CAAS ANNUAL REPORT 2022

Compiled by the
Department of International Cooperation of CAAS

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Chinese Academy of Agricultural Sciences

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EDITORIAL BOARD

Message from the President

In 2022, adhering to setting its sights on the global frontiers of science and technology, national economic development, the major needs of the country, and the health and safety of the people, as well as focusing on the country's most fundamental interests, CAAS accelerated the establishment of "four centers and one think tank", i.e. national agricultural Science & Technology (S&T) innovation center, national agricultural technology transfer center, national talent center for agricultural S&T innovation, national center for agricultural S&T cooperation and exchange, and national leading agricultural think tank. This rigorous approach effectively promoted agricultural S&T innovation, and provided significant expertise, contributing to the bumper harvest for the 19th consecutive year in grain production, food security of the Chinese people, the continuous consolidation of poverty alleviation, and the comprehensive promotion of rural revitalization.

In the past year, CAAS's major S&T projects yielded fruitful results, garnering 33 awards at the provincial and ministerial level, of which 14 were first-place awards. Technological service delivered by CAAS scientists effectively bolstered stable agricultural production and the supply of agricultural products, and the development of agricultural sectors. CAAS continued to strengthen its talent force, further improved the conditions and capabilities to support S&T innovation. CAAS also expanded cooperation with the international agricultural research community, signaling its unwavering commitment to broader global engagements.

Breakthroughs were achieved in original and pioneering S&T innovations. Significant original discoveries were made in high-yield gene mining in rice, genetic diversity of potatoes, genetic variation of tomatoes, and targeted biosynthesis of chitin. New achievements were made in breeding of key varieties, including "Zhongyouza 501" cultivar, which set a new record for winter rapeseed yield and oil content in China, and "Huaxi Cattle" breed, which is the first domestically-bred new breed of beef cattle. In addition, the "Peste des Petits Ruminants Virus Antibody Test Paper" was approved as a national first-class new veterinary drug. With regard to the critical issues related to arable land, emphasis were placed on enhancing the healthy cultivation of black soil through integrated innovation, introducing appropriate crops to better use saline-alkali land, promoting highly adaptable varieties, improving farmland quality, increasing grain production, and deploying smart agricultural machinery so as to improve the overall food security. Expert groups were established for six agricultural sectors, namely wheat, rice, corn, soybean, oilseed rape and vegetable, so that experts can work in expert workstations at major production regions and deliver "field classes" to local farmers. A thousand experts from CAAS were involved in special initiatives, such as ensuring summer grain harvest and expanding rapeseed cultivation acreage, by providing regular technological guidance to field production.

CAAS spearheaded the establishment of 8 national key laboratories for rice, vegetables, crop genetic resources, etc., and participated in the building of 7 national key laboratories for animal breeding and other fields.

CAAS plays an active role in the construction of Yazhou Bay Seed Laboratory, and officially established a key laboratory for gene editing. CAAS expanded its array of agricultural major science facilities, such as the Northern Rice Research Center of CAAS, and accelerated the construction for regional centers such as Chengdu National Agricultural S&T Center and Northwest China Agricultural Research Center of CAAS.

CAAS persistently advanced its high-level international S&T cooperation. The preparation work for kicking off the International Mega Science Project "From Genome to Phenome-Deciphering Crop Genetic Resources (G2P)" went on smoothly, as 24 international partners have already signed the letter of intent. The newly built "FAO-CAAS Innovation Platform" was one of the 7 major actions taken by China to implement the Global Development Initiatives.

For years to come, CAAS will continue to shoulder the responsibilities and missions as the national agricultural research team to build up China's strength in agriculture. It will spare no effort in enhancing the overall effectiveness of S&T innovation, and strive to write a new chapter in agricultural S&T development!

Prof. Wu Kongming
President of CAAS

COMMITMENT

As a national agricultural research institution, CAAS is dedicated to comprehensive agricultural scientific research, and is responsible for providing strategic advice on agriculture and agricultural science and technology. CAAS functions as the major national technological force for the development of agriculture, rural areas and farmers.

CAAS primarily engages in fundamental and applied basic research, applied research, and high-tech research in agriculture, addressing major science and technology issues in agriculture and rural development that are nonprofit, fundamental, vital, strategic and forward-looking. In the new era, CAAS is striding towards a world-class research academy leading across research disciplines, thereby supporting and making a pivotal contribution to the advancement of China's agricultural science and technology.

CONTENTS

2022 IN NUMBERS

629 new national science and technology projects were approved, among which 51 were national key research and development projects.

7,734 scientific papers were published with 4 papers in *Nature* and *Science*.

Demonstration of integrated technologies of high-yield and high-efficiency in 20 fields, such as rapeseed, vegetables and rural household living environment, was carried out in major production areas. A total of 209 advanced and practical technologies were integrated, and 167 demonstration bases were established, covering 113, 000 ha.

11 demonstration counties for rural revitalization with scientific and technological support were continuously built, and 78 science and technology envoys were dispatched to 42 key counties for providing targeted assistance in national rural revitalization.

1,584 invention patents were granted, and the commercialization rate of intellectual property achievements was 25%.

Led the building of 8 national key laboratories for rice, vegetables, and crop genetic resources, etc.; participated in the building of 7 national key laboratories, such as for animal breeding, etc.

11 international joint laboratories were newly built. Awarded a total of 1,475 academic degrees throughout the year, including 376 doctoral degrees and 1,099 master degrees. 300 individuals were enrolled in the postdoctoral programs.

373 international students from 54 countries around the world were enrolled, covering 41 majors.

Major Science and Technology Platforms

Category	Name	National level	Ministerial level	Institute level
Scientific research	Major scientific programs	2		
	Key laboratories	16	90	52
	Risk assessment laboratories and research centers		30	25
Technical innovation	Engineering laboratories and research centers	7		
	Engineering technology research centers	6		32
	Improvement centers (sub centers)		22	
	Industrial technology systems		26	
	Agricultural products processing technology R&D centers		8	
Basic support	Scientific and technological resources sharing service platforms	6		
	Field testing stations	7	73	60
	Crop germplasm banks and nurseries		30	
	Quality inspection centers and benchmark laboratories	3	37	
	Reference laboratories	9	9	
Total	550	56	325	169

SCIENCE AND TECHNOLOGY INNOVATIONS

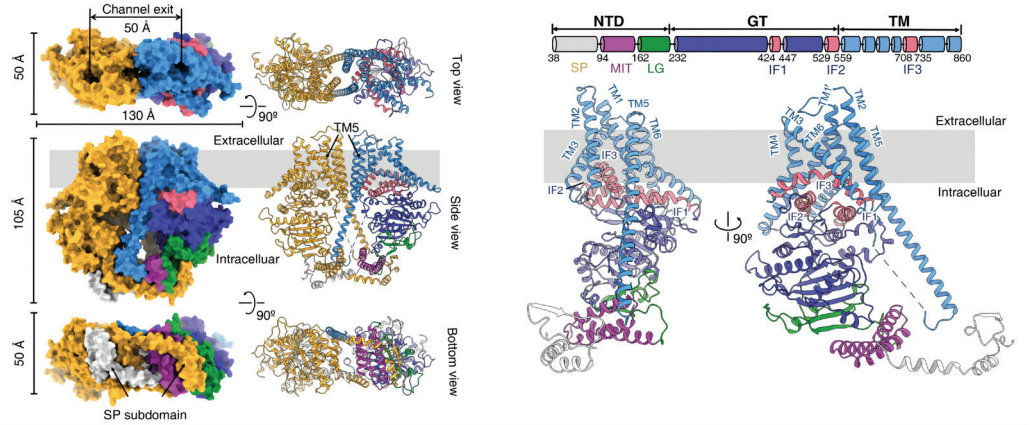
- Major Scientific Discoveries of 2022
- Major Product Developments, Technological Breakthroughs, and Think Tank Reports of 2022

Major Scientific Discoveries of 2022

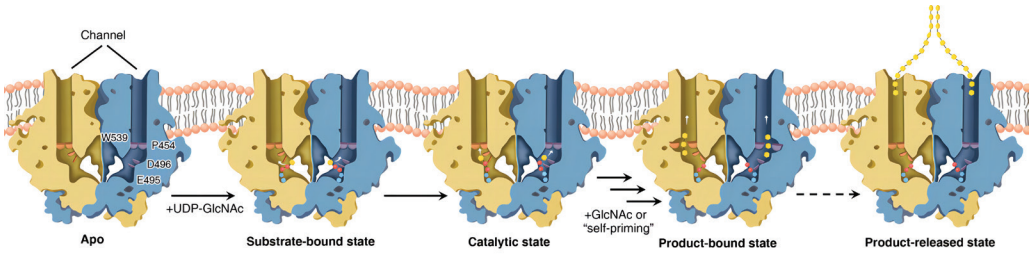
Structural basis for directional chitin biosynthesis

Using a chitin synthase from Phytophthora sojae (PsChs1), this study revealed the directed chitin synthesis processes, including substrate binding, chitin chain extension, and product transport and release, which is controlled by a "gate-lock" loop. The inhibitory mechanism of the natural product nikomycin was also uncovered. It is the first time to elucidate the mechanism of chitin biosynthesis that has existed since the Cambrian at the atomic scale. This study provides fundamental and key information for the development of green pesticides targeting chitin synthase, which has significant theoretical and application value.

