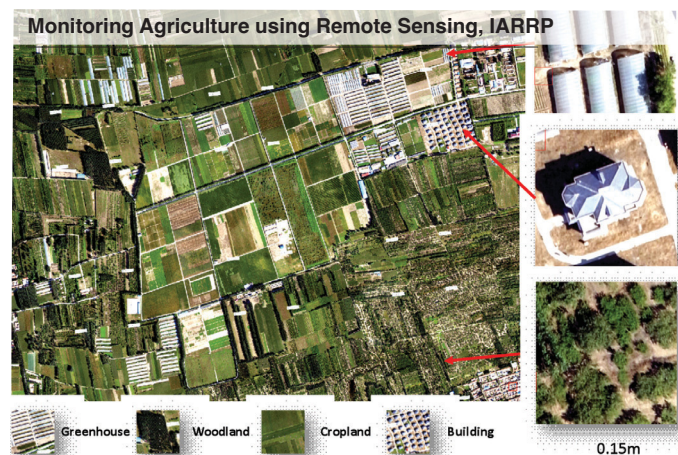
## Agricultural Information Institute

The Agricultural Information Institute (All) is a national research institution with a mission to advance scientific innovation in the field of agricultural information and to provide agricultural science and technology information services nationwide. All is also the national agricultural science and technology documentation center, and houses the National Agricultural Library. This library maintains a collection of 2.1 million books and journals. All itself publishes 13 periodical titles.

The Key Laboratory of MOA for Agricultural Information Service Technology and two field observation stations, the Field Science Observation Station for Information Agriculture and the Field Science Observation Station for Digital Document Information Service Systems, are affiliated with All. Additionally, the institute contains the National Agricultural Science Data Sharing Center. All has also built collaborative research partnerships with more than 40 foreign institutions and international organizations.

All has 20 divisions which are all part of the disciplinary cluster on Agricultural Information and Economics. The three major scientific research fields are the application of information and communication technology (ICT) to agriculture, agricultural information management, and agricultural information analysis. The primary research focuses at All include: agricultural information resource building, information organization and digital library technology, agricultural knowledge management and services, agricultural data acquisition and virtual technology, digitalization technology of agricultural production management, agricultural intelligent control technology, agricultural information services technology, agricultural information monitoring and early warning systems, agricultural risk analysis, and food security decision simulation.

Since its establishment, All has received over 80 national- and provincial/ministerial-level research awards in the areas of ICT application,



information management, information services, digital libraries, information research, and agricultural macro-strategy research.

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## Institute of Quality Standards and Testing Technology for Agro-Products

The Institute of Quality Standards and Testing Technology for Agro-Products (IQSTAP) is the only national scientific institution in China engaged in agro-products quality and safety research. There are seven research divisions which emphasize testing technology, risk analysis, standards, policy, and information about the quality and safety of fruits, vegetables, grains, oils, meats, dairy, and feed products.

IQSTAP covers four main research fields: testing technology, risk assessment, traceability and authenticity identification, and management systems for agro-product quality and safety. Some of the major research projects focus on advances in rapid sample pretreatment technologies, pesticides and pesticide residue analysis, testing technologies for veterinary residues and illegal drugs, environmental and persistent contaminants analysis, traceability and authentication for agro-products, risk monitoring and assessment for quality and safety of agro-products, and agricultural standards and reference materials.

Several research facilities are affiliated with IQSTAP, including the Key Laboratory of MOA for Agro-Product Quality and Safety, the National Feed Quality Control Center (Beijing), and the Key Open Laboratory for Agro-Product Quality and Food Safety. The laboratory space covers nearly 10,000 m<sup>2</sup> and contains over 450 pieces of state-of-the-art equipment that are actively used for scientific studies.

IQSTAP has made significant breakthroughs in areas such as inspection and testing technologies for pesticides, veterinary drugs, biotoxins, heavy metals, feed and feed additives, and in sample pretreatment technology research. The institute's scientists have formulated and amended over 30 national or ministerial food product standards and have been granted a total of 11 national patents for inventions, as well as 13 software copyrights.

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## Institute of Food and Nutrition Development, Ministry of Agriculture

The recently established Institute of Food and Nutrition Development (IFND) of MOA serves as both the research laboratory and as the head office for the State Food and Nutrition Consultant Committee (SFNCC). The institute provides assistance for safeguarding the national food supply; optimizing the components of a balanced diet; improving nutrition; coordinating the oversight of food production, consumption, and nutrition; and improving the quality and healthfulness of China's food supply.

IFND makes recommendations to policymakers based on the study of food and nutrition development theories, methods, policies, and strategies as well as conducts research on the food quantity security system,



**Sampling, IQSTAP**

food quality security system, and the nutrition improvement system. In addition, the IFND has commissioned and organized the publication of *Outline of National Food and Nutrition Development* and also tracks the program's progress in order to drive its implementation. The institute carries out the mandates from and the day-to-day work issued by SFNCC and mobilizes experts in relevant fields to conduct research on important issues. Moreover, the institute organizes and participates in important global activities focused on regional food security and nutrition, and is actively participating in the formation of the international information network and organization of academic exchanges and collaborations. In addition to the cultivation of high-level talent, including postgraduate students and postdoctoral researchers, the institute compiles and publishes food and nutrition briefs and research findings on food safety, nutrition, and health.

