As an internationally renowned plant molecular biologist, Professor Jiayang Li is now wearing the heavy hat of the Vice-Minister of Agriculture and the President of Chinese Academy of Agricultural Sciences (CAAS). During an interview with NSR, Li talked about the recent development of the CAAS innovation program, the mission of CAAS in fulfilling the country’s needs, the promises of ‘molecular breeding by design’, the public concerns on genetic modified food and how he maintains an active laboratory amid heavy administrative duties.

REACHING FOR THE SKY WHILE ROOTING TO THE GROUND

NSR: You had previously served as Vice-President of Chinese Academy of Sciences (CAS), what is the difference between CAAS and CAS in their agricultural research?

Li: CAS pays more attention to the science frontier, whereas research programs in CAAS institutes and research centers (http://www.caas.cn/en/about_caas/basic_facts/index.shtml) are tightly linked to national needs. Some programs are geared towards solving bottle-neck problems in agriculture in a targeted time frame.

After taking the position at CAAS in 2011, I made extensive visits to CAAS institutes across the country and consulted with many scientists. There is an old saying in CAAS that ‘scientific papers shall be written on the ground, and achievements shall be recognized by farmers’, implying the importance of linking research to agricultural productions. However, I think now we should set an even more prestigious goal for CAAS—research...
papers from CAAS shall also make substantial contribution to
science, and our achievement should be visible in the interna-
tional community. We believe that ‘reaching for the sky while
rooting to the ground’ should be the long-term strategic goal of
CAAS.

Traditional breeding is a practical tool that is deeply rooted
to the ground. However, developments in molecular breeding
offer new technologies that can facilitate traditional breeding.
The genome sequencing of rice, wheat, corn, potato, cucumber
and cabbage, and the dissection of many important func-
tional genes in recent years allowed us to pin-point which gene
locus controls which trait. These studies allowed us to identify
many molecular markers that can be used for precision breeding
with multiple traits. Through such research, we have made im-
portant progresses in fundamental plant science and published
many papers in high-profile journals such as Nature, Science and
Nature Genetics. For example, recent sequencing of the cucum-
ber genome followed by large-scale genome-wide association
studies (GWAS) has allowed us to identify eight genes that are
responsible for the bitterness in cucumber fruits. Such informa-
tion will be used to remove the bitter taste in cucumber breeding.
This is a good example of research that is reaching for the sky and
at the same time rooting to the ground.

THE AGRICULTURAL SCIENCE AND TECHNOLOGY
INNOVATION PROGRAM

NSR: What programs have you initiated to attain this research
goal?
Li: We have implemented an Agricultural Science and Technol-
ogy Innovation Program (ASTIP) to reform the research activ-
ities in CAAS since late last year. The first three years of ASTIP
will be devoted to assembling research teams, setting research
strategies and establishing evaluation mechanisms. This will be
followed by two 5-year phases for development and optimiza-
tion, respectively. This program is similar to the CAS’ Knowl-
edge Innovation Program initiated in 1998 in some aspects, but
distinct in its operation and evaluation mechanisms. Researches
in CAS are mostly curiosity driven and initiated by individual
principal investigators (PI). In CAAS, we were hoping to assem-
ble research teams based on national interests and initiate re-
search programs that integrate multiple teams of different expert-
ise throughout the academy.

In practice, we have sorted research activities of CAAS
into eight disciplinary clusters including crop science, horti-
culture science, animals science, veterinary science, agricul-
tural resources and environment, agricultural mechanization
and engineering, agro-product quality, safety science and process-
ing, and agricultural information and economics (http://www.caas.
cn/en/research/disciplinary_clusters/index.shtml). These clus-
ters are further divided into over 100 research areas, and each
area consists of several research directions and each direc-
tion is executed by a research team. In some interdisciplinary
areas, several research teams with closely related directions are
formed. For example, in the area of wheat research, there are se-
parate teams for yield, grain quality as well as disease and insect
resistances. In principle, we hope each well-structured research
team shall have one chief scientist, about three core research
scientists, several well-trained technical staff and some graduate
students.