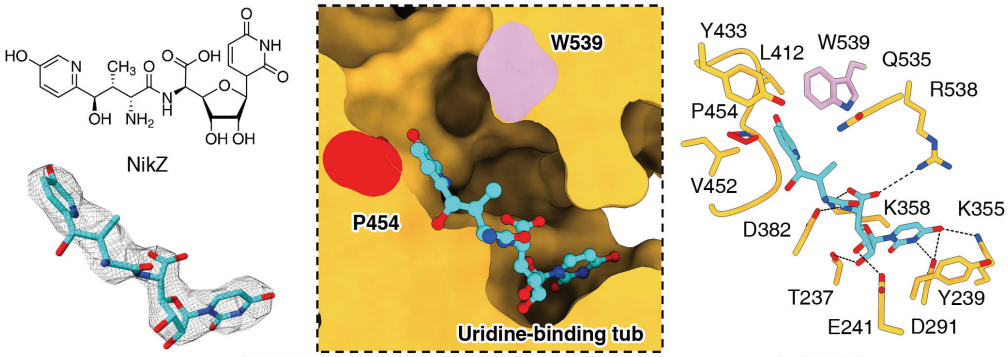
Nature - https://doi.org/10.1038/s41586-022-05244-5



The 3D structure of PsChs1, a chitin synthase from Phytophthora sojae



A model of chitin biosynthesis

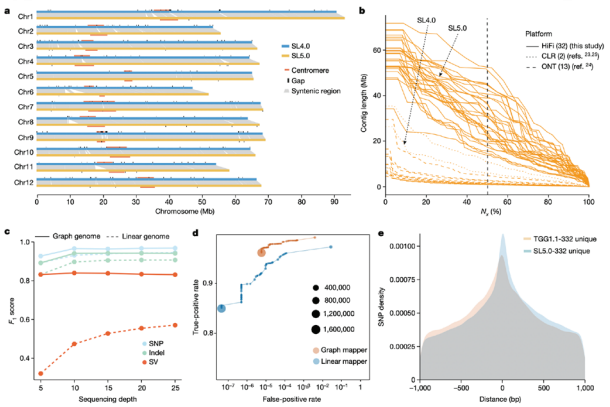


Inhibitory mechanism of the natural product nikomycin

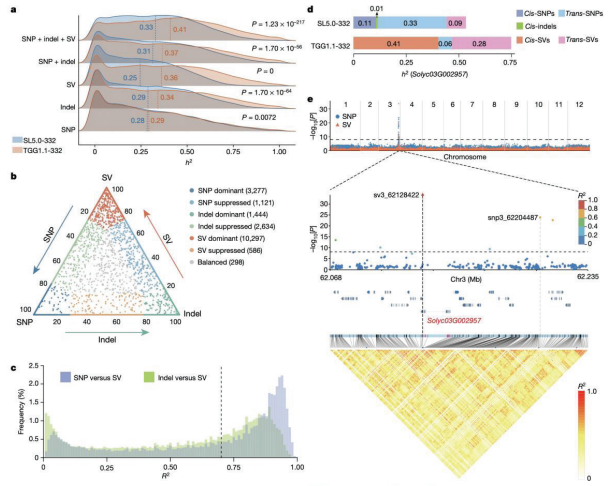
Graph pangenome captures missing heritability and empowers tomato breeding

Using tomato as a model organism, the "missing heritability" could be recovered from three aspects: incomplete linkage, allelic heterogeneity and locus heterogeneity, by combining the graph pan-genome with the newly developed association analysis process based on multi omics. Furthermore, it has been proven that retrieving the "missing heritability" could promote tomato flavor breeding through molecular marker assisted selection and genome selection.

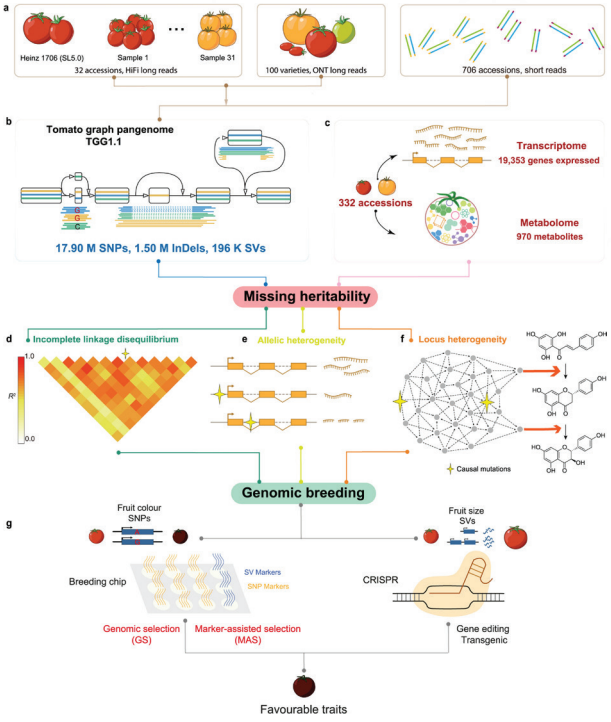
Nature - https://doi.org/10.1038/s41586-022-04808-9



Genome and graph pangenome of tomato



The contribution of genetic variants to heritability

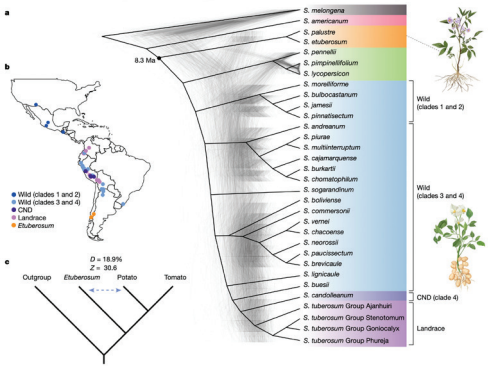


Graph pangenome research design

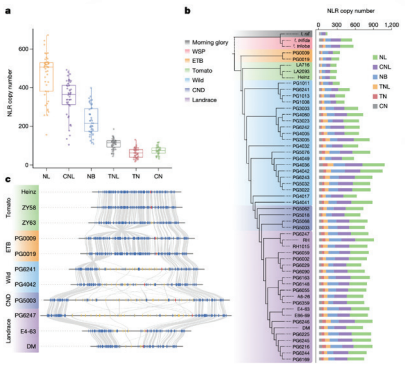
Genome evolution and diversity of wild and cultivated potatoes

This study elucidated the genetic diversity and complex evolutionary history of cultivated and wild potatoes. It was found that compared with closely related species relying on seed reproduction, the number of potato disease-resistant genes in potato vegetative reproduction relying on tubers was significantly expanded. Through multi-omics comparative analysis, the essential gene *IT1* that regulates potato tuber development was discovered. A potato inversion map was constructed, providing insights for eliminating linkage drag in the breeding process.

Nature - https://doi.org/10.1038/s41586-022-04822-x



Geographical distribution and phylogeny of the Solanum genus

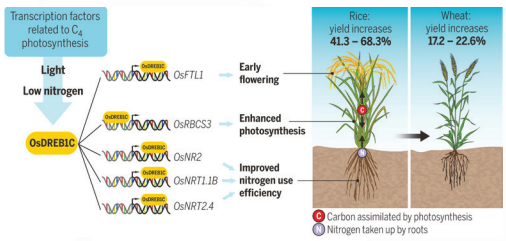


Evolution of resistance genes in potato

A transcriptional regulator that boosts grain yields and shortens the growth duration of rice

This study identified a transcription factor OsDREB1C, in which expression is induced by both light and low nitrogen status. OsDREB1C drives functionally diverse transcriptional programs determining photosynthetic capacity, nitrogen utilization, and flowering time. It was demonstrated that verexpression of OsDREB1C not only boosts grain yields but also shortens growth duration, with yield increase and early maturity observed in wheat and other species. This study achieved a breakthrough in yield improvement through genetically modulating the expression of a single transcriptional regulator gene, providing important genetic resources and innovative theories for future crop improvement strategies toward more efficient and more sustainable food production.

