FAO Regional Meeting on Agricultural Biotechnologies in Sustainable Food Systems and Nutrition in Asia-Pacific, Kuala Lumpur, Malaysia, 11-13 September 2017
Website: http://www.fao.org/asiapacific/events/detail-events/en/c/1440/

The first afternoon of the regional meeting consisted of the opening ceremony and a plenary session with keynote addresses. The next day and half consisted of 4 plenary sessions and 6 parallel sessions, where 41 presentations were made. The last half day consisted of short reports from these 4 plenary sessions and 6 parallel sessions, some reflections on the way forward and the closing ceremony. All of the 41 speakers in the 4 plenary sessions and 6 parallel sessions were asked to provide an abstract of their presentation (max. 200 words). All of these abstracts are provided here.

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12 September 2017

Plenary Session 3: The status and challenges regarding agricultural biotechnologies in Asia-Pacific

The status of application, capacities and the enabling environment for agricultural biotechnologies in the Asia Pacific region: Presentation of some preliminary findings

Ravi Srinivas Krishna
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This presentation is based on the study commissioned by FAO to RIS on the status of application, capacities and enabling environment for agricultural biotechnologies in Asia Pacific. Forty-three countries in the region were covered by this study which included crop, forestry, livestock and fisheries. The statuses were assessed in term of applications, capacity and enabling environment and covered low-technologies, medium-technologies and high-technologies in agricultural biotechnologies. Situating the status of agricultural biotechnologies in the context of global development and challenges such as climate change, this study points out that agricultural biotechnologies have an important role to play. It finds that while low and medium technologies are widely used in the region, few countries have adopted high technology applications such as genome editing and genome mapping. Agricultural biotechnologies are firmly established in the region with many countries having specific policies to promote them and many more have integrated them in agricultural development plans. The Enabling Environment is mostly positive and there is new dynamism in some countries in supporting agricultural biotechnologies. However, the gap among countries in application, capacity, and enabling environment remains huge and this has to be addressed. Capacity building and Technology Needs Assessment are necessary to harness fully the potential of agricultural biotechnologies.

Personal reflections on the status and challenges regarding use of agricultural biotechnologies in the livestock sector

Neena Amatya Gorkhali
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Developments in modern biotechnology and genetic engineering have introduced a new horizon in agriculture. Many developing countries in Asia-Pacific region have proposed biotechnology as a key investment area to stimulate the productivity especially more emphasizing on the application part of biotechnology which directly resulted in benefits to farmers, producers, and consumers in many countries. They have also made policy statements asserting biotechnology as being integral to priority planning for agricultural development. The potential of biotechnology in improving agricultural productivity is thus well recognized including that of small holders. In the paper, some of the achievements in the application of animal biotechnology in different sectors (such as animal genetics, breeding and conservation, reproduction, nutrition and feed, disease diagnosis etc.) that have brought about tangible benefits in terms of improve strains or better management practices are summarized. In addition, the different challenges and future consideration in realizing its global potential in agricultural biotechnology are also discussed.

Personal reflections on the status and challenges regarding use of agricultural biotechnologies in the fishery sector

Anchalee Tassanakajon
Center of Excellence for Molecular Biology and Genomics of Shrimp, Department of Biochemistry, Faculty of Science, Chulalongkorn University, Thailand

Agricultural biotechnologies have been widely and successfully applied in food crops and farmed animals but relatively little has been implemented and should be encouraged in the fields of fisheries and aquaculture in order to enhance the production efficiency and quality, prevent outbreaks of infectious diseases and improve sustainable development of economic aquaculture species.

Because disease outbreaks are the major constraint for development of sustainable aquaculture, biotechnological tools such as molecular diagnostic methods, pathogen identification, and development of recombinant vaccines have gained attention and are being applied in fish and shellfish health management in the Asia-Pacific region including Thailand.

However, biotechnology and genomics approaches applied in the genetic improvement of aquaculture species are still limited and require long term commitment of government and/or private sectors. The opportunities and challenges on applications of fish and shellfish breeding based on transgenic technology and recently developed genome editing technologies will also be discussed.

Personal reflections on the status and challenges regarding use of agricultural biotechnologies in the crop sector

Rajeev K Varshney
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A range of biotechnologies including genomics, molecular breeding, genetic engineering/ genetic modified organisms (GMOs), microbiology, bioremediation, etc. are being used for accelerated crop improvement in the Asia Pacific region. Advances in genomics have unraveled genome architecture of several crop species including for seven crops from ICRISAT and its partners. QTL mapping have identified several QTLs/genes for several agronomic traits in many crop species. For instance, several improved molecular breeding lines have been developed in chickpea (yield under rainfed condition, Fusarium wilt), groundnut (late leaf spot, rust and high oleic acid), pearl millet (downy mildew), etc. by ICRISAT and its partners. Similarly several molecular breeding derived varieties in rice, maize are being grown by small-holder farmers in the region.

However, there is a need to replace mega-varieties by newly developed varieties at large scale. In the case of genetic engineering, Bt-cotton has proven a success story and helped India as a nation as well as its small holder farmers. In my personal opinion, some concerns, as perceived by some quarters of the society, related to GM technologies e.g. risk assessment, risk management and stewardship need to be addressed properly and adequately. Countries governments in the region should have very clear and time bound approval policies. It will be desirable, in my opinion, governments need to be pro-active in creating public awareness and firm in commercialization of GM products for the benefit of its farmers and consumers. New technologies such as gene editing also need to be explored. It will also be desirable to have educated society and media in understanding biotechnologies applications for enhancing the quality and quantity in the crop sector to address the big challenges of food and nutrition security in the Asia Pacific region.