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## The Farmland Irrigation Research Institute

The Farmland Irrigation Research Institute (FIRI) is committed to applied and basic research in and developing new technologies for farmland irrigation and drainage. The four disciplinary areas within the institute are the efficient use of water for crops, the safe and sustainable use of agricultural water resources, irrigation technology and engineering, and farmland drainage technology and engineering.

The research laboratories and facilities at FIRI include an experimental field station for crop-water interaction research, a hydraulic laboratory to test sprinkler and microirrigation systems, a lysimeter station, and two comprehensive experimental stations in Shangqiu and Xinxiang. Further-



**Field Test of Sprinkler Irrigation Machine, FIRI**





more, FIRI hosts the National Scientific Observation Station of Farmland Ecosystem of MOST in Shangqiu and the Key Laboratory of MOA for Crop Water Requirement and Regulation.

FIRI is authorized by the Ministry of Water Resources as a national center for irrigation and drainage research and as a test center for water-saving irrigation equipment. In addition, FIRI houses the National Sprinkler Irrigation Information Association, the National Groundwater Resources Information Association, and the National Irrigation Experiment Information Association.

FIRI is one of the first institutes to research water-efficient technology and equipment development in China and has made pioneering contributions to the standardization and universalization of China's water-efficient irrigation products. The two works entitled *China's Main Crop Water Demand and Irrigation* and *Contour Map of China's Main Crop Water Demand*, published by FIRI, have become seminal texts in this area. Moreover, FIRI researchers have been granted a total of 131 national patents and software copyrights, and in the past five years have published more than 340 scientific papers.

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## China National Rice Research Institute

The main mission of the China National Rice Research Institute (CNRRI) is to help China enhance food security, improve nutrition, protect the environment, and eliminate poverty through rice research.

CNRRI focuses on solving significant scientific and technical problems in rice production through basic and applied research. The institute prioritizes rice genetics and genomics research that may be useful for improving rice yield, grain quality, pest resistance, and stress tolerance as well as focuses on the conservation and utilization of rice germplasm resources. Moreover, the institute is developing environmentally friendly and cost-efficient rice cultivation technologies.

CNRRI plays a key role in coordinating rice research program priorities for the country, conducts national and international training seminars, creates opportunities for scientific and technical exchange between researchers, and compiles the content for and publishes academic journals and books about rice.

The institute covers more than 500 hectares of land and includes 45,000 m<sup>2</sup> of dedicated research grounds. The laboratories are equipped with cutting-edge instruments valued at over 110 million Yuan (US\$16 million) in total. Moreover, the institute encompasses 18 laboratories,

centers, and experimental stations, including the China National Center for Rice Improvement; the State Key Laboratory of Rice Biology; the Research and Development Center of Rice Production Technology; the Quality Inspection, Supervision, and Testing Center of MOA for Rice Products; and the Rice Science and Technology Information Center. CNRRI has also established the Hainan Trial Center in Hainan Province.

Since its founding, CNRRI has accumulated over 146 notable achievements in scientific research, including the creation of new rice varieties, breeding materials (cytoplasmic male sterility lines and restorer lines), and cultivation technologies, as well developed a number of farming-related products. CNRRI has released 96 new rice varieties (inbred and hybrids) for commercial use that have been certificated by national or provincial evaluation committees. In addition, CNRRI has been granted 11 patents covering rice breeding and farming technologies. These accomplishments have been widely accepted and implemented over an area of 10 million hectares on average per annum and have helped advance China's ability to maintain a self-sufficient food supply.

As a non-profit organization, CNRRI adopts an open door policy and welcomes collaborations from public and private sectors around the world.

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## Institute of Cotton Research

The Institute of Cotton Research (ICR) is China's only national research institute and research center specializing in cotton. Centered on basic and applied research, ICR organizes and presides over major national research projects addressing significant science- and technology-related issues in cotton production. The institute coordinates international cooperation and exchanges about cotton research, cultivates high-level talent to advance cotton technologies, and facilitates the transfer of new technologies to farmland. In addition, ICR is responsible for the editing and publishing of the journals *Cotton Science* and *China Cotton*.

The institute is located on 319 hectares of land and includes 26,000 m<sup>2</sup> of dedicated laboratory space. Moreover, ICR has built a national cotton resource nursery and a breeding base located in Sanya, Hainan Province in southern China, as well as three ecological experimental field stations for cotton breeding located in the Xinjiang Uygur Autonomous Region and Anhui Province.

The institute's main research focuses are genetic breeding, germplasm



resources, farming and cultivation, plant protection, molecular biology, agricultural product quality and safety, plant nutriology, pesticide science, and biosafety.

Thus far, ICR has built various research facilities that can be classified into three categories: (1) Basic research, which is carried out at the State Key Laboratory of Cotton Biology and the Key Laboratory of MOA for Cotton Biology and Genetic Breeding; (2) Technological research and innovation, which is performed at the National Engineering Laboratory of Cotton Transgenic Breeding, the National Cotton Improvement Center, the National Transgenic Cotton Pilot and Industrial Base, the National Medium-Term Gene Bank for Cotton Germplasm, and the National Wild Cotton Nursery (Hainan Province); and (3) National cotton technology service infrastructure, which encompasses the Quality Supervision, Inspection, and Testing Center of MOA for Cotton Products; the Supervision, Inspection, and Testing Center of MOA for Transgenic Plant Environmental Safety; the National Regional Cotton Pilot Station; and the breeding base in southern China.