Science - https://doi.org//10.1126/science.abi8455



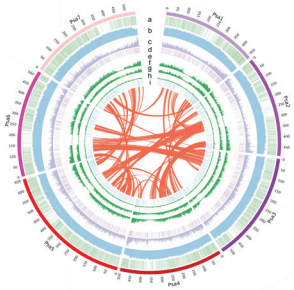
OsDREB1C coordinately regulates yield and growth duration

Prof. Zhou Wenbin and members of his research team were observing the growth of rice

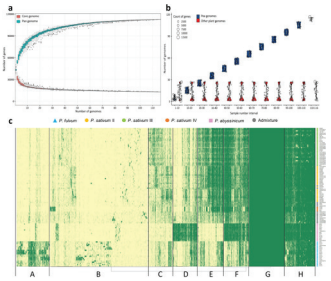
Improved pea reference genome and pan-genome highlight genomic features and evolutionary characteristics

This study assembled and analyzed the genome of the mainly cultivated pea variety of China, "Zhongwan 6", which solved a long-standing problem of assembling a high-quality pea genome. The study revealed the unique features of pea genome structure and evolution, uncovered several loci and genes related to Mendel's traits such as seed shape, plant height and other important agronomic traits, constructed a pangenome of cultivated and wild relative peas, and demonstrated the great potential value of pea related wild species and local varieties as breeding resources for genetic improvement of pea in the future. High-quality reference genome and pangenomes provide important insight and valuable resources for pea domestication, gene mining, germplasm innovation and breeding improvement as well as comparative genomics studies of legumes.

Nature Genetics - https://doi.org//10.1038/s41588-022-01172-2



Important features of the pea genome

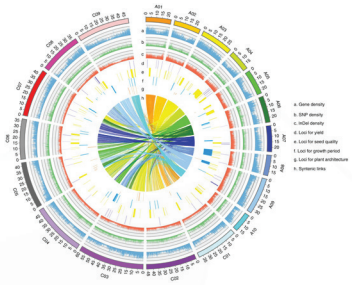


A pan-genome based on 116 representatives cultivated and wild pea

Genetic basis underpins continuous yield increasing in rapeseed

The research found for the first time that the genome of Brassica napus went through two processes of selection for adaptability, and high yield and good quality, and that the improvement of adaptability and seed yield was promoted through the multifaceted and continuous selection of beneficial genes controlling developmental rhythm, plant type, photosynthesis, seed yield and stress resistance; at the same time, 628 genetic loci or genes controlling 56 breeding traits were discovered, including the functionally validated grain re-generation gene, *BnRRF*. The study revealed the genetic basis for the sustained improvement of rapeseed yield, and laid an important theoretical, technological, and genetic resource foundation for the further improvement of rapeseed production performance.

Nature Genetics - https://doi.org/10.1038/s41588-022-01055-6



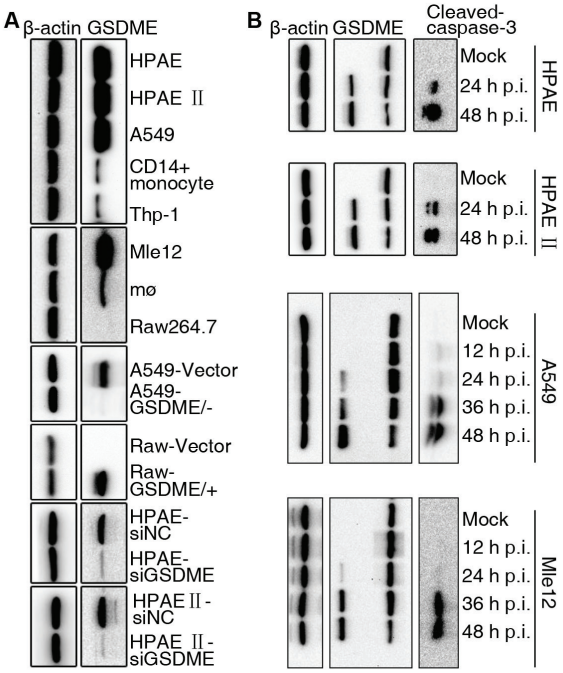
Genomic variation and locus distribution of agronomically important traits in rapeseed

Prof. Wu Xiaoming and member of his research team were conducting a survey on the agronomic traits of rapeseed

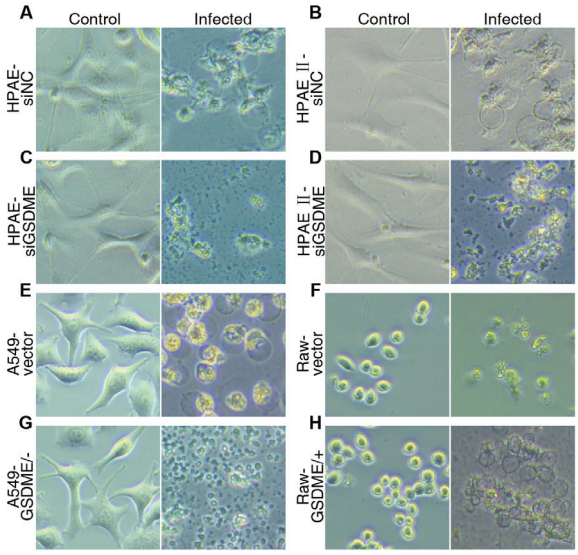
Molecular mechanism of lethal infection of H7N9 avian influenza virus in humans

This study found that H7N9 virus can activate caspase-3 in alveolar epithelial cells when it replicates efficiently in the lungs, causing it to efficiently cut the GSDME molecules that exist in large numbers in alveolar epithelial cells. The N segment domain of GSDME molecules after cutting punches the membrane of alveolar epithelial cells, causing them to "scorch", and then trigger a cytokine storm. It was found that GSDME knockout mice can resist the lethal infection of H7N9 virus and survive completely. The study revealed that GSDME-mediated lung epithelial pyroptosis is the unique mechanism of H7N9 virus induced lung "cytokine storm" leading to death, suggesting that H7N9 virus infection can be treated by blocking the strategy of GSDME molecular cleavage, which provides a new idea for the development of efficient treatment drugs for the H7N9 virus infection.

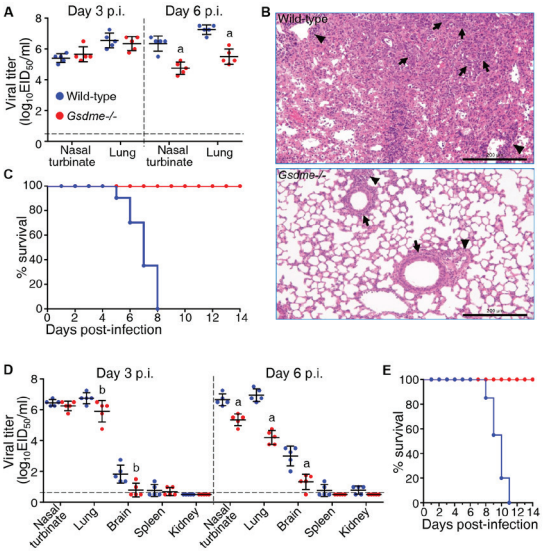
National Science Review - https://doi.org/10.1093/nsr/nwab137



(A) GSDME expression levels of different cells
(B) Activation of caspase-3 and Gsdme-N in different alveolar epithelial cells after AH/1 infection



GSDME mediated pyroptosis caused by H7N9 virus infection in alveolar cells

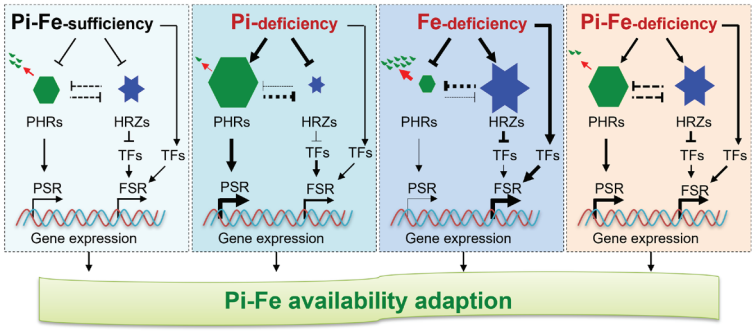


H7N9 avian influenza virus replication and virulence significantly decreased in Gsdme knockout mice

A reciprocal inhibitory module for Pi and iron signaling

It was found for the first time that PHRs, the central regulators of phosphorus (P) signaling, and HRZs, the master regulators of iron (Fe) signaling, integrate the reciprocal inhibitory processes of P and Fe signaling to adapt to different soil P and Fe availability and ensure normal P and Fe requirements of crops. The discovery of the reciprocal inhibition mechanism of P and Fe nutrient signaling provides a novel way to solve the imbalance of P and Fe nutrients in the yellow and red soils of China through molecular breeding.