Personal reflections on the status and challenges regarding use of agricultural biotechnologies in the forestry sector

Yongqi Zheng
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Traditional breeding methods were difficult to achieve significant improvements to the complex traits such as wood properties, disease and pest control, and tolerance to abiotic stresses due to the long reproductive cycles of most tree species. Biotechnology, focusing on DNA-level analyses, transfer of genes from a different species, and cloning by somatic embryogenesis, and utilizing fundamental discoveries in the field of plant tissue culture for clonal forestry, gene transfer techniques, molecular biology and genomics, provides an extended platform for tree improvement of these complex traits. It is one of the scientific fields in which the most rapid advances have been made in recent years. Forest trees have entered the genomic era. Biotechnological tools such as tissue culture, genetic transformation, RNA interference, functional genomics, marker assisted selection and QTL etc. have paved road for successful exploitation and integration of scientific fields, both in academia and industry. Advances in micro-propagation, cryopreservation, molecular breeding, transgenesis, *in vitro* culture, abiotic and biotic stress resistances, modification of lignin of trees and integration of such fields will have a great impact in many aspects, and will continue to provide new information, thereby offering exciting prospects for future tree improvement programs worldwide. For a rapidly developing world, the needs for investment of much more in the development of high-yielding short rotation plantation forests and biotechnology is essential to achieve this goal. Biosafety concerns with the increasing use of transgenic remains to be addressed in future.

Parallel Session 1: Investments in agricultural biotechnologies

Investment and R&D of agro-biotechnology in China

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Ensuring food security and major agricultural products supply has always been the primary task in China, and in the medium- and long-term period, will ultimately rely on scientific-technological progress, especially constant innovation and application of biotechnology.

China has always taken great importance to the development of agro-biotechnology. Since the beginning of the 21st century, biotechnology research and development (R&D) has been fully deployed and strengthened in China. In 2001, biotechnology R&D was proposed as a state-level high-tech program in the tenth five-year plan of national economic and social development, and will always be the interfiled program in the national medium- and long-term outline for science and technology development (2006-2020) launched in 2006. Furthermore, overall scheme of bio-industry was proposed and deployed in the 12th five-year plan for national economic and social development.

Agro-biotechnology R&D has contributed to a production value of over 120 billion RMB in China. During the period of 2008 to 2016, 168 novel transgenic cotton varieties have been developed, with a cumulative extending area of 28.7 million hectares. Bio-fertilizer, bio-pesticide, and bio-feed have shown a good development prospect. Major animal diseases have been effectively controlled by genetic engineering vaccines developed in China. Biomass conversion and refining technology has promoted the development of bio-energy industrialization.

China will continuingly promote the agro-biotechnology R&D, such as functional genomics, molecular design, drug target design, bio-transformation and bio-catalysis etc., to enhance the core innovation ability and competence.

A case study in public-private funding partnership

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Malaysian Vaccines and Pharmaceuticals (MVP), Sengalor, Malaysia

Malaysian Vaccines and Pharmaceuticals (MVP) is Malaysia’s very own biotechnology company, specialising in veterinary vaccines production and as to-date, the only successful vaccine manufacturer in the country. It is co–owned by both public and private parties. MVP’s origins stemmed from the issue of lack of protein intake among citizens of the country during the 1970s. Realising that chicken was the cheapest source of protein, efforts were made by our local university, University Putra Malaysia, to develop vaccines as protection against Newcastle Disease virus, a deadly and most common disease in the poultry farming. The University’s efforts were to ensure continuous growth of the poultry industry and sustain the supply. MVP was formed by a local entrepreneur with the help from an Australian company as technology provider, when it saw opportunity to commercialize the vaccines. The government, through its investment arm, joined much later and expanded it further by adding in more product lines. With the new partnership and increment in resource backing, MVP was able to grow into the top-tier biotechnology organisation it is today, overcoming mishaps and obstacles along its way. This case study will look into the interesting and eventful details of this company, along with the advances in its field it was able to make due to the nature of its partnership.

Parallel Session 2, Dissemination, adoption and use of biotechnologies

Challenges to develop new functional crops and silkworms that consumers can accept in Japan
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Many important genes and biological functions of plants have been discovered in genomic and molecular studies in Japan. Japanese institutions succeeded in accelerating and improving breeding using DNA markers and successfully developed varieties that eliminate adjacent defective traits that were difficult to eliminate until now. In the case of DNA marker breeding, it can be accepted by consumers, so when a variety of excellent character is generated, it will be accepted by consumers. On the other hand, development of genetically modified (GM) crops using genes with useful functions has also been advanced. For instance, the development of crops resistant to multiple diseases and those tolerant to environmental stress has been promoted. However, in Japan, these crops are not cultivated commercially yet. GM crops accepted in Japan are only color-modified carnation and rose. What is considered as a reason why Japanese consumers are not accepting most recombinant crops might be a merit for consumers. Even if the producers/farmers have benefit, consumers will not accept it if merit is not felt for consumers. The concept of development of Product-Out was changed to that of Market-In. We will introduce the challenges to develop new functional crops and silkworms that consumers can accept in Japan.

Knowledge platforms; ongoing initiatives on mudcrab biotech for adoption by farmers
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In this paper, some of the solutions developed at the Practical Genomics Laboratory at DLSU are presented as examples of how biotechnology can be used to develop solutions to crab rearing issues identified by farmers, fishers and field researchers.

