

Workshop on “International Mega Programme-Lessons to Learn” at CAAS

CAAS Key project: Best practice of Plant Health

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Contents

- **Introduction of Institute of Plant Protection**
- Team building of ASTIP for Plant Health
- Collaborative innovation research in China
- Importance for international cooperation

Major agricultural diseases and insect pests

- About 120 species
- Type I : 14 species, Type II : about 100 species

Type I : More than 100 million mu per year

Actual loss over one million tons per year

Have a huge influence on politics and society

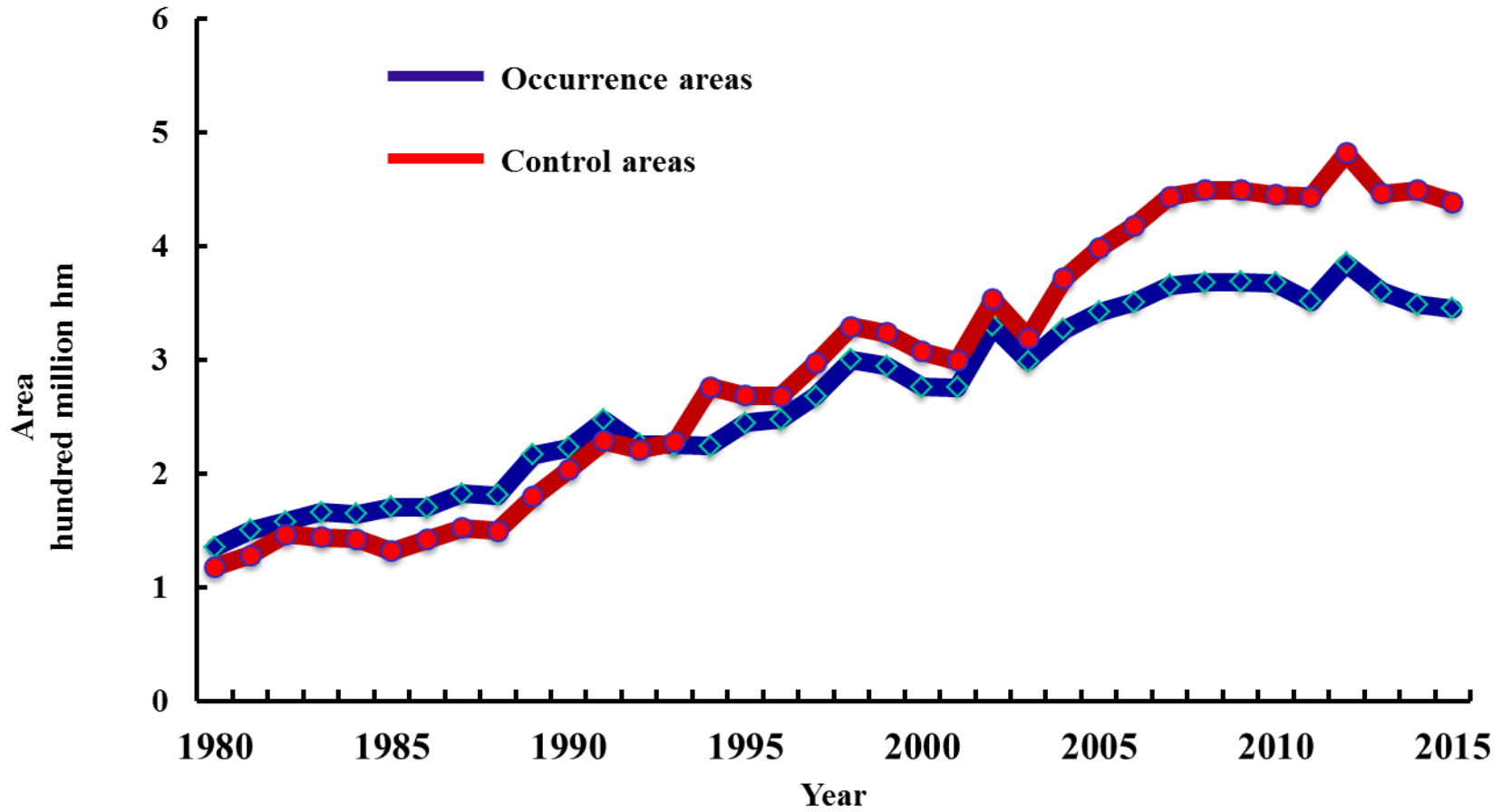
Wheat (5) : wheat aphids, stripe rust, gibberellic disease, powdery mildew,
sheath blight

Rice (4): rice planthopper, *Cnaphalocrocis medinalis*, rice blast, rice sheath blight

Maize (2): corn borer, corn leaf spot disease

Polyphagous pests (3): locust , armyworm, meadow moth

Major Pest Monitoring and Control



Major Pest Monitoring and Control

- **Spray pesticide**
- **Cultivate resistant cultivars**
- **Protection & use of bio-diversity**
- **Protection & use of natural enemies**
- **Use of non-chemical measures**

Pesticide Management

● **Pesticide reduction:** *The MOARA issued a decree to take actions via green pest management and farmer pest management cooperatives or specialized associations: Aiming at zero increment of pesticide usages along with crop intensification until 2020 in China.*

● **Green pest management:** *Strategies, tactics & technologies of non-chemical pest management were promoted aiming at reducing pesticide usages.*

In order to protect human health and environmental safety, pesticide management was strengthened and pesticide registration system was improved.

---The Regulation on Pesticide Administration and its supporting polices such as the Pesticide Registration Data Requirements, the Measures for the Administration of Pesticide Product Labels and Instructions, the Measures for the Administration of Pesticide Test Institutions were being revised.

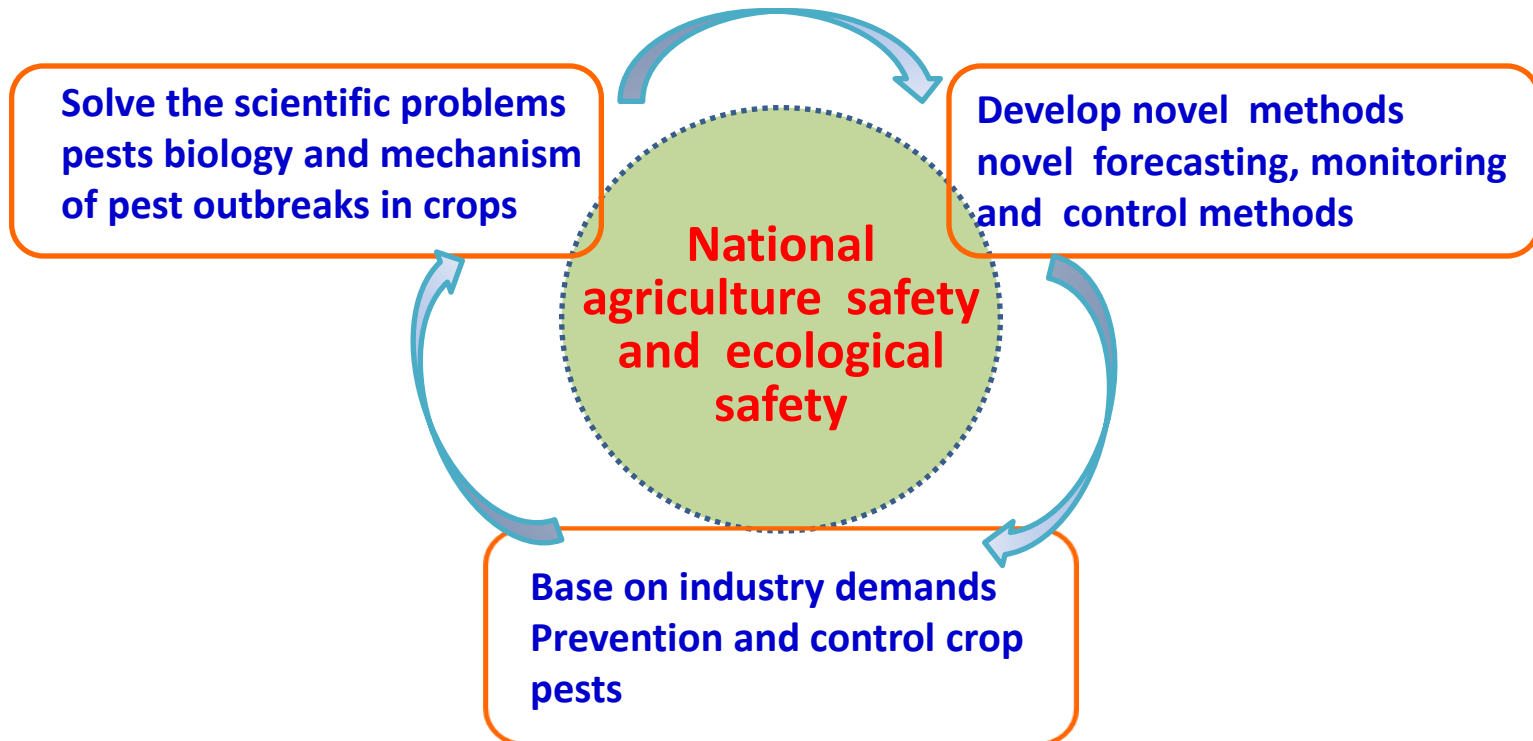
Pesticide Management

● Ban & restriction on the use of the high risk and hazardous pesticides

- *The No.2032 Notice was published by the MOARA in 2013, for the revocation and restricted use of chlorsulfuron, metsulfuron-methyl, ethametsulfuron, asomate, urbacide, chlorpyrifos and triazophos.*
- *In accordance with the No.1745 Notice, the formulation paraquat SC registration and manufacture permit were withdrawn in July 1st, 2014, and is canceled to use in July 1st, 2016.*
- *To fulfill the POPs Convention, the last production line of dicofol in the Yangnong Corporation was closed in May 17th, 2014, which marked dicofol to be completely banned in China.*