Between 2008 and 2012, ICR released 20 new varieties of cotton and obtained 33 invention patents, eight utility model patents, and five software copyrights. In addition, ICR has successfully sequenced the cotton genome and is now conducting preliminary studies investigating the evolution and genetic diversity of different cotton varieties.

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## The Oil Crops Research Institute

The Oil Crops Research Institute (OCRI) is a national center specializing in the research and development of oil crops. The institute's mission is to conduct basic and applied research that enhances the productivity and utilization of oil crops, including rapeseed, soybean, peanut, and sesame. The current research disciplines cover germplasm, genetics, breeding, functional genomics, genetic engineering, safety assessments for genetically modified organisms, plant nutrition and physiology, plant pathology, chemical analysis, food safety, and product processing.

The institute has four research stations with well-designed laboratories, greenhouses, and field facilities, which occupy a total of 143 hectares. Several national research centers have been set up and based at OCRI, including the National Center for Oil Crops Improvement, the National Engineering and Technology Research Center for Rapeseed, the Key Laboratory of MOA for Oil Products, and the Supervision, Inspection, and Testing Center of MOA for Environmental Biosafety of Transgenic Oil Crops. The editorial offices for the *Chinese Journal of Oil Crop Sciences* and the Oil Crops Association of China are also affiliated with OCRI.

The largest collection of oilseed germplasm in China, which consists of 27,000 accessions from around the world, has been assembled, characterized, and conserved in the National Medium-Term Gene Bank



at OCRI. Many of these highly valued germplasm are widely used for breeding purposes.

OCRI has been the nationwide leading or coordinating institute for many high-profile projects and has undertaken over 960 research projects supported by various funding sources. Significant progress has been made in researching the germplasm, utilizing heterosis for enhancing rapeseed and sesame, increasing the resistance of rapeseed to *Sclerotinia* and of peanuts to bacterial wilt, and managing viruses affecting peanuts. OCRI researchers also make important contributions in the areas of genetic engineering, quality standards, food safety, and product development.

To date, OCRI has released 166 varieties of oil crops, developed 53 national and industry standards for oil crop production and industrialization, and secured 103 national patents. OCRI researchers have recently taken leading international roles in the sequencing of the rapeseed, cabbage, and sesame genomes; discovering new genes and enhancing germplasm in order to produce higher oil content from rapeseed; and improving quality assessment and aflatoxin detection techniques.

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## Institute of Bast Fiber Crops

The Institute of Bast Fiber Crops (IBFC) is China's only national comprehensive institute specializing in the study of bast fiber crops. IBFC has six laboratories plus the Yuanjiang Experimental Station, which are dedicated to studying ramie, kenaf, jute, flax, hemp, biological product processing, protected agriculture, and crop quality and information.

The institute also accommodates 11 national- and provincial-level laboratories that are focused on technological innovation, including the National Breeding Center for Bast Fiber Crops; the Key Laboratory of MOA for Bast Fiber Biology and Processing; the Quality Supervision, Inspection, and Testing Center of MOA for Bast Fiber Products; the Hunan Provincial Key Laboratory for Bast Fiber Genetic Breeding and Bast Fiber Product Bioprocessing; the Key Field Observation Station of MOA for Bast Fiber Resources (Yuanjiang); and the Hunan Provincial Research Center for Bast Fiber Engineering Technology.

Research at IBFC covers six different fields with distinct directions within each discipline: (1) Bast fiber resources and breeding, pertaining to bast fiber resources and evaluation as well as annual and perennial bast fiber breeding; (2) Bast fiber crop cultivation, which involves annual and perennial bast fiber cultivation; (3) Southern China's cash crops, such as southern horticultural crop resources and utilization as well as







**Institute of Bast Fiber Crops**



**Greenhouse Cultivation of Peaches, ZFRI**

southern forage crop resources and utilization; (4) Agricultural microbes, pertaining to degumming microbes and enzymes; (5) Microbial resources and utilization, including mushroom cultivation; and (6) Comprehensive bast fiber processing, pertaining to multifunctional fiber mulch film and fiber products.

Since its establishment, IBFC has undertaken 485 research projects, resulting in 187 notable scientific research achievements and 21 patents. For example, the institute has released 46 new varieties of bast fiber crops, and its researchers have been involved in the publication of 97 books in total. After more than 50 years of dedicated research, IBFC holds scientific expertise in several unique areas, including special varieties of bast fiber crops, bio-degumming, bast fiber mulch films, and cellulosic ethanol.

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## Institute of Pomology

The Institute of Pomology (IOP) is China's earliest national comprehensive fruit research institute. IOP specializes in researching northern deciduous fruit (such as apples, pears, and grapes). More specifically, the institute's research studies fall into six research focuses: apple resources and breeding, pear resources and breeding, cultivation and physiology, integrated pest management, fruit storage and logistics technologies, and fruit quality and quality testing.

IOP has set up a number of national- and ministerial-level research centers, including the National Apple and Pear Germplasm Resource Nursery; the National Apple Breeding Center; the National Detoxification Center for Deciduous Fruit Trees; and the Quality Supervision, Inspection, and Testing Center of MOA for Fruit and Seedlings.