The specific needs are as follows: (1) identification to species of wild caught juvenile and instar mud crabs prior to stocking into farms; (2) identification of populations naturally adapted to heat stress for use as broodstock in hatcheries; (3) more rapid conduct of factorial experiments to test for the ideal temperature and salinity combination that hastens molting and (4) possibility of breeding for the market preferred intermediate sex phenotype in cultured populations. The solutions we developed for adoption are based on integration of work on molecular markers with image analysis, GIS and mobile computing. They include
(1) CrabAPP – a phone app for species identification to species based on diagnostic DNA regions;
(2) CrabADAPT – a RNA-Seq based analysis that evaluates responses of crab populations to heat stress
(3) CrabMAP – a simple GIS analysis of temperature range and anomalies in of crab rearing and fishing areas
(4) CrabMOLT – using qPCR to determine the best temperature and salinity combinations to hasten molting
(5) CrabSNPs – a genome wide association study on the high value intermediate sex phenotype in crabs for possible use in breeding.

Use of biotechnologies for producing clonal teak as planting materials for smallholders
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The fast decline of natural teak (*Tectona grandis*) forests has accounted for a greater interest in teak plantation establishment. The planting of clonal teak has now become a reality and is a priority for a lot of land owners and investors in many humid tropical countries. Contribution from smallholder farmer plantings can be quite significant given the availability of selected quality planting materials produced from the use of biotechnologies. YSG Bioscape, a commercial subsidiary of the Sabah Foundation Group, has been involved in the mass propagation of superior teak clones that can be planted either as monocultures or in combination with other crops using efficient nursery and *in vitro* propagation techniques since the early 1990s. Jointly developed with the forestry division of Cirad, the technologies allow mass production of clones from any outstanding teak tree selected based on traits such as fast growth, straight bole, minimal branching and high heartwood to sapwood ratio.

The promising yield from planting clonal materials is greatly encouraging to smallholders who are eager to maximize in the shortest delays. Further, the possibility to intercrop teak clones with rubbers, coffee, cocoa or even annuals such as legumes with nitrogen-fixing ability allows farmers to have more practical and profitable land use.

Use of artificial insemination to improve goat meat production in Nepal

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Goat is an important livestock species that has been identified as having potential for reducing poverty in the rural areas of the country. Goats have multifaceted use and serve as handy source of cash at the time of need. The contribution of goats in terms of food and nutrition security at household level is significant. Goats are being reared by more than half of the farm families in Nepal for their various utilities but primarily for meat (chevon) production and as a living bank during the time of need. This sector contributes to about 4 percent of Agriculture Gross Domestic Product (AGDP) and about 20 percent of the total meat production in the country. There are more than 10 million goats in Nepal, of which 90 per cent are indigenous breeds and owned by the smallholder farmers. To some extent productivity of these goats is low mainly due to low genetic potential of the goat in terms of meat production and lack of good animal husbandry practices. Human populations are growing, and creating a significant and increasing demand for additional animal protein foods. The goat can play an important role in meeting these demands. This calls for farmers to put value in their goat enterprises by shifting from subsistence production to commercial production. It is easier to increase the population of small ruminants (goats and sheep) than large ruminants. In economic terms, the opportunity costs are low for goat production.

The Nepalese Government has tried many different exotic goat breeds to increase the productivity of goat in terms of meat viz. Jamunapari, Kiko, Barberi, Sirohi, Damascus and many more. High genetic merit exotic goats were brought for this purpose, but could not be successful and ended up in failure. Recently, Boer goat which has average daily weight gain of 200-250 grams per day in their home tract has been introduced. Nepal Agricultural Research Council (NARC) has developed an appropriate goat breeding strategy (Goat Open Nucleus Breeding Scheme) for goat improvement program and Government organization (Livestock Development Services Offices) is an implementing agent to create genetic change in the goat population in order to benefit goat keepers and wider group of stakeholders. Learning from earlier experience, not only live animals are brought in but also semen is collected for them for sustainability. With the popular simple biotechnological tool especially by using Fixed Time Artificial Insemination (FTAI), farmers are getting good genetic material and having more production than earlier. Interestingly, the research revealed around 50% and 25% increment in annual growth rate respectively in 50% and 25% Boer crossbred in farmers' condition in comparison to the common indigenous goat breed, Khari goat. The farmers are enthusiastic to achieve better conception rate from FTAI (using CIDR followed by PMSG) which is about 65%. Hence, implementation of FTAI in wider scale together with systematic pedigree and performance recording scheme will ensure the sustainability of the commercial meat goat production.

Parallel Session 3: Social and economic impact of agricultural biotechnologies for communities

Social and economic potential of agricultural biotechnologies for crop diversification in South East Asia

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Increasing populations, climate change, disparate economic growth and urbanisation constitute major challenges for the ASEAN region. `Business-as-usual' will not be enough. We need fresh ideas and innovative solutions, especially in agriculture which can be a major engine of socio-economic growth. Recent biotechnological advances in major crop species show significant potential for sustainable gains in agricultural productivity, reducing poverty and enhancing *food security*. However, major staples alone cannot ensure the *nutritional security* of a growing population or novel sources of livelihoods from marginal landscapes.

This paper shows how knowledge of the genetic resources of currently underutilised crops can be linked with modelling and geospatial tools to predict their potential in new locations. Data driven biotechnology linked with value chains can enhance our understanding of agricultural biodiversity and accelerate selection for suitable crop traits for specific locations and end uses. Using the example of bambara groundnut, this paper presents a case study of crop suitability for soil and climatic conditions of Peninsular Malaysia. Through such an approach, the paper demonstrates how locations and end uses can be identified for particular crops. Comparisons will show potential distributions and uses of underutilised crops in the ASEAN region as an evidence base for agricultural diversification.