Molecular Plant - https://doi.org/10.1016/j.molp.2021.09.011

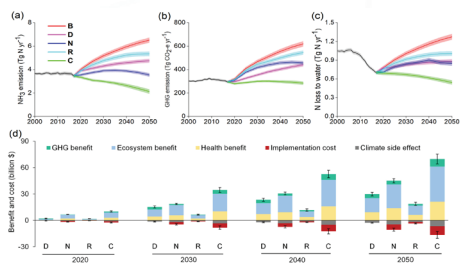


HRZs and PHRs forms a reciprocal inhibitory module to coordinate phosphate and iron signaling and hemeostasis in rice

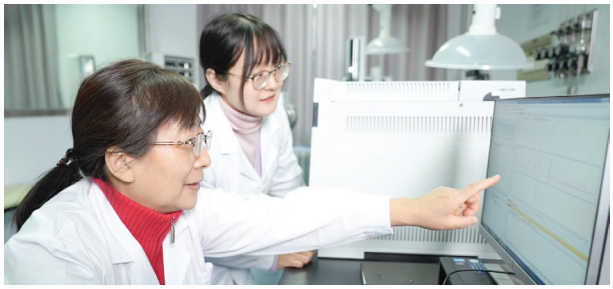
Comprehensive emission reduction measures for livestock and poultry farming can achieve positive environmental health benefits

This study was the first to construct an accounting method for environmental pollution in the livestock and poultry farming, establish a high-resolution farming layout and distribution map of livestock and poultry farming pollution status, and explore the temporal and spatial changes in the generation and emission of livestock and poultry farming pollution in China. It is proposed that optimizing the spatial layout of the aquaculture industry, implementing waste utilization policies, improving the nitrogen utilization efficiency of the livestock system, and improving the recycling rate of livestock and poultry waste could drive regional agricultural nutrient cycling, significantly reducing environmental pollution and nutrient loss. The input-output ratio of relevant technologies and policies could reach 1 : 5, effectively improving the ecological environment and human health, and achieving positive economic and ecological benefits.

Nature Food - https://doi.org/10.1038/s43016-022-00462-6



Emission reduction effects and environmental health benefits of different emission reduction scenarios

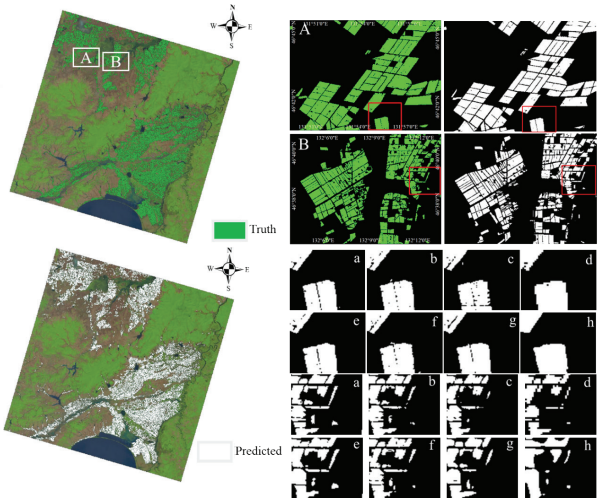


Discussion between Prof. Dong Hongmin and team member on the composition of livestock and poultry manure

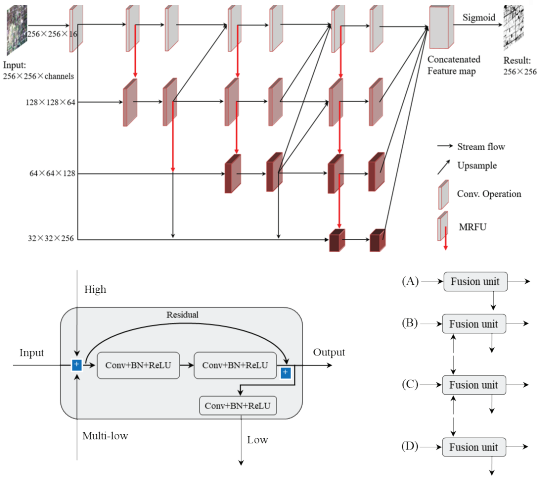
A full resolution deep learning network for paddy rice mapping using Landsat data

Rice mapping in a timely and accurate manner is of great significance for food security in China. In this study, a high-quality training dataset of rice and a full-resolution network (FR-Net) was proposed. The FR-Net could analyze the spatial semantic information of Landsat data and overcome the coarse boundary led by the deep learning semantic segmentation model. This study provided a new approach and idea for high precision, high timeliness, and intelligent monitoring of the spacial-temporal distribution of rice.

ISPRS Journal of Photogrammetry and Remote Sensing - https://doi.org/10.1016/j.isprsjprs.2022.10.005



The results of rice in Sanjiang Plain in Heilongjiang Province



The structure of the multi-resolution fusion unit and FR-Net

Major Product Innovations, Technological Breakthroughs, and Think Tank Reports of 2022

High quality variety "Zhongmai 578" promotes wheat processing quality in Yellow and Huai Valley

"Zhongmai 578" is distinguished by its bread-making quality and high yielding potential was officially released in Yellow and Huai Valley and southern Xinjiang. It was nominated as a leading variety by the Ministry of Agriculture and Rural Affairs, with sowing acreage of 369 thousand ha in 2022. It confers excellent bread-making quality, similar to imported Canada wheat, and creates a national high yield record of 12.62 ton/ha and the sampled yield of 11.09 ton/ha in 15 ha planting area. It is characterized by cold resistance, tolerance to high temperature, early maturity, lodging resistance, tolerance to sprouting, strong resistance to multiple plant diseases, cost saving and efficiency increase. It is also one of the few varieties that achieve order production, premium quality and high price in a large planting area in China, which makes an important contribution to enhancing the competitiveness of wheat industry in China.

Bread made from "Zhongmai 578"

"Zhongmai 578" in the field

Kernels of "Zhongmai 578"

High-yield technology for dense maize planting based on precise water-fertilizer regulation with drip irrigation

Combining the cultivation theory of dense planting and high-quality population regulation with the agricultural engineering technology of integration of drip fertigation, it has integrated and innovated a technical mode of "High-yield technology for dense maize planting based on precise water-fertilizer regulation with drip irrigation" to solve the bottleneck problems of lodging, poor uniformity, premature aging, etc. under denser planting condition. This technology has been popularized and applied in major maize-producing areas in China, with a cumulative area of 2.67 million ha. China's maize yield has witnessed 7 consecutive new records under this technical mode, and the highest yield per unit area reached 24.94 ton/ha. In the northern and the northwestern spring maize producing areas of China, over 667 ha contiguous land has given a kernel yield of more than 15 ton/ha. This technology has been selected as the National Agricultural Principal Extension Technology and one of the top ten leading technologies in agriculture and rural areas, which can significantly enhance the potential for maize yield and the use efficiency of water and fertilizer resources, and thus exploring a high-yield path for maize with Chinese characteristics.

The average yield of 667 ha contiguous land exceeds 15 ton/ha

National record for high yield of maize: 24.94 ton/ha

Comprehensive measures to improve the uniformity of dense planting populations, prevent lodging and premature aging

The UAV spray technology with adjuvant additive adds new power to crop pest control

To address the technical challenges of low pesticide deposition and high risk of droplet drift in plant protection unmanned aerial vehicle (UAV) spraying, a pesticide application technology called "one additive resulting in two increasements" was developed. With the additive of aerial adjuvants during UAV spraying, the use efficiency of pesticides could be increased by 10%~20%, and the control efficacy could be increased by 20%~30%. Thus, the technology protects the ecological environment while promoting the rapid development of the plant protection UAV industry. This technology has been widely demonstrated and applied, with the core patent winning the 2021 China Patent Excellence Award and being selected as the main technology for grain and oil production by the Ministry of Agriculture and Rural Affairs in 2022.