Moreover, the institute houses several well-equipped laboratories, greenhouses, and experimental field stations. IOP also hosts two scientific journals, *Chinese Fruit Trees* and *Applied Technology and Information of Fruit Trees*, and accommodates the Special Committee of Pomology of the Chinese Society for Horticultural Science.

Since its establishment, IOP has undertaken more than 540 national- and provincial-level research projects and has delivered more than 140 major scientific and technological advances. Researchers at the institute have released a number of new varieties of fruit trees and rootstocks and have successfully acquired the independent intellectual property rights. Moreover, IOP researchers have developed a series of advanced and practical procedures and technologies for efficient fruit production and fruit quality testing. Additional technological advances have been designed to dramatically improve fruit yield. These innovations have focused on canopy control and reshaping for closed orchards, the prevention and control of apple-tree pests and diseases, virus-free fruit breeding, fruit storage, potted fruit trees, and full chain quality control for apple production. IOP scientists have also formulated or amended more than 30 national and industry standards for fruit-related agriculture.

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## Zhengzhou Fruit Research Institute

The Zhengzhou Fruit Research Institute (ZFRI) is a national research institute studying deciduous fruit and certain cucurbits (watermelon and melon). ZFRI focuses its research on fruit genetics and breeding, cultivation, integrated pest management, postharvest research, and fruit quality and safety inspection.

The institute comprises 170 hectares of experimental fields and 15,000 m<sup>2</sup> of shared scientific laboratory space equipped with state-of-the-art instruments. ZFRI's affiliated research facilities include the National Grape and Peach Repository (Zhengzhou), the National Watermelon and Melon Gene Bank, the National Fruit and Cucurbits Improvement Center, the Key Laboratory of MOA for Fruit Breeding Technology, and the Quality Supervision, Inspection, and Testing Center of MOA for Fruit and Nursery Stock (Zhengzhou). ZFRI is also the host institute for the Professional Committee of Watermelon and Muskmelon under the Chinese Society for Horticultural Sciences, the Peach Branch of the Chinese Society for Horticultural Sciences, and the National Association for Watermelon and Muskmelon.



**Intelligent Greenhouse, IOP**

ZFRI preserves more than 6,000 accessions of fruit and cucurbits germplasm and is the biggest fruit conservation center in China. It has released more than 130 fruit and cucurbits varieties. The nectarine varieties alone now occupy about 20% of the peach planting areas in China. Moreover, the early ripening apple and pear varieties and the red orient pear varieties are the leading fruits cultivated in China, while the disease-resistant diploid and polyploid watermelon and melon varieties are popular with consumers. In addition, the institute's researchers have developed a series of modern cultivation models that are widely used in China. For example, some of ZFRI's cultivation technologies are now used for fruit production and cultivation in greenhouses. These advances have greatly supported and promoted the development of the fruit and cucurbits industry in China.

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## Tea Research Institute

The Tea Research Institute (TRI) is the only comprehensive institute dedicated to tea research at the national level in China. Over the past 50 years, it has grown into an acclaimed national center for scientific innovation and information regarding tea. TRI supports the development of the tea industry, promotes the development of tea technology, studies basic and critical technical problems in tea production, as well as integrates, demonstrates, and promotes useful technologies within the industry. The institute's research focuses on advancing basic knowledge, pioneering technologies related to tea, and comprehensively covering the tea production process. TRI has established a cluster of resources for research on germplasm resources, genetic breeding, physiology and nutrition, agronomy, integrated pest management, the technology of tea processing, and quality control and risk assessment.

The TRI has 15 research laboratories or centers, both at the national and ministerial levels, including the National Tea Improvement Center, the National Tea Germplasm Nursery (Hangzhou), the National Engineering and Technology Research Center of the Tea Industry, the Tea Research and Development Center of CAAS, the Key Field Station of MOA for Scientific Observation and Testing of Tea Trees (Hangzhou), and the Quality Supervision, Inspection, and Testing Center of MOA for Tea Products. The institute holds the second largest tea preservation resource in the world and currently conserves 3,013 different tea germplasm resources, encompassing the most genetic diversity of any tea resource in the world.

In total, researchers at TRI have contributed 225 scientific and technological advances to the field. 106 of these achievements have been recognized with awards, including eight national and 39 ministerial prizes. The institute has bred eight nationally certified tea varieties, has been granted 45 patents, and has established one international standard, 25 national standards, and 51 industrial standards for tea production. Some tea varieties, including "Longjing 43," have become some of the most well-known tea varieties in China.

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Tea Research Institute

## Harbin Veterinary Research Institute

The primary objectives of the Harbin Veterinary Research Institute (HVRI) are protecting the health of husbandry animals, ensuring the security of public health, and promoting scientific and technological advances that prevent and control animal infectious diseases. Research at the HVRI covers international and domestic infectious diseases that affect swine, birds, horses, cattle, and sheep as well as zoonotic and exotic diseases. More specifically, the institute's research is focused on epidemiology, pathogenic mutations, etiology and pathogenesis, technologies that prevent and control animal infectious diseases, basic immunobiology and immunology of infectious diseases, and techniques related to cultivation and quality control of experimental animals.