NSR: Are these teams organized by a top-down or bottom-up
approach?
Li: This is a critical question. We decided to organize these
teams primarily by a two-way approach. Each institute within
CAAS will formulate and propose to CAAS several research
directions within their specialty areas. Based on evaluations of
expert committees, the CAAS management team will assign cer-
tain research directions to each institute. In the past, each in-
stitute may have 30 to 80 research directions. Now we need to
identify only 10 to 20, enforcing researchers to collaborate with
each other.

NSR: How to ensure the efficiency of these research teams?
Li: A good evaluation system is critical. We are trying to estab-
lish a fair and performance-based evaluation scheme, offering
chief scientists the freedom and responsibilities in using research
funds, as well as in deciding the salaries of their team members
including themselves to some degree. Those chief scientists, who
are unable to evaluate their team members’ performance fairly or
fail to achieve their goals in time, will have to step down. In the
meantime, collaborations among different teams are enforced at
the institute level in order to solve difficult problems and to at-
tain significant achievement.

NSR: Flexibility of using research funds is a recurring issue in
many Chinese research institutions. How does CAAS deal with
this issue?
Li: This is related to national fiscal regulations—indeed there is
very little flexibility in using research funds. People complained
that ‘money for soy sauce is not allowed to be spent on vinegar’,
and all funds have to be spent by the end of the fiscal year. This
inflexibility has hampered effective research operation. Ministry
of Finance is currently considering to reform grant management
policies to increase the flexibility.

In the USA, government agricultural research institutions re-
cieve stable funding for salaries, research facilities and opera-
tions. The potential drawback of such an ‘eating from a big bowl’
funding system is the lack of personal drive for research achieve-
ment. However, we here have the opposite problem. Govern-
ment’s regular subsidy to CAAS covers approximately 30% of
our researchers’ total salaries. The remaining 70% have to be
earned through projects by themselves. We hope this will be

“We believe that ‘reaching for the sky while rooting to the
ground’ should be the long-term strategic goal of
CAAS.

—Jiayang Li
Distribution of the CAAS institutes. (Courtesy of CAAS)

changed, allowing roughly 50% directly from the government and the remaining from other resources.

NSR: How do research discoveries in CAAS translate into downstream application and commercialization?

Li: Some of the discoveries are commercialized via patent licensing, and others are commercialized directly by CAAS institutes themselves, which will ensure certain incomes to the institute for supporting their research.

NSR: Can you summarize international collaborative programs in CAAS?

Li: The Department of International Collaboration of CAAS is responsible for promoting collaborations with foreign universities, research organizations and companies. We have collaborations with over 80 countries in various forms such as co-funded laboratories, collaborative projects and scholar exchanges. To be noted, CAAS has the world’s second largest (and Asia’s largest) crop germplasm center with over 430,000 accessions, which are important resources that can be shared with international collaborators.

FORTHCOMING AGRICULTURAL REVOLUTION

NSR: The development of hybrid rice was a technological revolution in rice breeding. Can molecular breeding lead to another revolution?

Li: Breeding is at the eve of another technological revolution. The new technology is called ‘molecular breeding by design’ (also called ‘molecular breeding’ in short), which shall allow us to improve the quality and yield of many crops effectively, and shorten the translation from the lab to the field. For example, by combining genomic technology and molecular breeding, my team has identified major genes and regulation networks underlying eating and cooking qualities of rice, and has generated varieties with good qualities and high yield.

NSR: How do you use molecular breeding to increase the crop yield?

Li: Yield is the most important factor for crop production. Many crops including rice still have extensive yield potentials. Although rice in China has relatively high yield (about 7000 kg per hectare) as compared to most other countries in the world, it is still far away from the theoretical yield, which is 12,000 to 15,000 kg per hectare under optimal conditions. Many factors such as plant architecture, growth length, stress tolerance, water and nutrient use efficiencies, and soil condition may affect the rice yield. In recent years, a lot of genes determining plant architecture and grain quality have been characterized in rice. By combining these genes with stress-tolerant traits through molecular breeding, we shall be able to develop high-yield and high-quality varieties suitable for different regions.