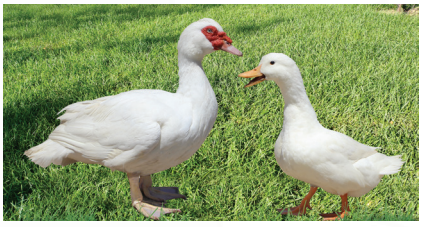
"One Additive Resulting in Two Increasements" technology for wheat field testing

Smart plant protection innovation team conducting technology application trials at Xinxiang base in Henan Province

The "Chinese Changbai Mule Duck" fills the blank in domestic mule duck breeding field

Fatty liver is a healthy and nutritious delicacy, with approximately 95% of the global market being duck fatty liver. As an emerging industry, China has long relied on imports of mule duck breeds for the production of duck fatty liver, which restricts the development of the industry. After 10 years of research, the team created new breeding techniques such as descent determination, ultrasonic determination, genomic selection, etc., and bred a new breed of "Chinese Changbai Mule Duck", which garnered the national approval. The weight of fatty liver of the new breed of mule duck reaches 670 grams per duck, with a feed-liver ratio of 16.3 : 1. Furthermore, the breeding duck lays 235 eggs by the age of 66 weeks, representing an international leading index of production performance. With an annual output of more than 20 million ducks, the share of the domestic market of fat liver has rapidly increased to about 40%.

Breeding of "Chinese Changbai Mule Duck"



Parent breeding ducks of "Chinese Changbai Mule Duck"

Production workshop for commercial meat duck of "Chinese Changbai Mule Duck"

Farm labor shortage and impact on food security strategy

Based on the estimation of the extent of abandoned farmland in different regions and terrains of China, the study indicated that abandonment of farmland currently exists only in a "sporadic" manner in certain localized areas. The causes and forms of abandonment are diverse, but primarily concentrated in hilly areas, slopes, or fragmented plots of land with low marginal returns, with limited impact on China's total grain production. This study argues that mitigating the significant risk of farm labor shortage requires policy incentives for farmers' engagement in farming, optimizing income protection mechanisms for crop growers, nurturing new types of crop cultivation entities and service providers, enhancing the fundamental conditions for agricultural production, and bolstering the capacity to manage abandoned farmland. This will provide proactive decision-making support to motivate farmers to engage in crop cultivation, ensure food security, and reaffirm China's food self-sufficiency.

Household survey

Grain producer survey

Conversion to palletized straw: A novel solution for crop straw returning to field effectively

Straw's direct return to the fields presents multiple challenges, such as large quantity, slow decomposition after returning, reduced grain yield, and poor enthusiasm of farmers. The granulator of straw *in situ* was developed to overcome these disadvantages in the field. Through conversion to palletized straw, the problem of "bottlenecks" with a large number of straw bodies is solved because of the reduced volume and the greatly increased density. This technology has outstanding advantages such as good quality for straw returning, a large amount of straw returning, decomposition in the year, and a significant increase in crop yield. It is an effective technology to make full use of straw to enhance soil organic matter rapidly and improve soil microbial activity. The technology has been demonstrated and applied in Northeast and North China and it won the award for technologies addressing agricultural bottleneck problems presented by the "Science and Technology Innovation in China" in 2021.

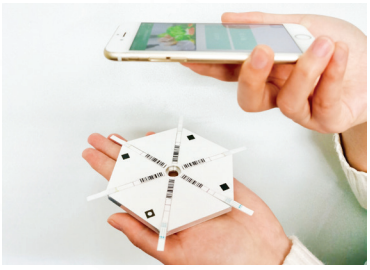
Granulator producing palletized straw *in situ*

Straw returning after pelletizing accelerated straw decomposition and increased soil microbial activity

Prof. Pang Huancheng reviewing the effects of straw pelletizing on soil fertility and crop yield

"Intelligent and Accurate Recognition Technology" drives agricultural products safety testing onto the fast track

Through the development of a colloidal gold test paper with precise colorimetric control for building quantitative chemical models, invention of a multi-channel light source balanced array tray, and the original immunochromatographic image recognition algorithms under ambient light conditions, combined with bar-code labeling, cloud computing and WeChat Mini Program photography, it is possible to achieve qualitative/semi-quantitative analysis of multiple pollutants within 5 minutes, while enabling real-time on-site testing, simultaneous testing of multi-objects, and instrument-free operation, to meet the needs of government regulation, enterprise self-inspection, consumer home self-test, among others. Currently, the series of testing products have been widely applied, covering over 100 kinds of pollutants, and won the "Excellent Product Award" at the 24th China International Hi-Tech Fair.



AI image recognition of pollutants

Mobile terminal interpretation, opening a new era of rapid inspection

A series of rapid detection packages covering over 100 pollutants

"Zhongpantao 11" Leading the high-quality development of the flat peach industry

Flat peach has been cherished by people since ancient times, however, the large number of cracked fruits in flat peach varieties and their lack of tolerance for storage and transportation have become bottleneck issues that constrain the development of the industry. Zhengzhou Fruit Research Institute (ZFRI) crossed Chinese local varieties with foreign germplasm for two generations, and used embryo rescue technology to cultivate the medium-ripe yellow flesh-insolute peach variety "Zhongpantao 11" after 15 years, and passed the examination by the National Forestry and Grassland Administration and approval of forest tree varieties. The variety of the promotion, caused the Chinese flat peach popular, leading the development of Chinese high quality peach, the variety has become China's first big flat peach cultivars, widely cultivated in the Yellow River in China, has achieved significant economic and social benefits.

Flat peach variety "Zhongpantao 11"

The bagged fruits of "Zhongpantao 11"

A gene deletion vaccine against swine pseudorabies virus

An inactivated swine pseudorabies vaccine (JS-2012-ΔgI/gE strain) was self-developed by the Shanghai Veterinary Research Institute of CAAS and approved for marketing by the Ministry of Agriculture and Rural Affairs of the People's Republic of China. The vaccine was developed by deletion of two virulence related genes, gE and gI, based on a pseudorabies virus variant, and it could provide 100% protection against challenge of both the variant pseudorabies virus and classical pseudorabies virus. Therefore, the new vaccine stands as an optimal solution in preventing and eradicating the variant pseudorabies virus, significantly benefits the swine industry.

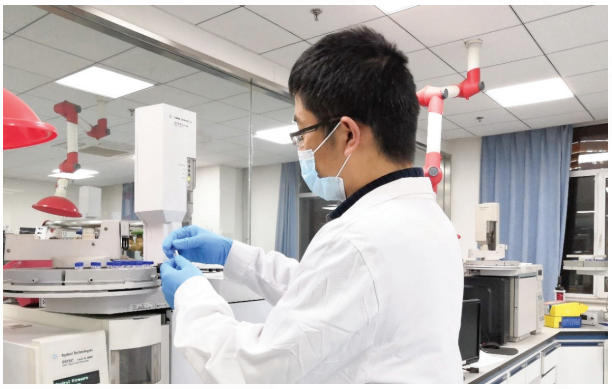
Products of inactivated swine pseudorabies vaccine (JS-2012-ΔgI/gE strain)

Prof. Tong Guangzhi presents research on pseudorabies virus variation at the International Conference of IPVS 2018

"Series of national standard substances" effectively support the demand for agricultural precision testing

The team innovatively applied high-resolution mass spectrometry trace impurity analysis technology and ultra-ton matrix standard grinding and preparation technology to develop and obtain approval for a national standard of level-1 substance for pesticide purity, and 19 matrix standard substances for the active state of heavy metals and organochlorine pesticides in arable soil and agricultural products. Series of national standard substances have significant industrial advantages in terms of uncertainty of characteristic value and coverage of indexes and are widely used in "the Third National Soil Census" and testing capacity verification of agricultural sectors, playing an important role in guaranteeing the accuracy and traceability of the results of the census.

Series of national standard substances



A researcher testing the substances according to the national standard

SCIENCE AND TECHNOLOGY SUPPORT

- Expert Groups
- Demonstration of Integrated Technologies of High-yield and High-efficiency
- Rural Revitalization
- Cooperation with Enterprises
- Intellectual Property
- Research Layout

Expert Groups

In its commitment to bolster agricultural and rural development, CAAS integrated the expert resources within the academy and established six expert groups, specialized in rice, wheat, corn, soybean, rapeseed, and vegetable. This helped establish expert workstations and "Field Classes", contributing to all-round, systematic and regular full support of national food security and the supply of important agricultural products. CAAS undertook large-scale and acute scientific and technological support operations, encompassing the capture of summer and autumn grain harvests. Over 1,000 experts were mobilized to provide scientific and technological guidance service in over 20 provinces and cities, spanning more than 100 cities and states, and over 300 counties and districts. CAAS also organized various types of scientific and technological training, including online and offline “Field Classes”, thereby furnishing robust technical assistance for achieving food harvest.