Mission and Goal

- IPP-CAAS, based on the industry demands for crop pests prevention and control, is carrying on research to explore the mechanism of pest outbreaks in crops, develop novel forecasting, monitoring and control methods, provide technology support and guarantee for sustainable development of agriculture in China



Organization

Administrative Departments

- ✓ Dept. of Research Management
- ✓ Dept. of Human Resources
- ✓ Dept. of Financial Management
- ✓ Dept. of Achievement Transformation
- ✓ Dept. of International Cooperation and Graduate Student
- ✓ General Office

Research Departments

- ✓ Dept. of Plant Pathology
- ✓ Dept. of Agricultural Entomology
- ✓ Dept. of Pesticide Sciences
- ✓ Dept. of Biological Control
- ✓ Dept. of Biological Invasions
- ✓ Dept. of Weed & Rodent Sciences and Plant Protection in Grassland
- ✓ Dept. of Biotechnology for Plant Protection

Service Departments

- ✓ Logistics service center
- ✓ Zhongbao Group Co.
- ✓ Langfang Test Base for Scientific Research

Disciplines

- ❖ Plant pathology
- ❖ Agricultural entomology
- ❖ Pesticide science
- ❖ Biological control
- ❖ Invasive species management
- ❖ Biosafety of GM crops
- ❖ Weed science
- ❖ Rodent management



Research Projects

In recent years, more than 300 national, ministerial, provincial and international research projects are under implementation

- ❖ **National Key Research and Development Plan: 13**
- ❖ **Natural Science Foundation of China (NSFC): 216**
- ❖ **Other financial funds from MOA: 52**
- ❖ **International Cooperation Project: 11**
- ❖ **EU Project: 3**
- ❖ **Others (Ministerial, Provincial, Company, etc.)**

Publications and Awards (2011-)

- ❖ Scientific Research Papers (SCI/EI): 1528
- ❖ Scientific Research Books : 113
- ❖ Awards : > 50



REPORTS

Suppression of Cotton Bollworm in Multiple Crops in China in Areas with Bt Toxin-Containing Cotton

Kong-Ming Wu,^{1,†} Yan-Hui Lu,¹ Hong-Qiang Feng,² Yu-Ying Jiang,² Jian-Zhou Zhao^{1*}



Mirid Bug Outbreaks in Multiple Crops Correlated with Wide-Scale Adoption of Bt Cotton in China

Yanhui Lu,¹ Kongming Wu,^{2,*} Yuying Jiang,² Bing Xia,² Ping Li,² Hongqiang Feng,¹ Kris A. G. Wyckhuys,^{2,†} Yuyuan Guo¹



Widespread adoption of Bt Cotton and insecticide decrease promotes biocontrol services

Yanhui Lu¹, Kongming Wu¹, Yuying Jiang², Yuyuan Guo¹, Nicolas Desneux³

Scientific Awards—National prize



First Prize of National Award for Science and Technology progress, China, 2012---

Integrated Management of Wheat Stripe Rust

➤ Key management

➤ Continuous control

➤ Comprehensive prevention

Oversummering area

Overwintering area

Epidemic area in Spring



Second Prize of National Award for Science and Technology progress, China



Research on the Establishment and Application of High - efficiency and Low - risk Technology System for Pesticides (2016)



The disastrous rule and green control methods of rice stripe and rice black-streaked dwarf disease (2016)



Research and application for the green control technology to pests of highland barley and grassland in Qinghai (2014)



Warning and Monitoring Technology of Invasive Species in Agricultural System (2013)



Assessment and Management of Ecological Safety of Bt Cotton (2010)



Multi-target insecticides for controlling outbreak of resistant insect pests (2008)



Regional migration of cotton bollworm and its monitoring and forecasting technology (2007)

Research Platforms

❖ National Key Laboratory for
Biology of Plant Diseases
and Insect Pests



❖ National Agricultural Bio-
Security Science Center



Korla, Xinjiang
Cotton, fruit and vegetable diseases and insect pests

Tianshui, Gansu
Crop rust disease

Xinlinhaote, Inner Mongolia
Rangeland diseases, insect pests, weeds and rodents

Gongzhuling, Jilin
Maize diseases and insect pests

Langfang, Hebei
Crop diseases and insect pests

Changdao, Shandong
Monitoring and forecasting of migrant insect pests by radar

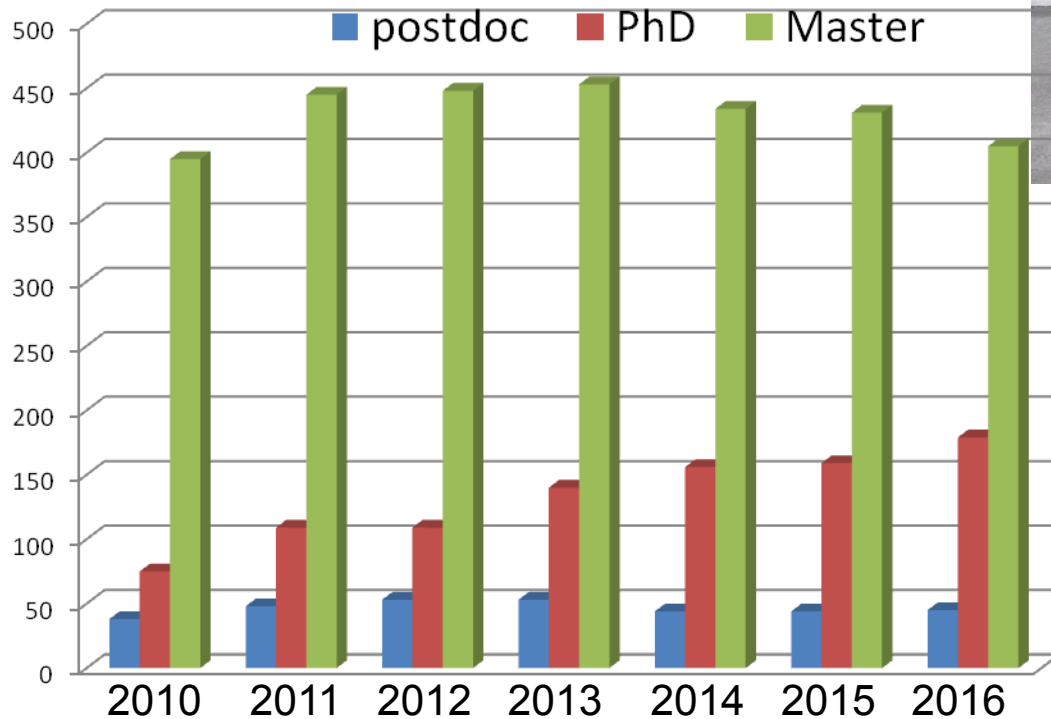
Guilin, Guangxi
Crop diseases and insect pests in South China, invasive species