The role of SROS in Samoa

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The Scientific Research Organisation in Samoa (SROS) has been established in Samoa since 2006. Its objectives include support for agriculture and the improvement of the livelihoods for local people. Samoa relies heavily on imported foods since local agriculture cannot sustain the present population growth. But a closer look has shown that there is a lot of wastage of the local produce due to a range of reasons including produce being only sold as fresh. SROS with the assistance from regional and international organisations have looked into ways to utilise the local produce such as the production of avocado oil, breadfruit flour, margarine, local whiskey, extraction of plant essential oils, soaps and the export of frozen produce. In addition, there is on-going research on post-harvest research to make sure the produce are collected properly resulting in limited wastage. SROS also analyses the fresh produce and products for biological, chemical and physical properties using a range of analytical equipment. Since SROS is also IANZ accredited, the results produced are international recognised.

Case studies on the impacts of biotechnologies and the missing biotechnologies in aquaculture

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Since 1987, shrimp farming in Thailand initially and gradually evolved into intensive farming of *P. monodon.* During this period, flow-through systems were used to maintain good pond water quality and to accelerate shrimp growth. With two crops a year, the national yield from these systems increased from 23,566 metric tonnes a year in 1987 to about 263,500 tonnes in 1994. Pacific white shrimp (*P. vannamei*) farming was introduced in Thailand in 2003-2004. From 2005 to 2008, a new breeding program to promote fast growth of white shrimp and a new super-intensive farming technology were developed. Thailand produced nearly 600,000 tonnes of shrimp in 2009-2010. The Thai Frozen Foods Association (TFFA) reported that during the past twenty years, frozen and processed shrimp have been the most important fishery export of

Thailand. Production from closed, intensive shrimp farms created export income of over $3 billion US annually during 2010–2011[1].

Two case studies of the impacts of biotechnologies in aquaculture in Thailand will be presented. The first case is on using HPLC to inspect shrimp products for antibiotic residues in 1997-1998. Investment of about US$10 million in the project by Thailand's Department of Fisheries (DOF) was able to maintain the quantity and quality of export products to U.S.A. and Japan, with a value of more than US$1 billion. The shrimp quality inspection system at farm level in Thailand has developed to include traceability of exported shrimp at the present time.

The second case is on a NACA shrimp project for Thailand in 2016 entitled "Adaptive learning in sustainable aquaculture best practices for small-scale shrimp farmers in Thailand (SSSF-Thailand)". A biotechnological approach was adopted in dealing with PCR screening of brood stock, shrimp larvae and monitoring for acute hepatopancreatic necrosis disease (initially termed early mortality syndrome or "EMS") during the grow out period in six demonstration farms under the project. These practices were in line with DOF's biosecurity measures and certification for shrimp hatcheries (FMD) and grow out farms (GAP)[2]. The project contributes to disease risk reduction and on-farm water management for sustainable shrimp farming for more than 2,000 small-scale shrimp farmers in Thailand.

From genetic perspective, we do not presently have biotechnology that allows aquaculture to adapt to the requirements of new and diverse farming systems, environments and consumer groups. Conspicuously missing biotechnologies in aquaculture are techniques for exchanging germplasm without transferring disease agents such as sterile egg/sperm transfer, nuclear transplantation and genome segment transplantation. Let's get on with it so we can improve the practices and productivity of the aquaculture industry.

Impact of crop biotechnologies for smallholder farmers in India: A case study of plant tissue culture
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Banana (*Musa* spp.) is one crop in which plant tissue culture technologies have greatly benefited smallholder farmers. However, in Maharashtra only few varieties are propagated by commercial laboratories, and cultivated by farmers. In recent years there is increasing demand for premium varieties of banana due to influx of people from other parts of the country and growing affluence. Increasing varietal diversity in banana can help both micropropagation industry and smallholder farmers. Unlike banana, plant tissue culture technologies in some other crops (for e.g. black pepper, small cardamom, turmeric etc.) have not benefited smallholder farmers as much as expected. This is either because of limitations of the technology (turmeric) or the crop being cultivated only in small areas where the conditions are conducive for their growth, because of specific agro-climatic requirements (black pepper, small cardamom). Because of the climate diversity available in the country, these high value, low volume, non-perishable agricultural produces have great potential for introduction to many new areas for the benefit of many smallholder farmers. For this, further improvements in tissue culture technologies and developing methods for their shade-house/ greenhouse cultivation outside the crops' native habitats are necessary. Attempts are being made to develop a method for high density greenhouse cultivation of saffron crocus (*Crocus sativus*) outside the crop's native range. Many parameters (time of corm lifting, corm size, planting medium, depth of planting, irrigation, day/ night temperature requirement - at different seasons and different developmental stages, chilling requirement etc.)

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[1]FAO. Regional Office for Asia and the Pacific (Bangkok, Thailand). Sustainable Intensification of Aquaculture in the Asia-Pacific Region/Documentation of Successful Practices. Editors W. Miao and K.K. Lal. 2016. Country Paper 12: Development and Dissemination of Closed (semi-closed) Intensive Shrimp Farming Systems in Thailand. Putth Songsangjinda (Email putths@yahoo.com, Marine Shrimp Culture, Department of Fisheries Kaset-Klang, Chatuchak, Bangkok 10900, Thailand).
[2] SSSF-Thailand. 2017. Quick Guide for Shrimp Farmers on Disease Prevention and Sustainable Best Practices

are standardized. The method being developed will help in introducing saffron crocus to many places having low cool deficit than its native range. Similar methods in black pepper (*Piper nigrum*) and small cardamom (*Elettaria cardamomum*) will be of benefit to small holder farmers.