The expert group in Jiangxi Province reported to Mr. Tang Renjian, Minister of Agriculture and Rural Affairs of China

Launch meeting of Expert Groups

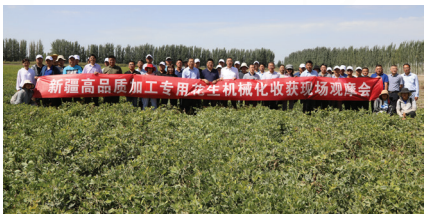
In nearly a thousand activities, the CAAS has distributed more than 20,000 copies of technical guidance materials such as pocketbooks, explanation documents, monthly wall newsletters, providing nearly 500 pieces of technical advice on drought relief, and condensing over 30 scientific research topics from the field production. Mr. Tang Renjian, Minister of Agriculture and Rural Affairs of China gave positive instructions to CAAS’s Science and Technology Serving Production Stabilization and Food Supply initiatives. Furthermore, CAAS’s Project of Science and Technology Serving Production Stabilization and Food Supply was awarded the national "Best Volunteer Service Project", showcasing it as an exemplary model.

The expert group from CAAS advised the wheat production in Xinjiang Uygur Autonomous Region

Demonstration of Integrated Technologies of High-yield and High-efficiency

In response to the technical needs of high-quality development of regional agriculture, CAAS has coordinated the deployment of 20 industrial projects for demonstration of integrated technologies of high-yield and high-efficiency in the main-producing areas covering rapeseed, vegetables, potato, cotton, apple, tea, peanut, dairy cattle and pig among others. In 2022, a total of 167 demonstration bases were established, encompassing a demonstration area of 113 thousand ha and an outreach area of 251 thousand ha. 209 advanced and practical technologies were integrated, and 82 sets of integrated green agricultural technical models that are suitable for different regional ecological conditions were developed. Notably, efforts in sectors like rapeseed and peanuts have catalyzed significant positive impacts.

2022 launch meeting of demonstration of integrated technologies of high-yield and high-efficiency



Field demonstration of the peanut project

Sheep-related field class

Field demonstration of the watermelon project

Rural Revitalization

CAAS has extensively incorporated the strategy of rural revitalization, conducted scientific and technological support in specific priority regions, and effectively expand the outcomes of poverty alleviation with rural revitalization. Specifically, CAAS has endeavored to establish 11 demonstration counties for rural revitalization, including Donghai, Wuyuan, and Lankao, etc. The working mechanism has been further improved, forming an approach wherein each demonstration county is spearheaded by a professional research institute, with the participation of other related research institutes and teams. CAAS also facilitated the successful selection of Wuyuan and Shouguang as National Pioneer Counties in agricultural science and technology, and

Prof. Zhang Hecheng, Secretary of the Leading Party Group of CAAS, visited Zhouqu County in Gansu Province to inspect the development of Tibetan herbal medicine industry supported by CAAS technology

Fuping and Langkao as National Demonstration Counties for rural revitalization. To effectively assist 160 prominent counties in the national rural revitalization effort, a group of 78 experts were mobilized to undertake science and technology supporting missions in 42 counties across 19 industries. Science and technology assistance in Zhouqu and Taijiang counties are smoothly advanced, proactive measures such as implementing industrial planning, constructing demonstration sites, providing science and technology training, planning projects, and creating brands were taken in place. Over 50 sessions of intensive training courses have been conducted in the two counties, more than 3,600 individuals benefited from offline training activities and consultation and guidance are provided to approximately 1,800 individuals. Furthermore, CAAS has introduced over 40 new varieties and demonstrated the application of more than 30 new technologies.

Prof. Sun Tan, Vice President of CAAS inspected the development of the rice industry in Taijiang County in Guizhou Province

Cooperation with Enterprises

To enhance the availability of scientific and technological advancements and further foster the transition and application of innovative solutions, CAAS implemented various strategies to bolster its collaboration with corporate entities at both the academy and institute levels. CAAS, together with more than 100 well-known enterprises, financial institutions, associations and societies, built a comprehensive academia-industry integration development consortium at academy-level and establish long-term and stable cooperative relations. The number of academy-level strategic cooperating enterprises increased to eight. The academy-affiliated research institutes cooperated closely with more than 400 enterprises, of which more than 20% of the enterprises and research institutes jointly built innovation platforms. The event of "Entrepreneurs Entering CAAS" was held, which invited 14 leading agricultural enterprises to visit the CAAS for discussions and exchanges. More than 30 matchmaking meetings with enterprises were organized as a platform to promoted information on scientific and technological achievements and potential cooperation.

Entrepreneurs were invited to visit CAAS

Intellectual Property

CAAS values the high-quality development of intellectual property rights, and remains committed to delivering higher-quality intellectual property services from inception to completion, throughout the whole process. Efforts were made continuously to enhance policy guidance, project promotion, talent cultivation, as well as to offer targeted services.

A total of 2,080 domestic patents were licensed, of which 1,584 are invention patents. The conversion rate of intellectual property reached 25%. 6 intellectual properties were transferred with a unit price of more than RMB 10 million yuan, and 55 intellectual properties were transferred with a unit price of more than RMB 2 million yuan. The China Agricultural Technology Transfer Fair 2022 was successfully held, where a hundred of major technology achievements and more than a thousand outstanding scientific and technological achievements were released. The total contracted value of 4 key projects reached RMB 290 million yuan.

Agricultural technology achievement brochure

Signing ceremony during China Agricultural Technology Transfer Fair 2022

High-Level Summit of China Agricultural Technology Transfer Fair 2022

Research Layout

CAAS promoted the construction of regional innovation centers such as the Northwest China Agricultural Research Center, the Chengdu National Agricultural Science and Technology Center, the Hainan National Breeding and Multiplication Institute at Sanya, the Central China Research Center and the North China Innovation Center for Agriculture and Animal Production, etc. The National Crop Gene Bank was newly-built and put into use, and the construction of the National Livestock and Poultry Gene Bank started. A cluster of high-level biosafety laboratories for animal disease prevention and control was established. The information support service was further improved with the launch of iCAAS 3.0 system.

Disciplinary development strategic seminar for the building of the National Key Laboratory for efficient utilization of dry and semi-arid farmland in northern China

Construction of Major Scientific Research Platform

CAAS took the lead in building 8 national key laboratories, namely in the field of rice, vegetables, crop genetic resources, cotton, farmland, animal diseases, plant diseases and insect pests, and livestock and poultry nutrition; participated in the building of 7 national key laboratories, in the field of livestock and poultry biotechnology, maize and rice germplasm, fruit and vegetable horticultural crops, agricultural microorganisms, agricultural water resources, resource insects, and tropical crops. These laboratories represent 40% of the total number of national key laboratories in the agricultural field in China.

The construction of "Belt and Road" joint laboratories progressed smoothly. The China-Kazakhstan "Belt and Road" Joint Laboratory of Agricultural Science has been ISO17025 certified; the China-Romania Agricultural Science "Belt and Road" Joint Laboratory completed the major construction project of the Bucharest Plant Factory; the China-Uruguay "Belt and Road" Joint Laboratory of Soybean Research and Innovation was officially approved for construction.

The new academic board of national key laboratory for vegetable biology and breeding

National Crop Gene Bank

Layout of Major Scientific Research Facilities

The Hainan National Crop Phenotypic Research Facility at Sanya completed its final acceptance. The Center for International Agricultural Research building and the Center for International Agricultural Science and Technology Exchange building are about to be put into use. The Agricultural Genomic Research Center and the Seed Industry Innovation Center are expediting the final stage of construction. The construction of the Northwest Sub-center of the Biosafety Science Center, and the National Livestock and Poultry Gene Bank has commenced. The project proposals of the National Agricultural Microbial Germplasm Bank, the National Digital Agricultural Collaborative Platform, and the National Agricultural Product Origin Environmental Sample Bank have been presented to the Ministry of Agriculture and Rural Affairs for assessment.