Xinxiang, Henan
Cotton, wheat and rice diseases and insect pests

Eight Field Experimental Stations



Education & Training



Number of Postdoc, PhD and Master students in IPP



Contents

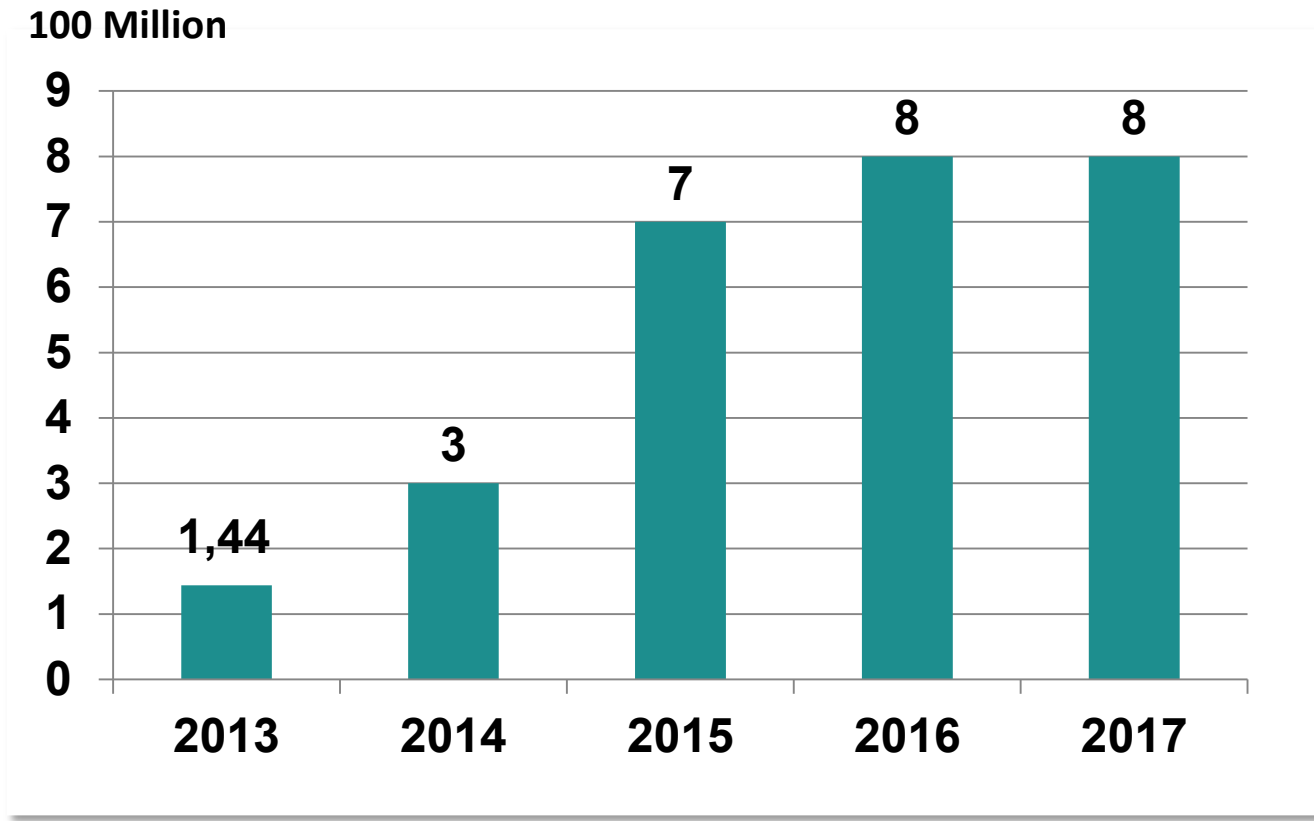
- Introduction of Institute of Plant Protection
- **Team building of ASTIP for Plant Health**
- Collaborative innovation research in China
- Importance for international cooperation

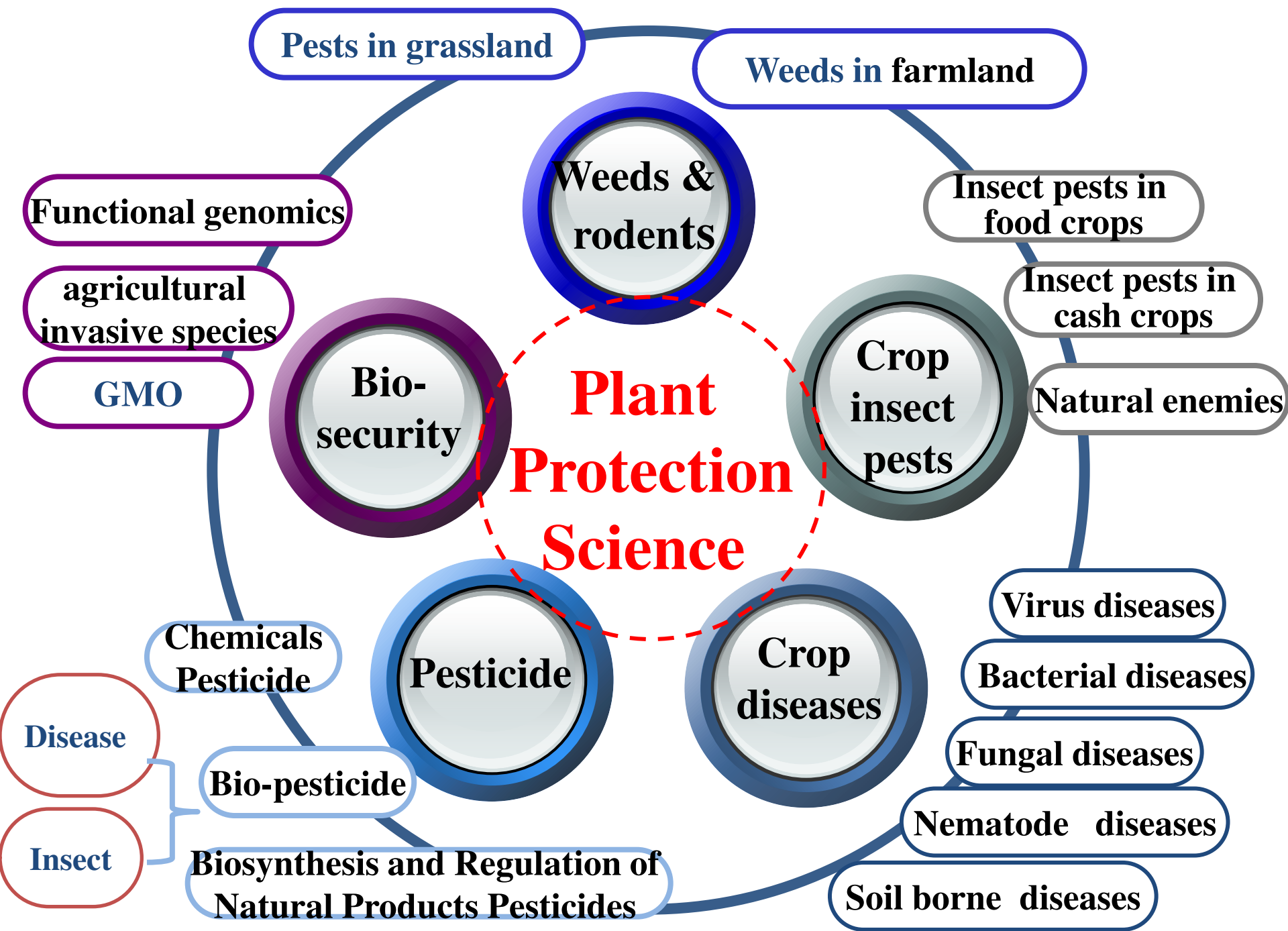
CAAS's “Meta-program”- Agricultural Science and Technology Innovation Program (ASTIP)



Budget

2013-2017 : 2.744 Billion RMB





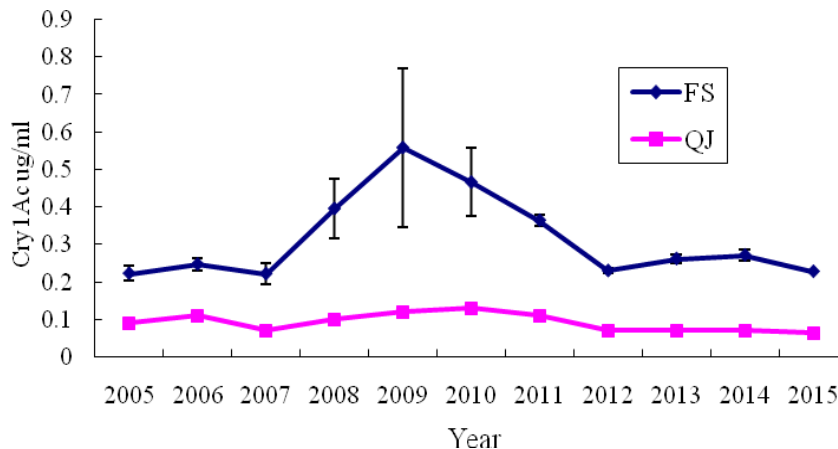
Team Construction:

17 innovation teams involved in ASTIP

- Epidemics and control of crop
 - fungal diseases (PI: Prof. [Chen Wanquan](#)); - virus diseases (PI: Prof. [Wang Xifeng](#))
 - bacterial diseases (PI: Prof. [Zhao Tingchang](#)) ; -nematode diseases (PI: Prof. [Peng Deliang](#))
- Monitoring and control of insect pests in
 - food crops (PI: Prof. [Wang Zhenying](#)); -cash crops (PI: Prof. [Lu Yanhui](#))
- Protection and application of the natural enemies (PI: Prof. [Xu Xuenong](#))
- Monitoring and management of
 - weeds in farmland (PI: Prof. [Li Xiangju](#)) ; -pests in rangeland (PI: Prof. [Zhang Zehua](#))
 - agricultural invasive species (PI: Prof. [Wan Fanghao](#))
- Pesticide chemistry and application (PI: Prof. [Zheng Yongquan](#))
- Development and application of bio-pesticides to
 - insect pests (PI: Prof. [Zhang Jie](#)) ; -plant diseases (PI: Prof. [Qiu Dewen](#))
- Safety assessment and management of biotechnology crops (PI: Prof. [Peng Yufa](#))
- Functional genomics for crop pathogens and insects (PI: Prof. [Zhou Xueping](#))
- Biosynthesis and Regulation of Natural Products Pesticides (PI: Prof. [Xiang Wensheng](#))
- Soil borne disease prevention and control (PI: Prof. [Cao Aocheng](#))