HVRI has developed more than 140 different diagnostic reagents and vaccines as well as enabled 335 significant scientific advances. For example, the institute developed the first lentiviral vaccine, the donkey leukocyte-attenuated vaccine, which has been widely used to control equine infectious anemia virus. The institute's attenuated ovine and caprine rinderpest vaccine for cattle and attenuated lapinized bovine pleuropneumonia vaccine have been successfully used to eradicate rinderpest and contagious bovine pleuropneumonia in China. Further, the attenuated lapinized Chinese strain of hog cholera virus vaccine, which was developed in cooperation with the China Institute of Veterinary Drug Control, is the most extensively adopted vaccine in the world. In recent years, HVRI has made significant progress studying animal influenza, porcine reproductive and respiratory syndrome, and other important animal epidemic diseases. The institute has also developed the first recombinant avian vaccine, the fowl pox viral vector-based chicken infectious laryngotracheitis vaccine. In addition, HVRI researchers have identified



Harbin Veterinary Research Institute



key proteins that are essential for trans-species transmission of avian influenza virus.

Furthermore, the development of diagnostic reagents and vaccines are currently under way at HVRI for several major zoonotic and exotic diseases, including brucellosis, rabies, peste des petits ruminants, Nipah virus infection, Ebola hemorrhagic fever, and Rift Valley fever.

Currently, HVRI is the host institute for the OIE Collaborating Center for Zoonoses of Asia-Pacific, the FAO Reference Center for Animal Influenza, the OIE Reference Laboratory for Avian Influenza, and the OIE Reference Laboratory for Equine Infectious Anemia. HVRI also hosts several national research facilities, such as the State Key Laboratory of Veterinary Biotechnology, the National Reference Laboratory of Avian Influenza, the National Reference Laboratory of Contagious Bovine Pleuropneumonia, and the National Experimental Animal Resource Center of Poultry.

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## Lanzhou Veterinary Research Institute

The Lanzhou Veterinary Research Institute (LVRI) is a prestigious center dedicated to animal disease research in China. LVRI comprises five research divisions: foot-and-mouth disease (FMD), animal infectious diseases, animal parasitic diseases, zoonoses, and avian diseases.

LVRI is unique in China in that it has received government authorization to investigate FMD. Researchers at LVRI also study other infectious diseases such as peste des petits ruminants, porcine reproductive and respiratory syndrome, rabies, chlamydiosis, and tuberculosis. In addition to infectious diseases, the institute extensively explores parasitic diseases caused by ticks and tick-borne pathogens, helminthes, and ectoparasites, as well as avian-specific diseases such as avian influenza, Newcastle disease, and coccidiosis.

The institute is mainly tasked with application-focused research such as the development of novel diagnostic techniques and vaccines. However, LVRI also advances basic research in fields such as epidemiology, pathogenesis, immunology, genomics, and pathology. As a national-level institute, LVRI is partially responsible for animal disease surveillance, collecting scientific support for government-issued animal-disease control plans, and for training national and international professionals.



Helminth Parasites Exhibition Room, LVRI



LVRI comprises seven science and technology innovation laboratories including the State Key Laboratory on Veterinary Etiological Biology, the OIE Reference Laboratory for FMD, the National Reference Laboratory for FMD, the Key Laboratory of MOA for Animal Virology, the Key Laboratory of MOA for Epizootic Diseases, and the Key Laboratory of MOA for Zoonosis. The institute also possesses state-of-the-art instruments and equipment, including a genechip workstation, a protein-protein interaction assay workstation, a protein purification system, and an automated DNA sequencer. Moreover, LVRI has a biosafety level 3 (BSL-3) laboratory as well as an animal BSL-3 facility. At present, a BSL-3 Plus laboratory is under construction.

Since its establishment, LVRI has undertaken and implemented over 700 scientific research projects and won 127 awards (including 13 national awards). Moreover, the institute has successfully developed 135 new products including 94 diagnostic reagents, 34 vaccines, and seven animal-specific pharmaceuticals.

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## Lanzhou Institute of Husbandry and Pharmaceutical Sciences

The Lanzhou Institute of Husbandry and Pharmaceutical Sciences (LIHPS) is dedicated to addressing major scientific issues related to livestock production. Specifically, LIHPS is focused on four research areas: animal husbandry, veterinary medicine, traditional Chinese veterinary medicine (TCVM), and prataculture. Many of the institute's studies are dedicated to developing sustainable breeding techniques for Tibetan sheep and yak, and immunological approaches to enhance the fertility of ewes using a steroid antigen. Moreover, researchers at LIHPS are developing chemical and biological medicines along with TCVM compounds for veterinary use, as well as safety evaluations for these medicines. The institute also investigates metabolic and poisoning diseases, dairy cow diseases, and ways to enhance veterinary surgery with acupuncture anesthesia. In addition, LIHPS focuses on improving and constructing grasslands and cultivating new pasture varieties.

LIHPS has built 15 scientific research facilities that provide invaluable support to scientific researchers, including the Quality Supervision, Inspection, and Testing Center of MOA for Animal Fiber, Fur, Leather, and Products (Lanzhou); the Scientific Observation and Experiment Field Station of MOA for Ecological Systems in Loess Plateau Areas



**Shanghai Veterinary Research Institute**



**Institute of Grassland Research**

(Lanzhou); the Key Lab of MOA for Veterinary Pharmaceutical Development; the Research Center of CAAS for Risk Assessment on Quality and Safety of Animal Products (Lanzhou); and the Key Laboratory of Gansu Province for Yak Breeding.