Parallel Session 4: Regional innovation opportunities in agricultural biotechnologies

Newcastle Disease Virus: from poultry vaccine to malignancy hero

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Food security remains an issue perennially plaguing many developing economies worldwide, including Malaysia. With the unrelenting increase in the world population, agriculture is vitally important in providing both food security as well as food safety, significantly contributing to the development and wealth of nations. To overcome inadequate food supply, four pillars of food security - availability, access, utilization and stability, need be addressed, thus ensuring a continuous food supply for the future. Malaysia, in particular, has formulated the National Agro-Food Policy 2011-2020, giving utmost priority on increasing food production to ensure food supplies are sufficient, of better quality, safe and nutritious at affordable prices. Over the years, Malaysia has achieved significant increase in the production of several basic food items such as rice, fruits, vegetables, fisheries, and poultry. For this talk, we will focus on the development of a poultry vaccine, particularly the role of the Newcastle disease virus (NDV), in controlling disease outbreak for sustainable poultry meat production. We would also highlight an exciting new development - the potential role of NDV in making treatment of cancer more effective and affordable, thus contributing to the good of public health, both locally and globally.

The role of genomics in shrimp improvement

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The application of genomics has offered a powerful solution to revolutionize food security and sustainable aquaculture. The genomes of several major aquaculture species have been completely sequenced or are being sequenced including Atlantic salmon, rainbow trout, tilapia, seabass as well as oyster and shrimp. The genome of Pacific white shrimp *Litopenaeus vannamei* has been sequenced and assembled but it is not yet being published. Nevertheless, large numbers of expressed sequence tag (EST) resources and large RNA-Seq datasets have been generated for major shrimp species. The genomic information of shrimp is important for identification of genes associated with metabolism, growth and diseases, biomarker discovery and breeding selection. Recently, we conducted RNA-Seq analysis to identify differentially expressed genes in response to infectious diseases and to identify candidate markers associated with disease resistance in *L. vannamei* in order to assist selective breeding of disease resistance shrimp lines and to develop a platform to evaluate health status of shrimp based on gene expression profiling.

Novel biotechnologies for raising stress tolerant and high yielding crop plants

Sneh Lata Singla-Pareek
Plant Stress Biology Group, ICGEB, New Delhi, India

Abiotic stresses reduce the crop yield significantly and hence, pose a major threat to agriculture. It is thus, much desirable to generate crops which are resilient to stress conditions. In this endeavor, knowledge of processes related directly or indirectly to mechanisms of stress tolerance is vital which can then be altered for raising stress-tolerant plants. Our studies show that plants accumulate methylglyoxal (MG), a cytotoxic metabolite, as a common consequence of various stresses and that its efficient detoxification via glyoxalase pathway overexpression imparts tolerance against abiotic stresses in rice. Further, we have stacked various pathways of stress response for their overexpression in transgenic rice which has resulted in raising the limits of tolerance to multiple abiotic stresses and improved yield. Simultaneously, we demonstrate that a significant enhancement in total yield of rice, under both non-stress and stress conditions, can be realized by

RNAi based knockdown of a cytokinin metabolism gene to maintain hormone homeostasis. We are also taking new initiatives to explore the "unknowneome" for functional validation of several "so far uncharacterized" stress-responsive genes/proteins with the aim of identifying novel candidate genes for raising stress-tolerant crops. Considering the complexity of stress response, our results suggest that a combinatorial approach targeting diverse pathways is better than the 'single gene approach' to tame the harmful effects of environmental extremes for genetic improvement of crops for sustainable agriculture.

Radically simple innovations for Indian agriculture

Pannaga N. Prasad
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Indian agriculture is currently reeling under an unprecedented crisis. Drought, unseasonal rains, declining soil fertility, alarming water scarcity, high input costs, rock-bottom market prices of produce and unsupportive policies have pushed our food producers to the brink. GDP data confirms deflation. Farmers' incomes are at an all-time low while rural unemployment and malnutrition are on the rise. Genetically engineered varieties warrant ever increasing costs while producing drastically diminishing profits.

Given the looming threat of runaway climate change, natural farming based on agroecological principles hold the only hope for Indian agriculture. Collectives, often led by women are securing high yields of diverse food crops, grown with carefully preserved traditional seeds and usage of freely available farm-based low-cost environment-friendly inputs. Evolving through thousands of years, these native nutritious seeds and farming practices can deliver productive and resilient agro-ecosystems and eradicate world hunger, as opposed to newer varieties being developed in labs as quick technology fixes.

Agroecological methods present a viable, environmentally, socially and economically sustainable and scalable way forward. My talk will present successful case studies from across India with specific methods which can be replicated in several countries representing the global South.

Applications of biotechnologies in the forestry sector

Zheng Yongqi
Chinese Academy of Forestry, Beijing, China

Traditional breeding methods are often constrained by the long reproductive cycles of most tree species and the difficulty in achieving significant improvements to the complex traits such as wood properties, disease and pest control, and tolerance to abiotic stresses. Biotechnology can be broadly defined as anything that combines technology and biology. It focuses on such things as DNA-level analyses, transfer of genes from a different species, and cloning by somatic embryogenesis. Biotechnology provides important tools for the sustainable development of agriculture, fisheries and forestry. It is one of the fields of scientific research in which the most rapid advances have been made in recent years. Forest trees have entered the genomic era. Biotechnological tools such as tissue culture, genetic transformation, RNA interference, functional genomics, marker assisted selection and QTL etc. have paved road for successful exploitation and integration of scientific fields, both in academia and industry. Advances in micro-propagation, cryopreservation, molecular breeding, transgenesis, *in vitro* culture, abiotic and biotic stress resistances, modification of lignin of trees and integration of such fields will have a great impact in many aspects, and will continue to provide new information, thereby offering exciting prospects for future tree improvement programs worldwide.

Parallel Session 5: Regulation, policies and intellectual property rights

How to ensure access of small farmers to technologies they need
Elenita Daño
Action Group on Erosion, Technology and Concentration (ETC Group), Davao City, The Philippines

In the midst of failure of many government policies and strategies in the region to promote agricultural biotechnologies to small farmers, there is an imperative to rethink the assertion that small farmers need biotechnologies to increase productivity and break from the poverty trap. Unpacking agricultural biotechnologies is integral in this rethinking since these are wide range of technologies that have varying implications and covered by different regulations. Technology options that should be made available to small farmers should not be limited to technologies created by formal institutions but bottom-up technologies in agroecology that communities developed to respond to local needs and specific conditions. Ensuring access of small farmers to technologies they need is a more bottom-up and inclusive question that should be addressed.