Highlights -- cash crops

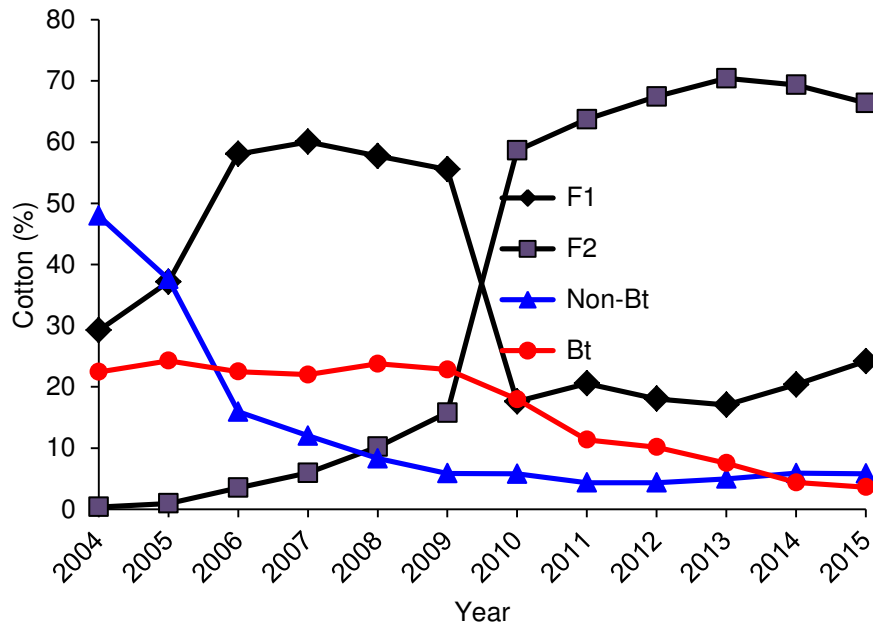
Hybridizing transgenic Bt cotton with non-Bt cotton counters resistance in pink bollworm



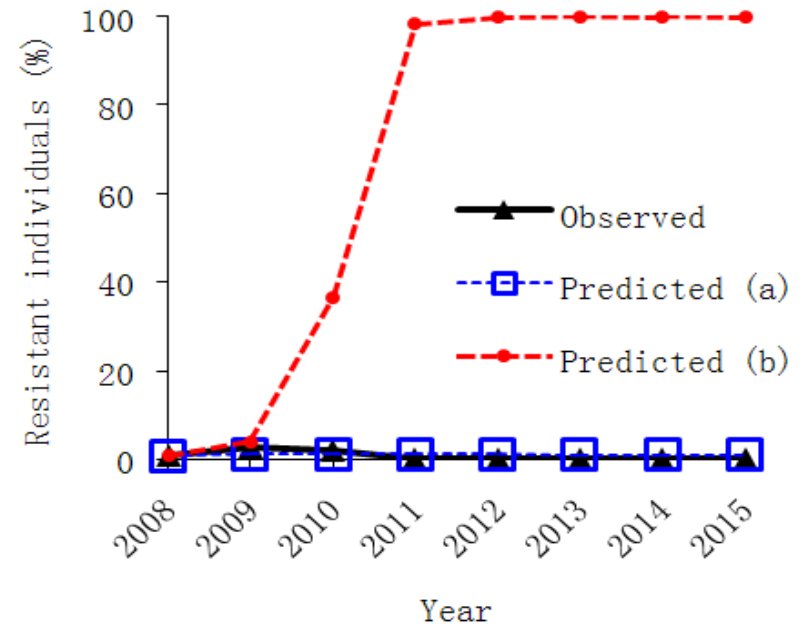
A small but statistically significant decrease in susceptibility of the pink bollworm to Cry1Ac from 2005–2007 to 2008–2010.

Without major changes, rapid increases in resistance of PBW were anticipated after 2010 because refuges of non-Bt cotton varieties had decreased to only 6% of all cotton planted.

However, the expected results did not happen. Why?



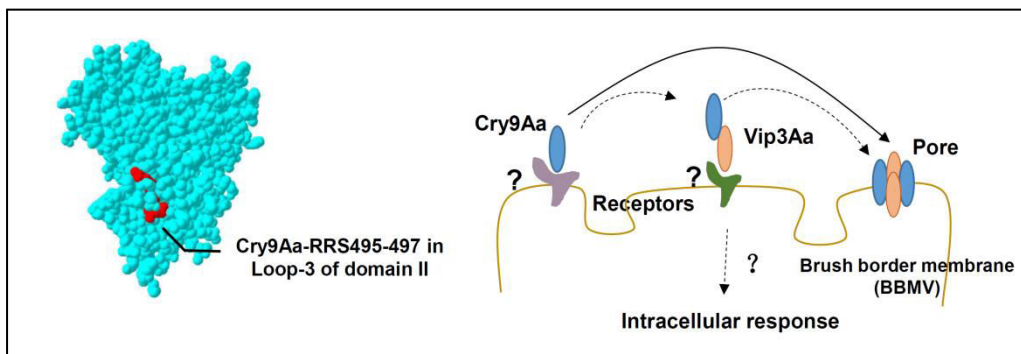
The percentage of non-Bt cotton plants increased in 2010 and subsequent years and found that more than 60% second-generation (F2) cotton hybrids was planted in the Yangtze River valley.



Increased planting of F2 hybrids from crosses between Bt and non-Bt cotton was associated with delayed evolution of pink bollworm resistance to Bt cotton.

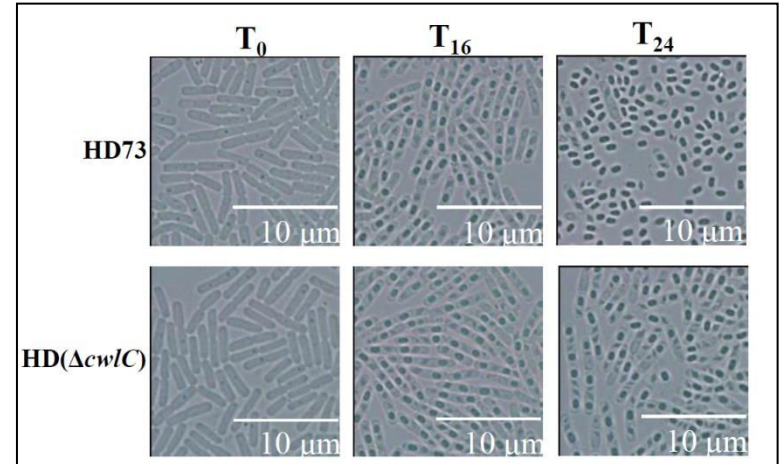
Development and Application of Bio-pesticides to Insect Pests

- More than 12000 Bt strains were isolated and stored , and some of them with high toxicity against *Lepidoptera*, *Coleoptera*, *Hemiptera*, and *Diptera* pests.
- 167 novel Bt insecticidal genes were cloned and named by Bt Endotoxin Nomenclature Committee.
- 27 patents for Bt toxin genes were obtained.
- The specifically binding of Cry9Aa and Vip3Aa toxins with BBMV and no competitive binding sites on receptors are prerequisite for synergy activity against *C. suppressalis*. The interaction between Cry9Aa and Vip3Aa proteins triggered synergistic effect on *C. suppressalis* directly.
- The peptidoglycan hydrolase CwlC was identified to be an N-acetylmuramoyl-L-alanine amidase. Deletion of *cwlC* completely blocked mother cell lysis in the late sporulation stage without affecting sporulation frequency and Cry1Ac protein production.
- Pesticide registration certificate of *Bacillus thuringiensis* engineering strain G033A. It is the first approved transgenic-insect resistant engineering strain in China, but also the first official registration of Bt products controlling coleopteran pests in China.



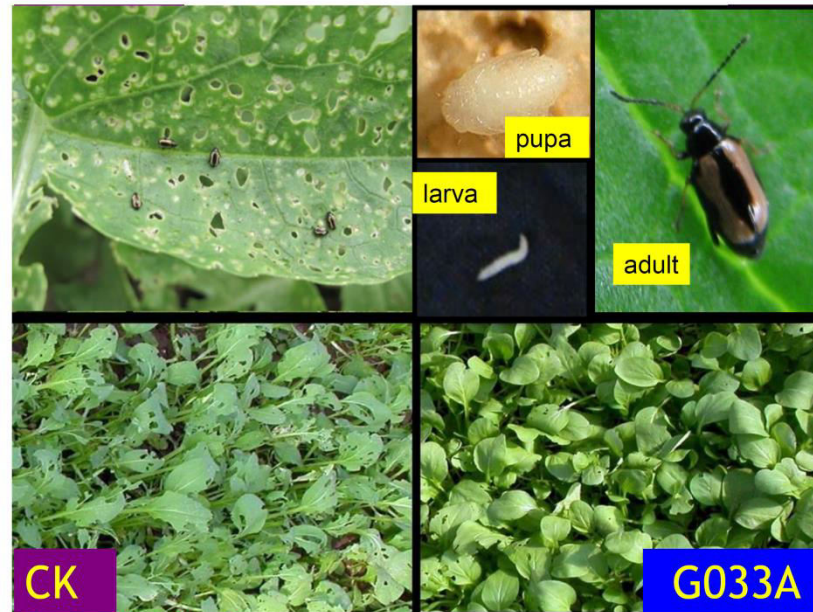
The interaction between Cry9Aa and Vip3Aa
(Wang Z.Y. et al., *Journal of Biological Chemistry*, 2018)

The specifically binding of Cry9Aa and Vip3Aa toxins with BBMV and no competitive binding sites on receptors are prerequisite for synergy activity against *C. suppressalis*. The interaction between Cry9Aa and Vip3Aa proteins triggered synergistic effect on *C. suppressalis* directly.