Since its establishment, LIHPS has undertaken 940 scientific research projects and won 201 awards, including 12 national awards and 114 provincial awards. The institute has also been awarded 37 patents, 56 new certificates of veterinary medicine, and three new national certificates of veterinary medicine. A new yak breed named “Datong yak,” for which the LIHPS received the independent intellectual property rights, is a momentous advance for yak breeding throughout the world.

LIHPS is also the host institute for the Veterinary Toxicology Special Committee of the Chinese Society of Toxicology, the Northwest Pathology Branch and the Northwest Chinese Veterinary Medicine Branch of Chinese Association of Animal Science and Veterinary Medicine, and the National Yak Breeding Cooperative Group.

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## Shanghai Veterinary Research Institute

The Shanghai Veterinary Research Institute (SHVRI)—formerly the Shanghai Institute of Domestic Animal Parasitology—is one of four national institutes for animal health studies. SHVRI is specifically focused on basic, applied, and biotechnology-related research for veterinary medicine. Moreover, the institute aims to conduct veterinary science research that has translational potential and contributes to technological advances and industrial development.

SHVRI comprises six departments: animal schistosomiasis, animal parasitology, animal pharmacology, swine infectious diseases, avian infectious diseases, veterinary public health, and safety of animal-derived foods. These departments are made up of 20 research groups in total, each led by a principal investigator.

Research studies within these departments are focused on the major swine- and avian-related infectious diseases, animal parasitic diseases, zoonoses, and anti-parasitic drugs, with an emphasis on etiological biology, molecular epidemiology, and the pathogenesis and immunological mechanisms underlying pathogens as well as applied research into the diagnosis and prevention of animal diseases and disease control technologies.

SHVRI also serves as a branch of the China Animal Health and Epidemiology Center. Several laboratories within the institute have been

authorized as leading research facilities in their respective fields by the Chinese government, including the National Laboratory of Animal Schistosomiasis Prevention and Control, the Key Laboratory of MOA for Animal Parasitology, and the CAAS Animal-Borne Food Safety Research Center.

Since its establishment, SHVRI has been credited with 60 significant research achievements, awarded the second and third prize of the National Scientific and Technological Progress Award, and won a first prize Scientific and Technological Progress Award of MOA. The institute has been granted 38 patent certificates and has had eleven new products and technologies—such as vaccines, drugs, and diagnosis-related products or techniques—approved for veterinary use by MOA. In the past five years, over 1,000 research papers have been published by SHVRI scientists, of which over 300 have appeared in international journals.

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## The Institute of Grassland Research

The Institute of Grassland Research (IGR) is the only national institute engaging in grassland research. IGR conducts basic and applied research on grassland ecosystems in nine research fields: germplasm resources and forage breeding, grassland ecology and vegetation recovery, disaster monitoring, early warning and evaluation of grassland disasters caused by biotic and abiotic factors, monitoring and evaluating grassland resources, evaluation of and recommendations for grassland management policies, establishment and management of grasslands, processing and efficient utilization of fodder grass, and development and testing of pasture machinery.

Currently, IGR hosts several research facilities, including the Key Laboratory of MOA for Grassland Resources and Utilization, the Field Scientific Observation Station of MOA for Grassland Ecology, the Comprehensive Test Station of MOA for Grasslands, the National Medium-Term Gene Bank for Grassland Germplasm, the National Nursery for Perennial Forage and Grasses, and the Quality Supervision, Inspection, and Testing Center of MOA for Forage Products.

Since its establishment, IGR has undertaken more than 500 research projects at the national or provincial level and received nine million Yuan (US\$1.4 million) in grant awards for 32 international collaborative projects. Moreover, IGR has been granted 100 awards for scientific achievements, including 13 national awards and 87 provincial awards. The institute’s scientists have developed 19 elite varieties of alfalfa,





**Agro-Environmental Protection Institute**

Siberian wild rye, and oats, as well as more than 20 machines, including a wind-driven generator and various technologies for silage bagging, grass cutting, and seeding.

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## Institute of Special Animal and Plant Sciences

The Institute of Special Animal and Plant Sciences (ISAPS) is China's only comprehensive institute that studies the protection, development, and utilization of special animal and plant resources. The institute conducts both basic and applied research focusing on rare and precious animals and plants with high economic value. ISAPS researchers aim to protect and utilize these species and provide new technologies that support rare animal and plant studies. The institute has three affiliated companies dedicated to translating independent scientific discoveries into practical applications.

Scientists at ISAPS focus on four broad subject areas: genetic resources and breeding of special animals, biotechnology for and feeding of special animals, special animal disease control, and special economic plants. More specifically, there are 10 research fields within these subject areas: special economic animals, economic animal preventive veterinary medicine, wild animal zoonoses, medicinal plants, special economic plant horticulture, animal biotechnology, ornamental animals, special animal and plant economy, product processing, and veterinary drug research and development.



**White Mink Improved by ISAPS**

ISAPS hosts two national scientific journals and 19 scientific and technological laboratories, including the State Key Laboratory for Molecular Biology of Special Economic Animals; the National R&D Center for Ginseng and Pilose Antler Product Processing; the Quality Supervision, Inspection, and Testing Center of MOA for Special Economic Animal and Plant Products; the Key Laboratory of MOA for Genetics, Breeding, and Reproduction of Special Economic Animals; the Key Laboratory of CAAS for Germplasm Resources and Genetic Improvement of Special Economic Animals; the National Field Gene Bank for Amur Grapevine (Zuoja Region, Jilin Province); and the Scientific Observation and Experimental Station of MOA for Biological Resources of Wild Animals in Changbai Mountain.