Small farmers must be regarded as hands-on researchers and innovators instead of mere end-users of technologies developed by formal institutions. Local innovations and indigenous technologies developed by farmers need to be promoted and their capacities to develop such technologies must be supported through enabling policies and programs. Technologies that are readily accessible, affordable, using local resources and built on farmers' knowledge must be prioritized.

Enabling policies for agricultural biotechnology
Vilasini Pillai
Quest International University Perak, Ipoh, Malaysia

Science and technology play a vital role in ensuring food security. The biggest challenge facing the world today is growing more food on less land, with less water and less labor, and under a more unfavorable climate. New technologies are now available to prolong the shelf life and improve the packaging of food, ensuring that more food will reach the hands of people. Biotechnology is an example of a powerful tool for sustainable agriculture, making crops more resilient to the diseases and pests that cause crop losses and low yields. Growing these Biotech crops have increased accessibility of food as well as benefited poor farmers greatly. However, the accessibility of these technologies to resource poor countries can be increased further if governments can minimize the regulatory burden on the agricultural sector and at the same time ensure enabling policies and sound regulatory approaches are used. Approval processes for groundbreaking innovations in agricultural biotechnology should be streamlined, consistent, and based on sound science. Government policies that encourage research and innovation especially public and private collaborations in the field of AgBiotech should be encouraged and given greater importance.

Global adoption and regulation impacting technology adoption
Bhagirath Choudhary
Founder Director, South Asia Biotechnology Centre (SABC), New Delhi, India

Biotechnology tools have been transforming agricultural research and production landscapes in the last two decades. Cutting-edge biotech crop innovations provide round the clock in-built protection against pests and efficient weed management systems that helped farmers to leapfrog production and productivity of food, feed and fibre crops. In 2016, the global adoption of biotech crops peaked at 185.1 million hectares planted by 26 countries registering an incredible 110-fold increase from 1996. Spreading its root from industrial countries, biotech crops were adopted rapidly by around 16 million small holder farmers in 19 developing countries surpassing the adoption by those in industrial countries. Global experience confirms that biotech crops increases farmers' income not only by decreasing cost of production but also by enhancing productivity through saving of losses caused by pests and weeds. Estimates indicate that biotech crops generated US$167.8 billion additional gain in farmers' income, contributed to large amount of additional food grain production and increasingly dominate the global trade in food grains, edible oil and meal from 1996 to 2015. Expectedly, biotech crops will continue to be important to meet the 50% increase in food demand by 2050. However, the timely delivery of biotech crops to farmers and consumers will depend largely on a predictable but non-onerous science-based regulatory process, and a pre-emptive role by governments to drive the transfer of biotech innovations from the lab to the land.

Intellectual property rights and agricultural biotechnologies

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The management of intellectual assets is key to ensuring access and use of agricultural biotechnological innovations. This entails an understanding of various areas of law such as intellectual property laws, contract law, environmental protection legislations, food safety regulations, and international laws, just to name a few. The challenge for intellectual property (IP) management offices of public and private sector organisations is for such professionals to equip themselves with knowledge of both the regulatory and scientific aspects in the management of such assets. An appreciation of public and private sector roles is also key to successful partnership building and product stewardship for biotechnological inventions. This presentation will discuss the various issues related to the management, commercialisation and stewardship of agricultural biotech innovations.

Parallel Session 6: Conservation, characterization and sustainable use of genetic resources for food and agriculture

DNA marker applications in the management of farmed aquatic genetic resources in the Philippines

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Molecular marker techniques have evolved quite fast from the simple allozyme protein analysis in the early 1980s to the advanced next generation sequencing methods applied in genetic stock characterization and genomic research. In spite the lack of funds, local laboratory facilities and difficulties in the procurement of reagents for DNA analyses, genetic marker studies to assess populations of major aquaculture species in the Philippines have been pursued through (a) externally funded research internship training, graduate degree thesis researches and/or collaborative projects with foreign academic and research institutions, and (b) for locally funded work, through sequencing services offered by commercial laboratories outside the Philippines. As such, DNA marker research on wild and hatchery stocks of tilapia (to include genetically improved strains), milkfish, shrimp, mangrove crab, abalone, mussel, oyster, seahorse, etc. have either been completed and written about in scientific publications or are in different phases of development. This paper shall briefly cover the status of the use of DNA marker technologies in managing stocks that are important in Philippine aquaculture and the prospects of utilizing such information for the sustainable development of the industry.

DNA markers and DNA profiling to verify species and individuals from confiscated wood in Thailand

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Illegal logging of tropical trees of high economic value in natural forests and protected areas is common due to high demands in international trade. DNA markers and DNA profiling have been acknowledged as an efficient tool to verify species and individuals from confiscated wood in Thailand. There are 3 cases in Thailand. The first case is to verify whether the confiscated mango wood is from the protected wild mango. The results showed that variable nucleotide sites at non-coding trnH-psbA spacer region in chloroplast DNA of the confiscated wood were the same as domesticated mango varieties. The phylogenetic analysis showed that this confiscated wood is genetically more closely related to domesticated mango varieties than to wild mango. This implies that confiscated wood is from domesticated mango rather than protected wild mango species. The second case is to identify whether the confiscated sawdust and confiscated wood at the crime scene are the same species and protected species. Based on the Chloroplast DNA sequence and phylogenetic analysis at non-coding trnH-psbA spacer region and Maturase K gene, the results showed that the confiscated sawdust is from Malvaceae, which is not from protected species and the confiscated wood is from Agarwood (*Aquilaria crassna*). The third case is to identify whether 142 confiscated pieces of wood are from any of 3 illegally logged trees of endangered rosewood (*Dalbergia cochinchinensis*) in the National Park. According to the analysis of 9 loci of SSR makers of 64 confiscated wood pieces, it turned out that there were 2 pieces of wood had genotypes and genetic identity to one of stumps of illegally log trees. This means that at least one tree in the National Park was possibly illegally logged. Therefore, DNA forensics is one tool to efficiently facilitate and enhance law enforcement in Thailand as well as help the innocent local people.