Lysis of mother cells of Bt was observed by optical microscopy
(Chen X.M. et al., *Applied and Environmental Microbiology*, 2018)

The peptidoglycan hydrolase CwIc was identified to be an N-acetylmuramoyl-L-alanine amidase. Deletion of *cwIc* completely blocked mother cell lysis in the late sporulation stage without affecting sporulation frequency and Cry1Ac protein production.



Flea beetle of leaf

Have get pesticide registration certificate of *Bacillus thuringiensis* engineering strain G033A. It is the first approved transgenic-insect resistant engineering strain in China, but also the first official registration of Bt products controlling coleopteran pests in China.

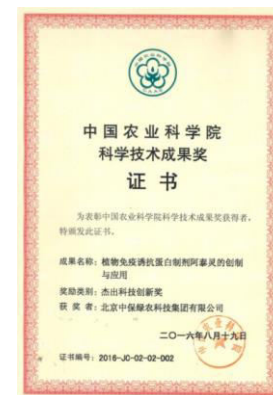
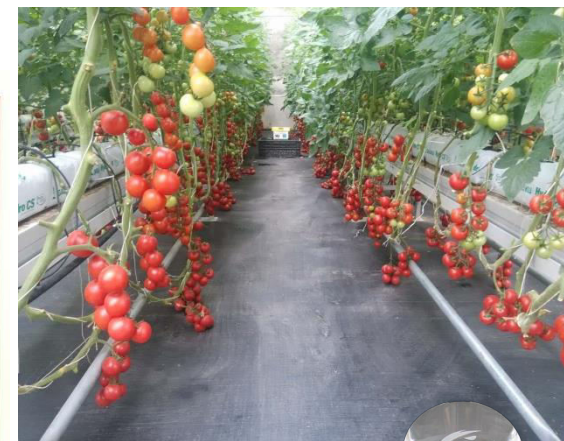
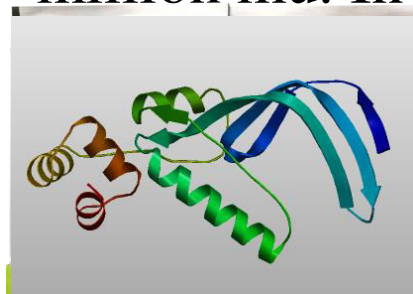
Bt engineering strain G033A

Development and Application of Bio-pesticides to Plant Diseases

- The research and development of bio pesticide products have made great achievements : plant immune inducer, Wuyi mycin, *Metarhizium anisopliae*, *Trichogramma*, *Beauveria bassiana*, Zhong Bao B2a powder, etc. A total of nearly twenty million yuan has been obtained from their patents, and more than ten commercially available biological pesticide products have been launched to the market.



- Among them, "Atailin " plant immunity protein biologic pesticide is a national patent product exclusively developed by IPP with 6 patents and 7 S & T Awards. It is the key promotion product of the National Agricultural Technology Extension Center and the listed brands of CCTV-7. Over the past four years, more than 1500 tons of production were accumulated, and the average annual application area was 10 million mu. In 2017, the market value was 100 million.



Technologies for controlling soil-borne diseases



1. Fumigants injection



2. Soil mixture



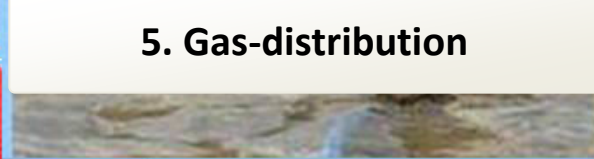
5. Gas-distribution



3. Chemigation



4. Gel-capsules



6. flaming



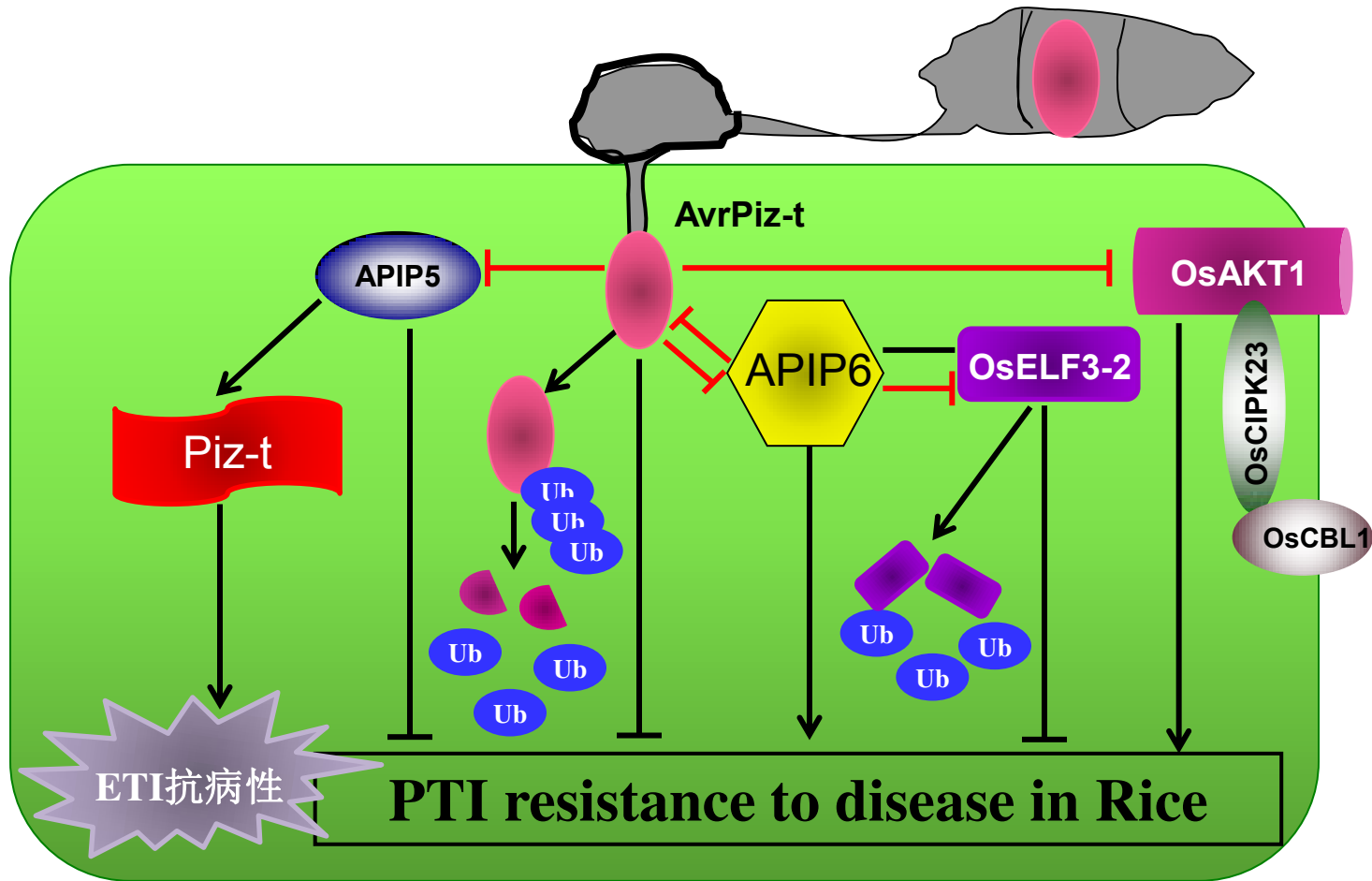
7. bio-fumigation



Soil treatment technologies were applied for controlling devastating diseases, such as ginger bacterial wilt, notoginseng root rot, yam soil borne diseases, successfully.