Sketch of the National Livestock and Poultry Gene Bank

The National Livestock and Poultry Gene Bank will be built into a national-level platform that is unparalleled in its quantity and quality, with the bank set to house the most abundant collection of breeds integrated into the most comprehensive and intelligent system. It will create a "global bank" for strategic preservation of livestock and poultry germplasm resources, capable of preserving 2,522 domestic and foreign livestock and poultry breeds with a capacity of 33.25 million samples stored at ultra-low temperatures. The Bank will cover all domestic and about 25% of foreign breeds.

Sketch of the Center for International Agricultural Research

The Center for International Agricultural Research is designed to establish a key platform for international cooperation and exchange, international talent training base, and information service platform for agricultural science and technology cooperation. It aims to become a modern hub of international cooperation for CAAS, and to provide services for open cooperation and technological innovation.

The Center for International Agricultural Science and Technology Exchange is a project to fully leverage the advantages of China's national strategic agricultural scientific and technological development. It is designed to actively conduct international agricultural science and technology exchanges and synergizes large domestic and foreign agricultural enterprises to form a platform with strong integration of industry-university-institute. It will function as an incubator for high-end agricultural technology and business and a future agricultural research and exchange center. By amassing a wealth of innovation resources, spanning agricultural science, top-tier talent, capital, and other critical components, the center aims to evolve into a highland for global agricultural scientific innovation and industrial incubation.

Sketch of the Center for International Agricultural Science and Technology Exchange

Sketch of the Agricultural Genomics Research Center

The Agricultural Genomics Research Center targets major national demands for food security, biosafety, and ecological security. With its sight set on solving major frontiers and technical issues in agricultural genomics, the center aims to take the lead in agricultural genomics research globally, and to develop itself into an international agricultural genomics research and development center, a national sharing platform for agricultural genome technology, and an international agricultural genome talent training center. The facility can achieve a data storage capacity of 20 PB, a peak computing ability of 500 trillion operations per second, and will complete genomic analysis of 100,000 agricultural biological resources.

Sketch of the Seed Industry Innovation Center

The Seed Industry Innovation Center is a comprehensive research platform and innovation highland for seed industry innovation in China. Designed to be the strategic force of China's seed science and technology, the center will play a crucial role in boosting construction of a tropical agricultural science center, and guaranting the supply of science and technology in the Hainan Free Trade Zone. After completion, it will be able to select 100-200 high-yield, high-quality, and efficient green germplasm resources, 30-50 breakthrough breeding parents, 10-15 strategic new varieties with a promotion area of over tens of millions of mu (1 mu = 0.0667 ha), and 5-10 high-yield, fine-quality, and stress-resistant livestock and poultry new breeds (matching series). It will also effectively improve water and fertilizer use efficiency, reduce pesticide application, and alleviate environmental and resource pressures.

Sketch of the Hainan National Crop Phenotype Research Facility at Sanya

The Hainan National Crop Phenotypic Research Facility at Sanya stands as a pilot project in promoting the construction of China's Silicon Valley of Agriculture and the National Tropical Agricultural Science Center. As a major scientific and technological infrastructure project focusing on crop field environment and environmental phenotype identification, it is poised to raise service ability and modern breeding level in China. After completion of construction of the facility, it can evaluate 3,400 environmental phenotypes, 4,600 field environmental phenotypes and create 10,000 genetic resources.

KEY INITIATIVES

- Agricultural Science and Technology Innovation Program (ASTIP)
- International Cooperation and Development
- Talent Pool

Agricultural Science and Technology Innovation Program (ASTIP)

CAAS implemented a list of 78 major tasks, providing stable support for 330 research teams to conduct long-term, non-consensus, and emergency research on major scientific issues and joint tackling of significant scientific and technological tasks. CAAS initiated the implementation of the "Science and Technology Innovation Program Leap Plan"; and issued the "Management Measures for the Science Center of the Agricultural Science and Technology Innovation Program" to clarify the main tasks, organizational structure, formation procedures, operational management, performance evaluation, etc. Nine science centers formulated their construction plans.

CAAS kept improving the management and evaluation of the performance of ASTIP. The research institutes put forward the research proposals and established indicator systems for the development period, composing of 1,566 tertiary indicators, among which 76 breakthrough indicators. CAAS optimized and adjusted the setup of ASTIP research teams and implemented the "Optimization and Adjustment Plan for Research Teams in the Comprehensive Promotion Period of the Innovation Project," supporting the construction of the Hainan National Breeding and Multiplication Institute at Sanya, and the Northwest China Agricultural Research Center, hence the total number of institute-level research teams has increased to 330. 94 research teams from 30 institutes replaced their chief scientists to optimize structure of research teams.

International Cooperation and Development

G2P International Mega Science Project

In collaboration with global partners, CAAS is initiating an International Mega Science Project: "From Genome to Phenome: Deciphering Crop Genetic Resources (G2P)". Aiming at inviting global partners to jointly establish a global crop germplasm resources sharing and exchange mechanism, G2P is dedicated to promote global plant genetic resources systematically understood and equitably utilized worldwide, thus contributing to global food and nutrition security for the present and future generations while adapting to a changing climate. Its concept note and implementation plan have been accomplished. Up to date, in total of 24 research institutions have committed to jointly launch the G2P, and extensive working consultations have been conducted to reach consensus on major concerns.

Agricultural Science and Technology Cooperation Platforms and Mechanisms

An initiative was proposed by CAAS to establish the Global Agricultural Research and Innovation Association as a global non-profit, non-governmental voluntary cooperation network open to all National Agricultural Research Systems (NARS) and international organizations, as well as agricultural innovation enterprises dedicated to agricultural and agro-product research. 21 foreign institutions and 34 domestic institutions have positively responded and expressed their willingness to join the Association.

Food and Agriculture Organization (FAO) of the United Nations and CAAS jointly signed an agreement to formally establish the "FAO-CAAS Innovation Platform", which aims to further deepen cooperation between FAO and CAAS in science, technology, and innovation. Both sides agreed to jointly build the innovation platform into a food and agricultural science and technology governance platform benefiting the Asia-Pacific region and further the global community. This innovation platform was one of the seven practical measures to be taken together with international partners to implement UN 2030 Agenda, as announced at the Ministerial Meeting of the Group of Friends of the Global Development Initiative (GDI).

Signing Ceremony of FAO-CAAS Innovation Platform

CAAS set up 11 new international joint laboratories and led the establishment of international professional cooperation networks such as the C4 Photosynthesis Consortium. Letters of Intent were signed with the International Rice Research Institute (IRRI) and the International Maize and Wheat Improvement Center (CIMMYT) to jointly build the "CAAS-IRRI Sanya International Rice Breeding Center" and the "CAAS-CIMMYT Sanya Breeding Center," promoting the establishment of a breeding innovation hub.

Projects jointly executed by the Biogas Institute of Ministry of Agriculture and Rural Affairs, and the Independent State of Samoa were picked as the selective case of United Nations' "Good Practices in South-South Cooperation and Triangular Cooperation for Sustainable Development" and "Good Practices in South-South and Triangular Cooperation for Sustainable Development in SIDS". The action plan on plant protection cooperation was signed with regional partners from countries such as Vietnam, Laos, and Cambodia. The "China-Africa Agricultural Science and Technology Innovation Alliance" was initiated, gaining approval from the Ministry of Agriculture and Rural Affairs and formal support from the Ministry of Science and Technology. Preparatory work for the Alliance is synchronizing with the African Academy of Sciences.

China-Southeast Asia International Seminar on Cross-border Pest Prevention and Control

International Academic Exchange

A total of 57 academic international conferences have been organized by CAAS in 2022, notably among them were the 2nd International Wheat Conference and China-Southeast Asia Seminar on Joint Prevention and Control of Cross-Border Pest. Additionally, 19 international training workshops were held, attracting more than 15,000 participants from over 78 countries through borth virtual and in-person modalities. As a satellite event of the World Food Forum (WFF), the final competition of 2022 Youth Hackathon for Reducing Food Loss and Waste was held in Beijing, co-organized by CAAS and FAO, attracting contestants from 21 countries.

CAAS scientists actively participated in various international events, such as the FAO's first "International Plant Health Day" and the World Food Forum's Chief Agricultural Scientists Roundtable, where they shared China's agricultural science and technology innovation experience.

A total of 116 CAAS experts serve adjunct positions in international initiatives, academic organizations, and governance mechanisms. Moreover, 358 experts serve as editors for 710 internationally renowned journals. CAAS sent 58 scientists for cooperative research abroad, and introduced 109 foreign experts for medium to long-term cooperation programs with CAAS, either virtually or in-person .