Molecular applications in characterization and differentiation of Sri Lankan wild boar (Sus scrofa affinis) meat from exotic and village pig (Sus scrofa domestica) meat

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Correct and precise identification of food and food combinations is vital in ensuring food safety as well as sustainable use of genetic resources in food systems. Cheap food resources are commonly used to adulterate highly demanded food items. Nevertheless, over extraction of natural food resources is continued, despite the regulatory actions for their protection and sustainable utilization. In Sri Lanka use of pork to substitute wild boar meat which is highly demanded but commercially banded item provides a classic example in this context. Attempts were made to differentiate Sri Lankan Wild pig (SLWB) meat from exotic and native domesticated pig (Village pigs or VP) meat using molecular tools. Mitochondrial DNA D-loop marker was successfully employed with PCR-RFLP analysis with a simple restriction digestion using cost effective Dra 1 enzyme. Enzyme targeted two unique polymorphic sites in reverse complement in SLWB differentiating SLWB from VP. As a tool for SLWB meat authentication a synonymous mutation at codon 207 of the Melanocortin Receptor 1 (MC1R) gene of SLWB was identified as a candidate allele which is unique to SLWB. Both the techniques can be routinely applied to authenticate and/or differentiate SLWB meat. Thus, can be a model for other meat authentication process.

Crop genetic improvement and utilization in China

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In China, 481,617 accessions for more than 360 crops have been collected by 2016, and 415,232 accessions have been inventoried in national crop Genebank in Beijing for long-term conservation. Every year more than 150,000 germplasm materials are distributed to over 4,000 users. At present, genome sequencing and germplasm re-sequencing have been completed in major crops. The genomic data have enhanced the discovery and utilization of crop genes. A number of genes in crops have been cloned, such as those for high yield, high quality, resistance to stress, disease and insect resistance, and efficient utilization of resources.

Development of genome-wide chips for rice, wheat, and maize has provided technical support for molecular breeding. Meanwhile, transgenic technology has been used to improve the resistance to insect, herbicide, and stress in crops. For example, the national growing area of insect resistant cotton (Bt) was 2.92 million hectares in 2016. Furthermore, CRISPR-Cas9 mediated genome editing technology has been applied in crop improvement

A case study from crop or tree genetic resources in the Pacific

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The Pacific Community's (SPC) Centre for Pacific Crops and Trees (CePaCT) is the only internationally recognised genebank in the Pacific. Established in 1998, with a mandate to support food and nutritional security, underscored by resilient and sustainable food systems, CePaCT aims to assist Pacific Island Countries and Territories (PICTs) to sustainably conserve and utilize their plant genetic resources through effective conservation methodologies, crop improvement activities, and germplasm exchange at both regional and international level. The Centre has state of the art plant tissue culture and virus indexing facilities, which are dedicated to the in vitro conservation of over 2,000 accessions of important food crops of the Pacific and to the safe transfer of germplasm to the region as well as outside of the Pacific. CePaCT conserves major collections of banana, breadfruit, taro, swamp taro, sweet potato and yam for the Pacific, in addition to other crops like Alocasia, bele, cassava, ginger, pineapple, potato, sugarcane, Xanthosoma, and vanilla. Under the auspices of the FAO International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA) and with support from the Crop Trust, CePaCT has internationally recognised collections of taro and yams, of which taro takes up more than half of the total collections with over 1,000 accessions originating from both Asia and the Pacific. Thus, CePaCT is globally recognised as the World Centre for Taro. Since 2004, CePaCT has distributed over 80,000 sterile tissue culture plantlets of 13 crops (Alocasia, banana, breadfruit, cassava, ginger, pineapple, potato, swamp taro, sweet potato, taro, Xanthosoma, vanilla and yam) to over 50 countries worldwide. The Centre continues to work with Pacific countries through its regional Pacific Agriculture Plant Genetic Resources Network (PAPGREN) to identify, collect and characterise important crop varieties, landraces, and crop wild relatives for conservation at CePaCT; and, to carry out activities to best utilise existing diversity for the benefit of the region. To address current and future regional challenges like climate change, pests and diseases and non-communicable diseases (NCDs), the Centre as a recent flagship area of SPC, focuses on upgrading its scale of operations, with particular emphasis on the use of new biotechnologies linking to effective conservation strategies that will also see the generation of new and resilient diversity. Genetic diversity of crops and diverse production systems are key to the development of sustainable food systems and fundamental for overall food and nutritional security in the region as well as globally.

<u>13 September 2017</u>

<u>Plenary Session 4: Improving nutrition using the biotechnology toolbox</u>

Pulses for improved nutrition and the role of biotechnologies

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Pulses because of their higher nutrient contents play an important role in providing nutritional food security in developing countries. Average productivity of pulse crops like chickpea and pigeonpea is very low as these pulse crops are grown in semi-arid regions and exposed to a number of biotic and abiotic stresses. Breeding efforts for enhancing productivity could not meet the desired target that are critical to feed the vastly growing global population. Biotechnologies such as molecular breeding, genetic engineering and genome editing therefore, have a huge potential to enhance the crop productivity and accelerate the rate of genetic gains. With an objective to understand the genome architecture and apply biotechnologies, draft genomes of several pulses have been assembled. Large scale re-sequencing efforts have been initiated in these crops for identifying new sources of genetic variation and allelic variants of candidate gene(s) associated with beneficial traits which can be targeted for molecular breeding and genome editing. In some pulses, genetic engineering approach has also been used to improve nutrition. Significant advances in different biotechnologies especially their deployment for improving crop productivity as well as nutrition will be presented.