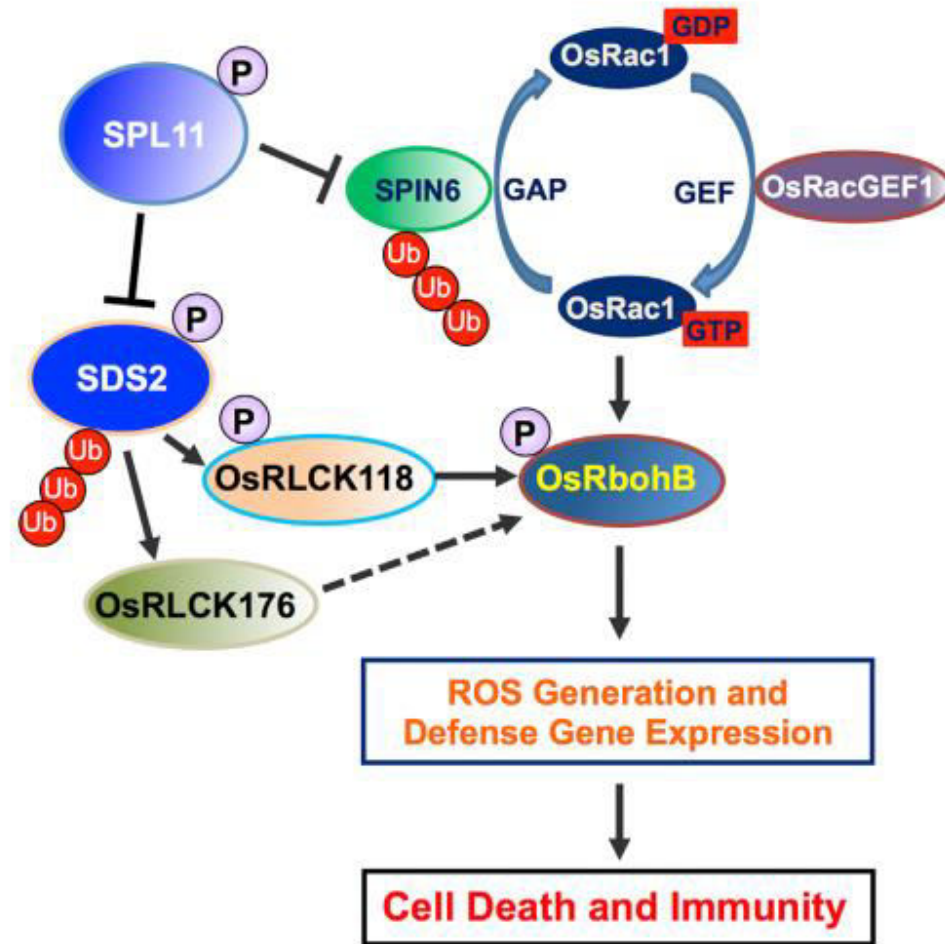


AvrPiz-t-Piz-t-mediated resistance mechanism against *Magnaporthe oryzae*



Ning et al., *Molecular Plant*, 2015
Ning et al., *Molecular Plant*, 2016
Wang et al., *Current Biology*, 2016
Shi et al., *PLoS Pathogens*, 2018

SPL11-mediated programmed cell death and immune signaling pathway in rice

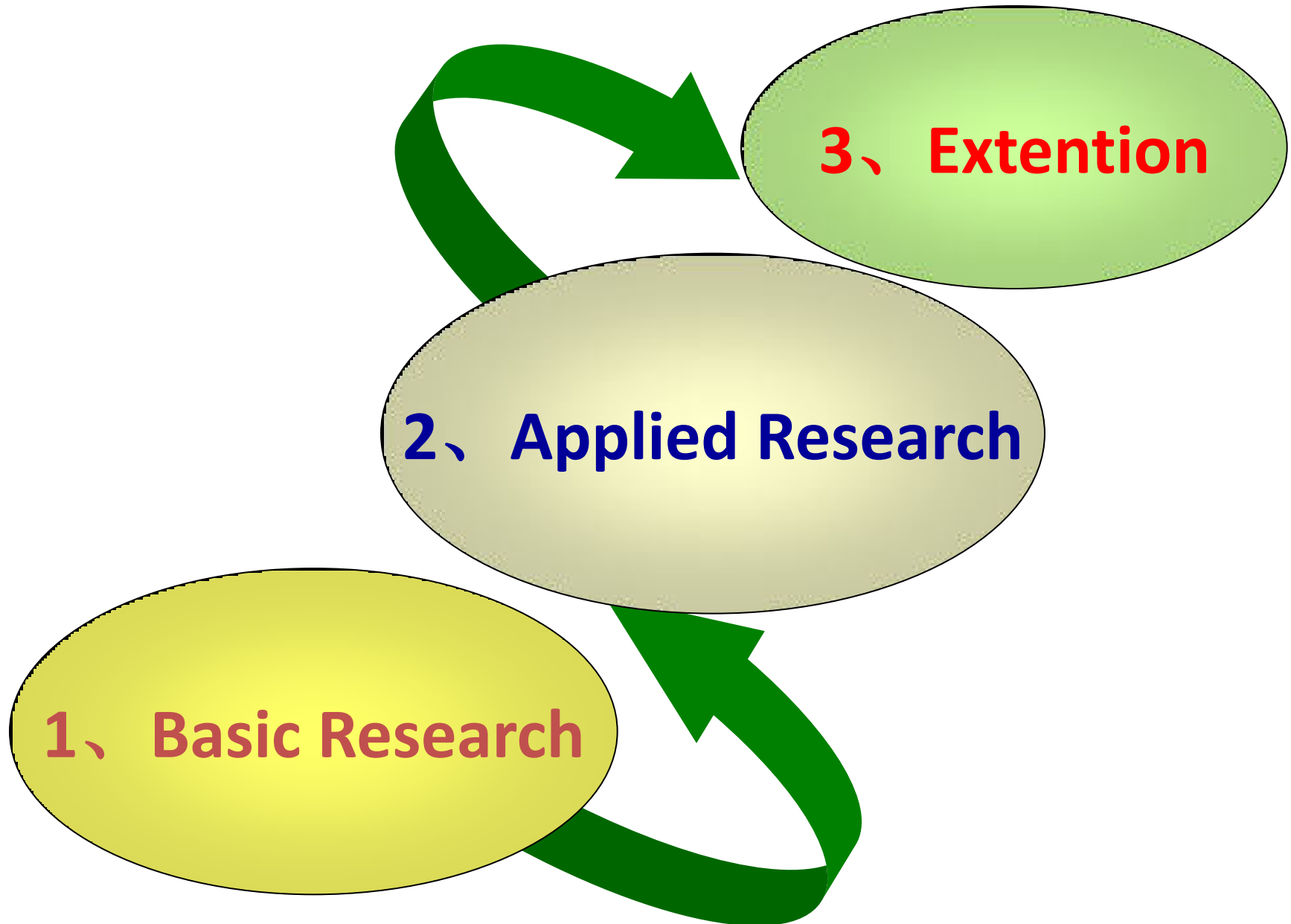


Liu et al., *Plant Physiology*, 2012
Liu et al., *PLoS Pathogens*, 2015
Fan et al., *Cell Host & Microbe*, 2018

Contents

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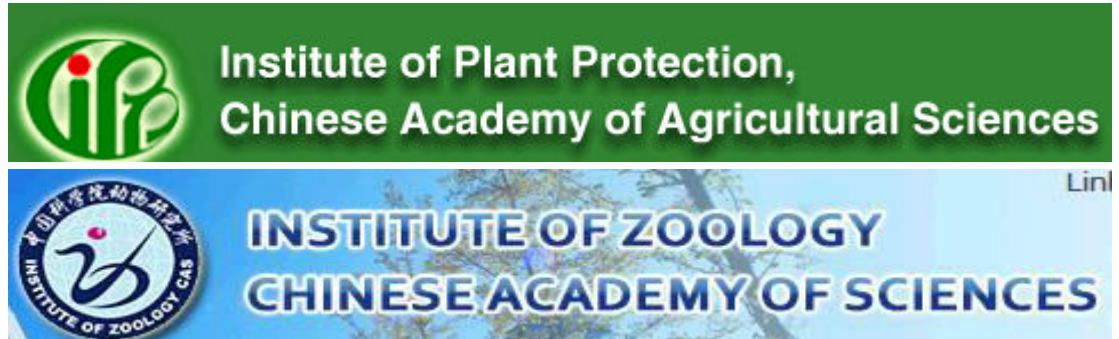
Basic Frame on Research System



Basic Research on Plant Health

□ Organizations

Research
Institution



College/
University



More than 30 Universities working on
the basic research on plant health

Zhejiang University

China Agricultural University

Nanjing Agricultural University.....

Basic Research on Plant Health

□ Progress (5 years)-*Representative papers*

Advances in Understanding Begomovirus Satellites

Xueping Zhou

Novel Insights into Rice Innate Immunity Against Bacterial and Fungal Pathogens

Wende Liu,¹ Jinling Liu,² Lindsay Triplett,³ Jan E. Leach,³ and Guo-Liang Wang^{1,4}

Playing on a Pathogen's Weakness: Using Evolution to Guide Sustainable Plant Disease Control Strategies

Jiasui Zhan,^{1,2,*} Peter H. Thrall,³ Julien Papaix,^{4,5} Lianhui Xie,² and Jeremy J. Burdon³

Molecular Mechanisms of Nematode-Nematophagous Microbe Interactions: Basis for Biological Control of Plant-Parasitic Nematodes

Juan Li,¹ Chenggang Zou,¹ Jianping Xu,² Xinglai Ji,¹ Xuemei Niu,¹ Jinkui Yang,¹ Xiaowei Huang,¹ and Ke-Qin Zhang¹

Role of Alternate Hosts in Epidemiology and Pathogen Variation of Cereal Rusts

Jie Zhao,¹ Meinan Wang,² Xianming Chen,^{3,*} and Zhensheng Kang^{1,*}

New Insights into Mycoviruses and Exploration for the Biological Control of Crop Fungal Diseases

Jiatao Xie^{1,2} and Daohong Jiang^{1,2,*}

6 papers published in Annual Review of Phytopathology

Basic Research on Plant Health

□ Progress (5 years)-*Representative papers*

Advances in Silkworm Studies
Accelerated by the Genome
Sequencing of *Bombyx mori**