Since its establishment, ISAPS has undertaken 490 research projects, which have resulted in 310 scientific research advances. Of these achievements, 196 have been recognized with awards, and 72% have been translated into practical applications. Moreover, the institute has trained nearly 200,000 farmers in the areas of special animal feeding and the cultivation economically important plants.

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## Agro-Environmental Protection Institute, Ministry of Agriculture

The Agro-Environmental Protection Institute (AEPI) of MOA is the first specialized institute in China to research, monitor, and exchange information for agro-environmental protection issues. After 30 years of development, AEPI has become one of the top 100 comprehensive agriculture research institutes in China.

AEPI covers four key research fields: remediation of farmland heavy metal pollution, environmental safety monitoring on the origin of agro-products, recycling of rural wastes and control of non-point source pollution, and biodiversity conservation and ecological security in farming areas. Moreover, the institute has seven research focuses: agricultural environment and ecotoxicology, agricultural waste recycling, biodiversity conservation and ecological security, farmland pollution and ecological regulation, agro-environmental pollution and recovery, environmental quality inspection and evaluation, and monitoring and early warning systems for agro-environmental issues.

Several research facilities are hosted at AEPI, including the Key Laboratory of MOA for Environmental Quality on the Origin of Agro-Products; Risk Assessment Laboratories of MOA on Environmental Factors for



**Biogas Institute of the Ministry of Agriculture**

Quality and Safety of Agro-Products; the Quality Supervision, Inspection, and Testing Center of MOA for Agro-Environment; the Eco-Safety Supervision, Inspection, and Testing Center of MOA for Genetically Modified Organisms; and the Scientific Observation and Experimental Station of MOA for the Eco-Environment (Dali).

In recent years, the AEPI has undertaken over 100 national and provincial research projects, which have resulted in more than 50 significant scientific advances. Of these accomplishments, 20 have been recognized with national and provincial awards. Moreover, the institute has been granted 36 national patents related to agro-environmental protection technologies.

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## Biogas Institute of the Ministry of Agriculture

The Biogas Institute of the Ministry of Agriculture (BIOMA) is the only national research institute in the field of biogas in China. It has a number of departments, including the Microbiology Research Center, the Biogas Engineering Research Center, the Biomass Energy Research Center, the Training and Information Research Center, and the Testing Technology Research Center for Renewable Energy. Much of the institute's efforts are centered on basic research, technology development, technology demonstrations, industry services, and domestic and international training.

BIOMA focuses on three main subject areas: energy and microorganisms, biotransformation of agriculture and forestry, and biogas engineering. Moreover, the institute has seven research fields, including microorganisms for biogas fermentation, microorganisms for hydrocarbon and ethanol production, biomass energy utilization technology, biomaterials, biogas fermentation processes, materials and equipment for biogas engineering, and biogas eco-technology and pollution control.

BIOMA is the leading institute in China for research on anaerobic organisms, anaerobic operation technology, preservation of anaerobic resources, and the treatment and utilization of livestock and poultry waste. BIOMA has built four scientific and technological innovation laboratories, including the Key Laboratory of MOA for the Development and Utilization of Renewable Energy Resources in Rural Areas as well as five laboratories for industrial services and technology transfer, including the Quality Supervision, Inspection, and Testing Center of MOA for Biogas Products and Equipment.



**Tea Garden Management Machine from NIAM**

Since its establishment over 30 years ago, BIOMA has undertaken over 400 national, ministerial, and provincial research projects which have covered areas such as anaerobic digestion treatment and discharge of industrial organic sewage, urban sewage, and waste from large livestock farms. In addition, BIOMA researchers have carried out over 650 biogas technology demonstrations and trained over 1,200 people from outside China via 52 international training courses. The institute published 400 feasibility study reports and has been awarded 30 national patents.

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## Nanjing Institute of Agricultural Mechanization of the Ministry of Agriculture

The Nanjing Institute of Agricultural Mechanization (NIAM) of MOA is considered to be one of the leading institutes in China for agricultural mechanization research. Its mission is to promote China's agricultural mechanization development through technical innovation.

Throughout the years, NIAM has been conducting research on grain crop and cash crop production mechanization, agro-product processing, pesticide application technology and equipment, the utilization of agricultural waste, and agricultural mechanization development strategies. To support this type of research, NIAM has established a number of research resources and ministerial- and provincial-level laboratories, engineering centers, and testing sites.

The institute's researchers developed the world's first rice transplanter in the 1950s and have made significant breakthroughs in production mechanization for crops such as rice, wheat, corn, peanut, tea, rapeseed, and cotton. NIAM's research has resulted in over 160 achievements, including 120 prizes which have been awarded at the national, provincial, and ministerial level. For example, the "new power-operated knapsack air-blast sprayer-duster" won the second prize National Science and Technology Progress Award in 2001, and the "development and demonstration of mechanized harvesting equipment for peanuts" project received the first prize Ministerial Science and Technology Progress Award in 2011. NIAM has also developed many agricultural machines, including high-efficiency and wide-swath power-operated sprayers, tea processing machinery, propelled tilling machinery, and seed processing machinery, all of which are widely used in China and have contributed numerous social and economic benefits.