NSR: What is the role of molecular breeding in dealing with global climate change?

Li: Climate change is a fact. Our agriculture has been affected greatly by the climate change. Since China is located in the monsoon region, climate change has brought us many natural disasters and caused frequent extreme weathers such as drought, heavy rainfall, very high and very low temperatures. Furthermore, climate change also led to some ecological changes, for example, in insect activities and migration habits. The elevated atmospheric CO₂ concentration for sure has affected photosynthesis activities in crops. Molecular breeding may help to develop new varieties that are able to tolerate these adverse climates to some extents. We should also realize that agriculture is a complex system that requires collaborative works from different aspects to ensure sustainable crop productions. For instance, the construction of agricultural facilities, the development of
agricultural mechanization and the application of information technologies are all very important.

PUBLIC EDUCATION ON GM FOODS

**NSR:** Crop breeding actually covers many technologies including genetic modification (GM). What is your view on the current debates in GM foods?

**Li:** In China, GM has not yet been used in major food crops. At the moment, GM in crop improvement is a very slow process, mainly because of many social barriers to overcome. What we could do now is to use molecular breeding to develop new varieties. This is an efficient and more targeted way of breeding as compared to traditional breeding. Since no biosafety issue is involved, it is faster in practice.

China used to be the leading country in the world in GM, even more advanced than the USA, for example, the virus-resistant GM tobacco developed in the Institute of Microbiology, CAS, in the 1990s. But now China has lagged behind in GM applications. We ranked only on the sixth in the world in the acreage of planting GM crops. Although GM soybean and corn are consumed in large quantity in China, they are imported from abroad. The current government regulation requires extensive and elaborate evaluations before GM crops could be marketed. In my opinion, the dispute on GM foods in China at the moment is linked to the fickleness of the general public and the irresponsibility of some media. The GM controversy is more a sociological issue than a scientific one. The concern of food safety including GM demands extensive public education.

**NSR:** Does CAAS have any programs and plans in public education?

**Li:** CAAS currently has public education in three areas: (1) the principles and applications of new technologies including plant breeding, genetic engineering and soil science; (2) the meanings of eco-agriculture, modern agriculture and organic agriculture, since definitions of these terms are confusing to the general public; (3) food nutrition and food safety, as public has misconception and the standards for nutrition and safety are far from perfect.

TRAINING OF AGRICULTURAL SPECIALISTS

**NSR:** What is the role of CAAS in training future agricultural researchers?

**Li:** We urgently need people with expertise in agricultural productions and technology applications. For example, we are short of technicians who can work in the field and give supports to farmers. In Israel, for example, about 80% to 90% workers of farms have received university education. They are the users and even the inventors of agricultural technologies. This is the area China needs to follow for its agricultural modernization. CAAS has tried her best to demo the most advanced agricultural technologies and efficient modern agricultural achievements to farmers and has actively carried out many training programs to farmers.

**NSR:** You have maintained to be an active scientist. How and why? How do you balance between management work and your own research?

**Li:** Keeping abreast with the scientific development is very important for the management work I am involved in. Being an active scientist helps me to define priorities, make right decisions, identify critical problems and more importantly find solutions. To handle both research and management work at the same time, I have to sacrifice many family hours, for things like movies or holidays. I spent lots of time with my students, talking to them and going through their original data. Another reason for continuing my own research is that I simply love science. I feel satisfied whenever I tackle an unsolved problem. All stresses and troubles in management work seem to disappear when I am in the lab.

**NSR:** What do you want people to remember you for your CAAS presidency?

**Li:** I hope people will remember me for my roles in reconstructing CAAS research programs and reforming management schemes, in setting up new evaluation mechanisms and in training young researchers. By doing these I hope CAAS can serve our national needs better and contribute to our agriculture modernization.

Chun-Ming Liu is Professor at Institute of Botany, Chinese Academy of Sciences, and Ling Wang is a science news reporter based in Beijing.