Qingyou Xia,^{1,†} Sheng Li,² and Qili Feng³

Invasion and Management
of Agricultural Alien
Insects in China

Fang-Hao Wan^{*,†} and Nian-Wan Yang[†]

Red Turpentine Beetle:
Innocuous Native Becomes
Invasive Tree Killer in China

Jianghua Sun,¹ Min Lu,¹ Nancy E. Gillette,^{2,*}
and Michael J. Wingfield³

Molecular Mechanisms of
Phase Change in Locusts

Xianhui Wang¹ and Le Kang^{1,2,*}

Biology, Ecology,
and Management
of the Diamondback
Moth in China

Zhenyu Li,¹ Xia Feng,^{1,*} Shu-Sheng Liu,²
Minsheng You,³ and Michael J. Furlong⁴

Whitefly Parasitoids:
Distribution, Life History,
Bionomics, and Utilization

Tong-Xian Liu,^{1,*} Philip A. Stansly,² and Dan Gerling³

6 papers published in Annual Review of Entomology

Basic Research on Plant Health

□ Progress (5 years)-*Representative papers*

nature
biotechnology

ANALYSIS

Large-scale test of the natural refuge strategy for
delaying insect resistance to transgenic Bt crops

Lin Jin¹, Haonan Zhang¹, Yanhui Lu², Yihua Yang¹, Kongming Wu², Bruce E Tabashnik³ & Yidong Wu¹

LETTER

Nature

doi:10.1038/nature14286

**Two insulin receptors determine alternative wing
morphs in planthoppers**

Hai-Jun Xu^{1*}, Jian Xue^{1*}, Bo Lu¹, Xue-Chao Zhang¹, Ji-Chong Zhuo¹, Shu-Fang He¹, Xiao-Fang Ma¹, Ya-Qin Jiang¹, Hai-Wei Fan¹,
Ji-Yu Xu¹, Yu-Xuan Ye¹, Peng-Lu Pan¹, Qiao Li¹, Yan-Yuan Bao¹, H. Frederik Nijhout² & Chuan-Xi Zhang¹

Nature

LETTER

doi:10.1038/nature11153

**Widespread adoption of Bt cotton and insecticide
decrease promotes biocontrol services**

Yanhui Lu¹, Kongming Wu¹, Yuying Jiang², Yuyuan Guo¹ & Nicolas Desnoux³

Applied Research on Plant Health

□ Organizations

CAAS and some universities, working on both basic and applied research, and more than 30 local plant protection institutions for each Province are also the main organizations working on applied research



Zhejiang Academy of Agricultural Science

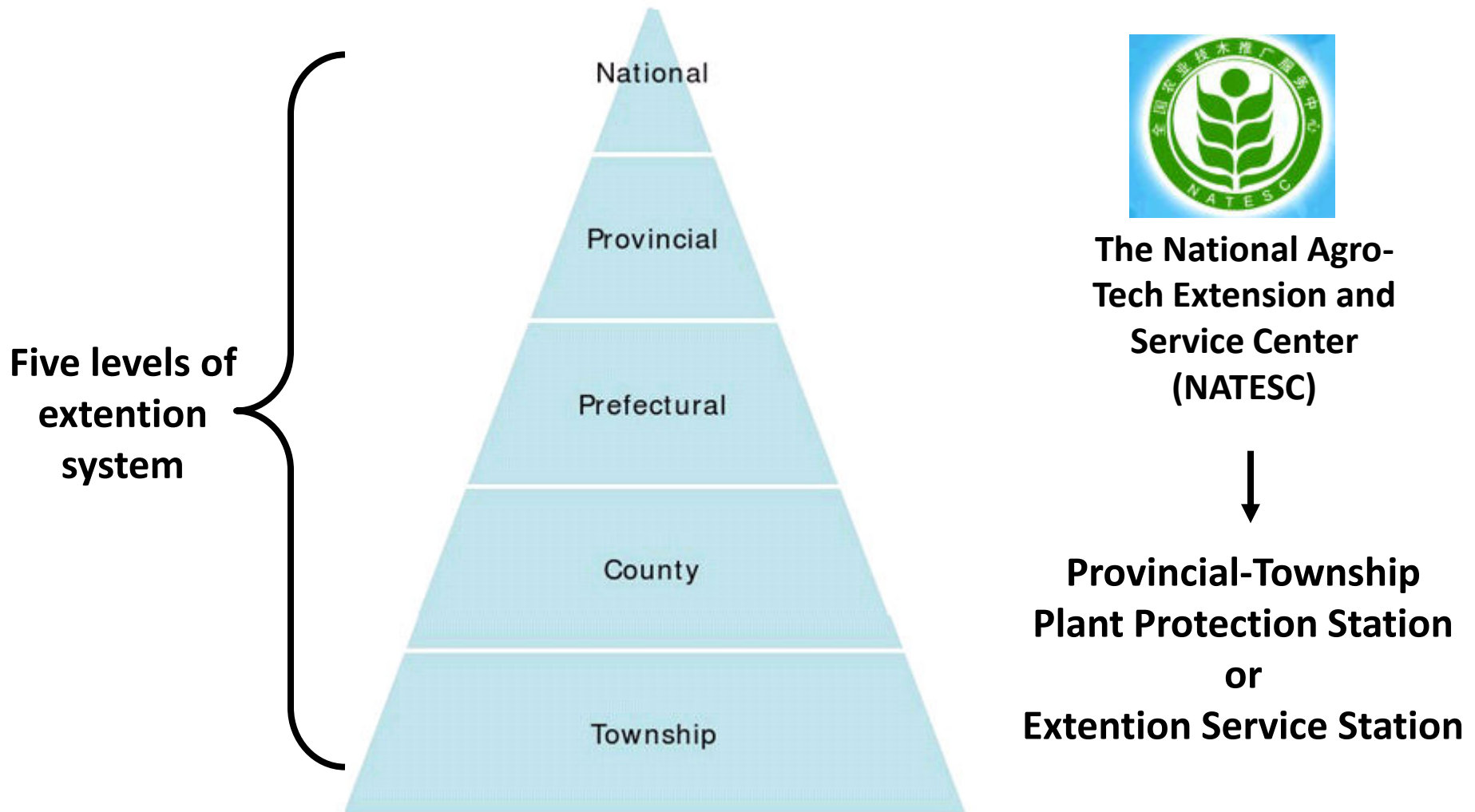
Jiangsu Academy of Agricultural Science

Shandong Academy of Agricultural Science

Beijing Academy of Agricultural Science.....

Extension

□ Framework of technology extension system



□ Main Methods of Extension System



Government-oriented extension



Farmers's demand-oriented extension

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International Cooperation and Exchanges



Partnership with 40 agricultural research agencies in more than 30 countries and international organizations

International Research Platform

National Center for International Research

- ✓ Established in 2012 by Ministry of Science and Technology
- ✓ National Center for International Research of Agricultural Bio-security



MOA-CABI Joint Laboratory of Bio-safety

- ✓ Established in 2008 by MOA and CABI
- ✓ 2 EuropeAid funded projects
 - GMSRice IPM project (1.984 million Euros)**
 - GMSMaize IPM project (2.818 million Euros)**
- ✓ Research collaboration including control of migrant pests, prevention and control of invasive alien species, IPM technologies
- ✓ Dr. Ulrich Kuhlmann received “Chinese Government Friendship Award” in 2012.



中国农业部与国际应用生物科学中心
生物安全联合实验室

MOA-CABI Joint
Laboratory of Bio-safety



Sino-American Biological Control Laboratory

- ✓ Established in 1988 by CAAS and USDA-ARS
- ✓ Introduction of resources and development of novel techniques for biological control of plant diseases, insect pests and weeds
- ✓ Joint Lab will be establish in Beltsville, Maryland, USA, collaborating with USDA-ARS



Vice minister of USDA, Cattie Woteki visited CAAS

China-Australia Joint Centre for the Prevention and Management of Exotic Invasive Species

- ✓ **Signed CENTRE AGREEMENT in June 2015**
- ✓ **Established in September 2015 by CAAS and Murdoch University**
- ✓ **To undertake projects development, staff and students exchange, development of a lead international e journal, information exchange, etc.**



International Conference

The 'Belt & Road' Plant Protection International Consortium & Multi-lateral Collaboration Programme Development Consultation Workshop

Multi-lateral collaboration: A call to governments, non-governmental and international organizations and other interested actors in the field of plant health along OBOR countries following the principle of mutual benefits and safety to agree on more profound, high level and deep regional collaboration in agriculture.