**Peanut Combine Harvester, NIAM**

NIAM has worked diligently to develop effective international collaborations. Thus far, the institute has successfully implemented technical personnel exchanges and developed collaborative agreements with more than 20 countries, including Argentina, Canada, the Republic of Korea, the United States, and Vietnam.

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## Tobacco Research Institute

The Tobacco Research Institute (TRI) is the only national institute able to conduct tobacco research with full funding support from the government. TRI has eight research departments that focus on four specific disciplines: tobacco genetic breeding and biotechnology, tobacco cultivation and processing, integrated pest management of tobacco, and tobacco chemistry, quality, and safety. The institute also hosts the publishing office of the *Chinese Journal of Tobacco Science* (formerly *China Tobacco*).

TRI has dedicated 60,000 m<sup>2</sup> of space exclusively to scientific research and experimentation and 68.7 hectares of land for experimental sites.



**Different Tobacco Phenotypes, TRI**

These facilities hold more than 1,000 pieces of specialized scientific instrumentation and equipment. Moreover, the institute houses a library of over 60,000 books, documents, and periodicals relevant to tobacco science. Supported by modern facilities, TRI has built 14 national and provincial laboratories for scientific and technological innovation, including the National Tobacco Improvement Center, the National Medium-Term Gene Bank for Tobacco Germplasm, and the Key Laboratory of MOA for Tobacco Biology and Processing.

TRI has cultivated over 30 new varieties of tobacco, sequenced the genomes of both *Nicotiana tomentosiformis* and *Nicotiana glauca*, investigated the genetic impact of more than 200,000 tobacco mutations, owns over 5,200 tobacco germplasm resources, and has adapted or amended over 60 national and industrial standards. Now, the institute is focusing on functional tobacco genomics, the reduction of tar content in tobacco, and identifying beneficial substances in tobacco.

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**CAAS Administration Building**



# The Elite Youth Program

Elite Youth Program is a recruitment program for outstanding young, creative academic leaders, with a focus on attracting top researchers, particularly those from overseas. Participants must be under 40 years of age, have an international perspective, and be able to face the future demands and challenges for scientific research development in China. CAAS will provide dedicated research funding, high-quality office and laboratory space, and competitive financial compensation and subsidies. The specific requirements are below.



**Wei Qi, Director General,  
Department of Human Resources**

notable scientific progress at an international level, and to publish peer-reviewed articles in international journals as the team leader (first author or corresponding author) or make other scientific advances recognized by national and international authorities.

3. To nurture early career scientists in the team, organize international academic exchanges, and develop fruitful scientific collaborations with relevant institutions and organizations in China and abroad.

## Eligibility

The candidate for this full-time position should:

1. Have a passion for agricultural research, impeccable scientific ethics and style of research, and bring a spirit of integrity and cooperation.
2. Be familiar with cutting-edge developments in the field, have a solid foundation in the techniques and technologies associated with the discipline, independently oversee or directly participate in the entire research process, and be capable of being a leading researcher in the field and achieving scientifically significant outcomes.
3. Be under 40 years of age and in good health.
4. Present two letters of recommendation from experts in the field, one of which must be from outside China.
5. Have three or more consecutive years of international work experience following their doctoral degree, or have conducted work that yielded influential journal papers in high-quality publications in the field (published as first or corresponding author), or have developed inventions that have generated patents and/or key technologies. Two years of international work experience will be accepted for those willing to work in the western regions or in remote areas of China on their return.

## Job Responsibilities

1. To bring a clear understanding of the discipline to the position, and develop basic strategies and forward-looking research projects that meet the major national and international strategic needs in agricultural development.
2. To lead a research team to produce innovative results and make

## Funding and Remuneration

1. A startup research fund of no less than 1 million Yuan (US\$161,000) will be provided by the relevant CAAS-affiliated institute during the one-year probationary period.
2. After completing the one-year probation and being officially recruited, the candidate will receive an additional research grant award of 2 million Yuan (US\$322,000) and equipment procurement monies of 1 million Yuan (US\$161,000), funded by CAAS headquarters.
  - Winners of funding from the National Science Fund for Distinguished Young Scholars from NSFC will receive an additional 1 million Yuan (US\$161,000) for research and an additional 2 million Yuan (US\$322,000) for equipment expenses.
  - Recipients of funding from the national Youth Thousand Talents Program supported by the central government will receive from CAAS an additional research grant of 1 million Yuan (US\$161,000) and additional equipment procurement monies of 2 million Yuan (US\$322,000).
3. A resettlement subsidy for accommodation, based on a standard 100 m<sup>2</sup> apartment, will be paid up to a maximum of 1 million Yuan (US\$161,000), or priority will be given if purchasing affordable accommodation built by CAAS.

In addition to the remuneration, benefits, and medical care enjoyed by official employees, a further annual allowance of 100,000 Yuan (US\$16,100), will be provided by CAAS for the first four years. This will be increased to 200,000 Yuan (US\$32,200) for recipients of funding from the National Science Fund for Distinguished Young Scholars from NSFC.

For contact information of the relevant institutes, please visit the official CAAS website, [www.caas.net.cn/caasnew/](http://www.caas.net.cn/caasnew/) and click on the "CAAS Science and Technology Innovation Program" link.

**For more information, e-mail: [kjry@caas.cn](mailto:kjry@caas.cn).**



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