The 2nd International Wheat Conference held in Beijing

Talent Pool

Talent Program

The high-level talent team continues to grow. CAAS is currently implementing policies to support agricultural talents, with 69 professionals selected for the national talent program and 26 urgently needed talents recruited. Launching the Youth Entrepreneurship Project, CAAS selected and supported the first batch of 41 outstanding young researchers under the age of 35. The average age of 144 newly appointed professors is 43 years old, while the average age of 279 new assistant professors is 37 years old. The average age of the chief scientist of the innovation team decreased to 48.7 years old. The structure of backbone talents was further optimized.

CAAS advanced International high-level talent exchange steadily. More efforts were accorded to strengthen the construction of the International Education College. The draft of the "Work Plan for International Enrollment and Overseas Talent Introduction of Hainan National Breeding and Multiplication Institute at Sanya and the Northwest China Agricultural Research Center of CAAS (2022-2026)" was released, aiming to expand the number of international students of Hainan National Breeding and Multiplication Institute at Sanya and Northwest China Agricultural Research Center of CAAS .

Postdoctoral Work

300 postdoctoral candidates were employed in 2022, an increase of 28% comparing to the previous year, bringing the total number of postdoctoral candidates working at CAAS to 817. The funding for postdoctoral fund projects reached a new scale, with 63 professionals receiving postdoctoral science funding. Additionally, 12 doctors are selected for postdoctoral talent projects.

Lanzhou Institute of Husbandry and Pharmaceutical Sciences, Institute of Grassland Research, and Hainan National Breeding and Multiplication Institute at Sanya were approved to set up postdoctoral research workstations. Moreover, Kunpeng Modern Agriculture Research Institute in Foshan was selected as Guangdong Province Postdoctoral Innovation Practice Base.

Postgraduate Education

At present, crop science, horticulture, plant protection, animal science and veterinary medicine for postgraduate education of CAAS are listed as the national A+ disciplines while biology, and agricultural resources and environment as A disciplines, ecology, and food science and engineering as A- disciplines.

There are currently 2,732 graduate supervisors, including 1,016 doctoral supervisors. Throughout the year, 1,475 students were awarded degrees, including 376 doctoral degrees and 1,099 master's degrees. As of the end of the year, the employment rate of 2,022 graduates was 92.08%.

International Education

The international level of graduate education continues to improve. In 2022, 373 international students were enrolled, covering 41 majors and coming from 54 countries worldwide. The number of doctoral students enrolled is among the top in domestic universities. 45 doctoral candidates were recruited for cooperative doctoral education programs between CAAS and foreign universities. In 2022, GSCAAS graduated 77 international students, of which 6 were awarded the honor of outstanding graduate at the school level.

17 outstanding international student representatives were selected to participate in the opening and closing ceremonies of the Beijing Winter Olympics and Paralympics, as well as dialogue and exchange activities, contributing to the successful hosting of the Winter Olympics.

CAAS signed the third phase of cooperation agreement on training for doctoral degree education with Wageningen University in Netherlands and University of Liège in Belgium.

Defense of a doctoral dissertation at the Wageningen University in Netherlands

Defense of a doctoral dissertation at the University of Liège in Belgium

APPENDIX

- Organizational Structure of CAAS
- Annual Budget and Staff
- Disciplinary System

Organizational Structure of CAAS

President

Secretary of Leading Party Group

Vice Presidents

Administrative Departments

- General Office
- Department of Research Management
- Department of Personnel
- Department of Finance
- Department of Development and Construction
- Department of International Cooperation
- Department of Technology Transfer
- Department of Major R&D Programs
- CAAS Party Committee
- Department of Supervision

Graduate School of CAAS

Research Institutes in Beijing

- Institute of Crop Sciences (ics.caas.cn/en)
- Institute of Plant Protection (ipp.caas.cn/en)
- Institute of Vegetables and Flowers (ivf.caas.cn)
- Institute of Environment and Sustainable Development in Agriculture (ieda.caas.cn)
- Institute of Animal Sciences (ias.caas.cn/en)
- Institute of Apicultural Research (iar.caas.cn/en)
- Institute of Feed Research (ifr.caas.cn/en)
- Institute of Food Science and Technology (ifst.caas.cn/en)
- Biotechnology Research Institute (bri.caas.cn/en)
- Institute of Agricultural Economics and Development (iaed.caas.cn/en)
- Institute of Agricultural Resources and Regional Planning (iarrp.caas.cn/en)
- Agricultural Information Institute (aii.caas.cn)
- Institute of Quality Standards and Testing Technology for Agro-Products (iqstap.caas.cn)
- Institute of Food and Nutrition Development of MARA (ifnd.caas.cn)

China Agricultural Science and Technology Press Ltd.

Research Institutes outside Beijing

- Institute of Farmland Irrigation (ifi.caas.cn/english)
- China National Rice Research Institute (cnrri.caas.cn/en)
- Institute of Cotton Research (cri.caas.cn/en)
- Oil Crops Research Institute (ocri.caas.cn/en)
- Institute of Bast Fiber Crops (ibfc.caas.cn)
- Institute of Pomology (ip.caas.cn/english)
- Zhengzhou Fruit Research Institute (zfri.caas.cn)
- Tea Research Institute (tri.caas.cn/english)
- Harbin Veterinary Research Institute (hvri.ac.cn/en)
- Lanzhou Veterinary Research Institute (lvri.caas.cn/en)
- Lanzhou Institute of Husbandry and Pharmaceutical Sciences (lzihps.caas.cn/en)
- Shanghai Veterinary Research Institute (shvri.caas.cn)
- Institute of Grassland Research (gri.caas.cn)
- Institute of Special Animal and Plant Sciences (tcs.caas.cn)
- Agro-Environmental Protection Institute of MARA (aepi.caas.cn/en)
- Biogas Institute of MARA (biogas.caas.cn/en)
- Nanjing Institute of Agricultural Mechanization of MARA (nnj.caas.cn/en)
- Institute of Tobacco Research (tric.caas.cn/en)
- Agricultural Genomes Institute at Shenzhen (agis.caas.cn/en)
- Institute of Urban Agriculture (iua.caas.cn/en)

Annual Budget and Staff

In 2022, the total financial budget of CAAS reached RMB 8.15 billion yuan, among which 3.84 billion yuan is allocated by the government from fiscal budget.

Currently, CAAS has a total of 11,330 employees, with 6,796 permanent employees. There are 6,195 professional and technical personnel, including 1,501 senior-level professionals and 2,182 associate senior-level professionals, accounting for 24.2% and 35.2% respectively. CAAS also has 16 academicians, over 400 high-level experts, and 387 CAAS Outstanding Talents. There are 11 mobile stations for postdoctoral research and 10 research work stations, together with a total of 817 postdoctoral candidates.

Disciplinary System

Comprehensively rebuilt the disciplinary system with 11 clusters of disciplines, 58 academic fields and 283 research directions.

Brief table of disciplinary setting of CAAS

Cluster of Disciplines	Academic Field	Major Direction
Agricultural Basic and Frontier Research	4 Academic Fields including basic theoretical research	26 Major Directions including basic research on agricultural biological classification
Crop Science	5 Academic Fields including crop germplasm resources	47 Major Directions including the collection and conservation of crop germplasm resources
Horticulture	4 Academic Fields including horticultural crop germplasm resources	20 Major Directions including collection, conservation, identification and assessment of vegetable germplasm resources
Plant Protection	6 Academic Fields including plant diseases and insect pests	19 Major Directions including epidemic detection and control of grain crop diseases
Agricultural Resources and Environment	6 Academic Fields including farmland and soil	22 Major Directions including soil fertilization and improvement
Animal Science	5 Academic Fields including animal germplasm resources	27 Major Directions including collection, conservation, identification and assessment of livestock germplasm resources
Veterinary Medicine	6 Academic Fields including animal diseases	21 Major Directions including avian diseases
Agricultural Microbiology	4 Academic Fields including agricultural microbial germplasm resources	16 Major Directions including collection, conservation, identification and assessment of agricultural microbial germplasm resources
Agro-product Quality and Processing	5 Academic Fields including agricultural quality standards and testing	25 Major Directions including agricultural quality standards and standard substances
Agricultural Equipment, Engineering and Information	6 Academic Fields including agricultural machinery and equipment	25 Major Directions including planting machinary
Agricultural Economics and Rural Development	7 Academic Fields including Marxist “Three Rural Issues” thought	35 Major Directions including Marxist “Three Rural Issues” thought development and innovation
11 Clusters	**58 Fields**	**283 Directions**

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