Changchun, China, 10-12 Sept. 2015



The 13th International Cereal Rusts and Powdery Mildews Conference in 2012



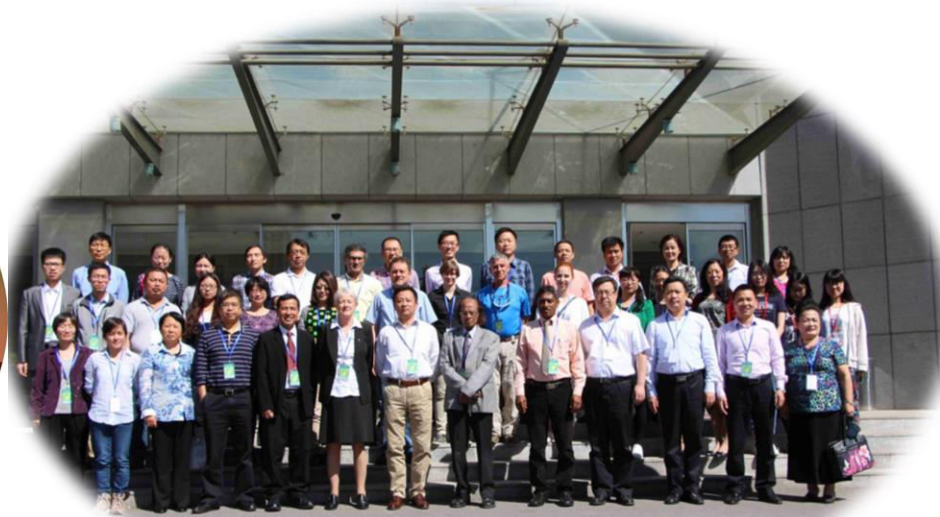
International Radar Technology Workshop in 2011



International Congress on Biological Invasions in 2009, 2013, 2017



The 6th International Weed Science Congress in 2012

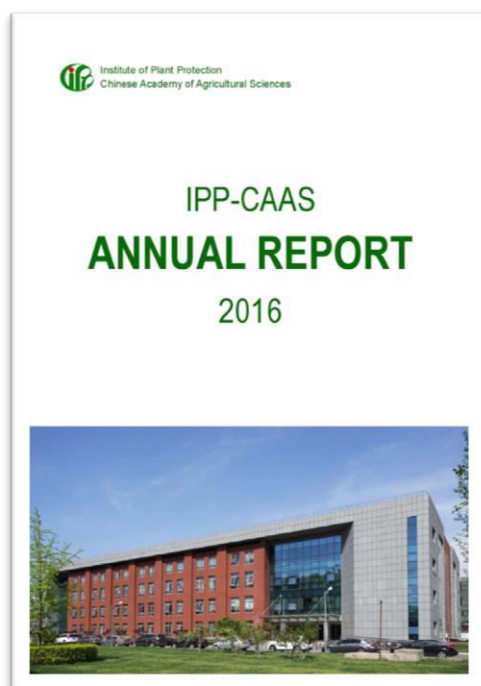


The 1st International Workshop of IOBC-APRS-Predatory Mites as Biological Control Agents Working Group in 2016



The 1st 2nd 3rd Beijing International Symposium on Molecular Plant Pathology in 2011, 2013, 2015, 2017

Newsletter and Annual Report



Center for International Agriculture Research (CIAR) for BRI



中国农业科学院

海外农业研究中心

Center for International Agricultural Research, CAAS



海外植物保护研究室

- Found in January 2016
- A state-level international center for scientific research and a thinking tank, providing information and agricultural talents training.

- International Agricultural Scientific Research

- International Agriculture Information Service

- Agricultural Technology “Go Global”

- Cultivate international agricultural talents

Take lead in cooperation issues nationwide



Key Areas for International Cooperation

- ❖ Regional monitoring and management of important harmful cross-border organisms
- ❖ Risk assessment and control of invasive alien species
- ❖ Introduction of insect natural enemies, microorganism for biological control, and germplasm resources resistant to plant diseases and insect pests
- ❖ New theories and methods for control of important harmful organisms

A misty, blue-toned landscape with a pagoda on a distant mountain peak. The scene is layered with mountains and dense forests, creating a sense of depth and tranquility. The text "Thank you!" is overlaid in a bold, red, italicized font.

Thank you!

Plant Pathology



Wheat rusts



Rice bacterial blight

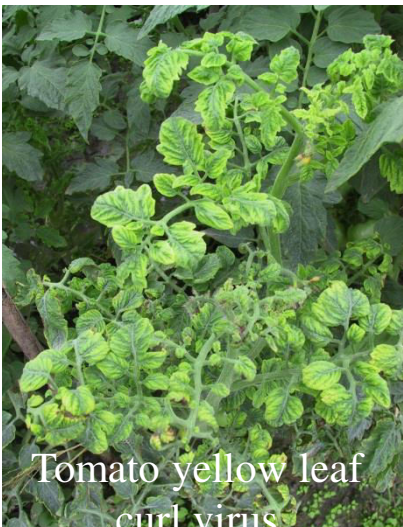


Powdery mildew



Cotton *Fusarium* wilt

- ❖ Plant-pathogen interaction
- ❖ Biology and pathogenicity of pathogen
- ❖ Integrated plant disease management
- ❖ Epidemiology & forecasting of plant diseases



Tomato yellow leaf
curl virus



Rice stripe virus



Soybean cyst nematode



Potato bacterial blight



Agricultural Entomology



- ❖ Integrated insect pests management
- ❖ Insect biology and behavior
- ❖ Insect ecology
- ❖ Monitoring and forecasting of insect pests



Cotton blind stink bug
Apolygus lucorum



Asian corn borer
(*Ostrinia furnacalis*)



Beet webworm
(*Loxostege sticticalis*)



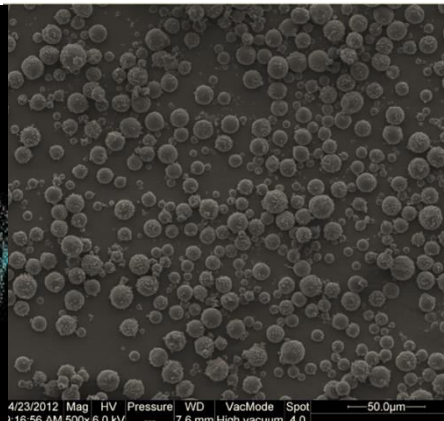
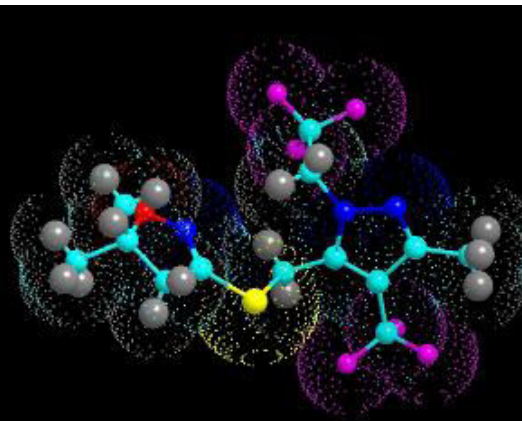
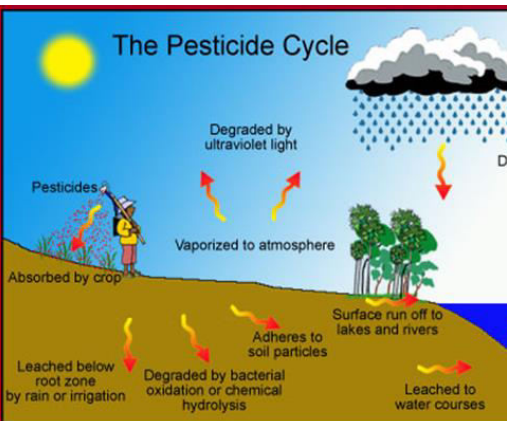
Army worm
(*Mythimna separata*)



Pesticide Science



- ❖ New Agrochemicals Design and Synthesis
- ❖ Pesticide formulation
- ❖ Biology, application technology of pesticides
- ❖ Pesticide Residue and Environmental Fate
- ❖ Pesticide environmental toxicology





Biological Control



- ❖ Biological Control to Insect Pests, Plant diseases and weeds
- ❖ Natural enemies mass rearing and release application
- ❖ Biopesticide developing , formulating and application



Bemisia tabaci



Bactrocera dorsalis



Invasive Biology

- ❖ Biology, ecology of invasive alien species (IAS)
- ❖ Risk forecasting methods of IAS
- ❖ Control tactics of IAS

Cydia pomonella



Eupatorium adenophorum



Ambrosia artemisiifolia

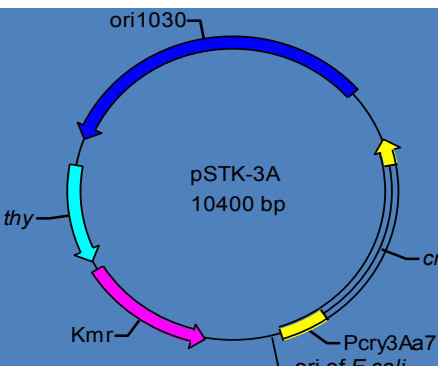


Alternanthera philoxeroides



Biosafety of GM Crops

- ❖ Impacts of transgenic plants on pest evolution
- ❖ Management of target pest resistance to transgenic plants
- ❖ Impact of GMOs on diversity of agricultural ecosystem



Weed Science

- ❖ Weed biology, physiology & ecology
- ❖ Integrated weed management
- ❖ Weeds resistance to herbicide



Rodent management

- ❖ Behavior of rodents
- ❖ Integrated rodent management
- ❖ Rodent resistance to rodenticide
- ❖ Mechanism of population outbreaks of rodent