Crop genomics: Towards nutritional security

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Crop genomics is the study of genes, their function and how the genetic information is organized within the genome of a plant. This field of science provides the essential tools to speed the work of the traditional geneticist where instead of single genes, the whole genome is sequenced and decoded. Through advancements in sequencing technology and bioinformatics, valuable information stored within the crop genome is decoded and used to decipher important cellular and biosynthetic pathways that are important in the production of valuable health benefiting nutrients. Crop genomics has ushered us into a modern breeding era and it is currently our “best bet” for embracing and sustaining nutritional security. This powerful technology has been applied successfully to unlock the potential of genetic biodiversity to develop highly nutritious crop varieties more efficiently than conventional breeding practices. Through its application in breeding program, a saving of up to 40% of operational costs has been reported in crop plants where its application increases efficiency of selecting desirable traits and reduces generation cycles. This technology can only be fully realised if serious efforts are made towards its awareness and adoption by next generation of breeders.

Plenary Session 5: The role of biotechnologies in climate-smart agriculture & bioeconomy

The role of biotechnologies in climate-smart agriculture

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Climate change is a big challenge to the attainment of the future food system that is envisioned to be safe, nutritious, resilient, and sustainable, in addition to meeting future population's food demand. Climate change can also have multiple impact and the intensity/severity of the climate events in the future is unpredictability. Responding to climate change requires not only proactive and integrated approach but also the rapid development of technological responses. In the presentation, we will discuss how biotechnology (i.e. rice) is being used to cope with climate change's current effects and future impact. The focus is on rice considering its role as major food security crop projected to be affected by climate change. Such biotechnology as molecular marker-aided selection and backcrossing, gene editing, genetic engineering and others are currently being applied. Biotechnology will be a key tool in sustaining the productivity of this crop, reducing its footprint including its contribution to GHG emission, and in enhancing its role in food security and nutrition. There are still some challenges in the effective application of the output of this technology that are specific to it, and as part of the response to climate change, in general.

Case study on recycling of oil palm biomass waste and turning it into renewable energy

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There is a big potential for biomass energy from various palm oil residues, wastes and effluent. Currently, biomass is widely used for heat and power generation through combustion process in the palm oil mills for their electricity and steam. The excess power from the plant can be connected to the national grid, as part of the national renewable energy requirement. This paper will address some of the issues in developing palm biomass and biogas energy. The government can provide support for the development of palm biomass utilization as renewable energy by legislative and fiscal incentives. This paper will specifically discuss the commercialization of biogas energy from palm oil mill effluent into green electricity for grid connection in Malaysia.

The use of wild relatives of rice through wide hybridization against drought, salinity, and low temperatures

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Rice (*Oryza sativa* L.) is the most important cereal crop for global food security. It is grown, harvested, and consumed worldwide under a range of agro-climatic conditions, including marginal lands and high-altitude regions, with a multitude of abiotic stresses that are the primary causes of unstable rice production. Rice production is further threatened by climate change-induced conditions, mainly drought due to changes in rain fall patterns, increasing salinity levels in agricultural lands due to rising sea levels, and temperature extremes. The genus *Oryza* has 22 wild species that can survive in diverse habitats. These wild rice species are an important reservoir of novel genes that control agriculturally important traits. Rare traits or genes in the wild species for tolerance to major abiotic stresses such as drought, salinity, and low temperatures have been identified at IRRI. We have transferred some of these genes into modern elite rice cultivars using

conventional crossing, backcrossing, and DNA analysis procedures. The new genetic materials we have developed serve as valuable resources for protecting rice farmers against the adverse effects of climate change and in making rice production sustainable.

Integrated aquaculture systems as climate smart aquaculture and ecosystem based bio-technology: Potentials for scaling out in the North Central Coast of Vietnam

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Coastal aquaculture production in the North Central Coast of Vietnam is dominated by small scale and resource poor aquaculture farmers. This farming activity is highly vulnerable to global climate change manifestations including extreme climate events such as storms, high and low temperatures, and flooding. In this study, we argue that integrated aquaculture systems in the North Central Coast of Vietnam can be considered as a climate smart aquaculture practice, and be an ecologically-based biotechnology approach. Empirical findings of pilot research (tilapia was raised in rotation with tiger shrimp, mud-crab and seaweed in a traditional extensive aquaculture system) by WorldFish and national partners (Vietnam Institute for Fisheries Economics and Planning-VIFEP, Thanh Hoa Agriculture Extension Centre) in the North Central Coast of Vietnam showed that adopting integrated and polyculture aquaculture systems can help farmers improve aquaculture productivity and household incomes, while also climate-proofing. In exploring the role of biotechnologies in sustainable aquaculture production systems, integrated and polyculture systems should be also investigated so that suitable biotechnologies can be developed for small scale and resource poor farmers.

Climate change impacts and potential benefits of heat stress resilient maize for Asian tropics

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In Asian tropics, millions of smallholders grow maize as rain-fed crop, highly vulnerable to extreme weather events including high temperatures and drought stress. Climate model studies show South Asia is heating up – both day and night. Sharp increases in temperatures adversely affect maize production in many parts Asian tropics. Maize varieties that thrive despite soaring temperatures and water deficits play an important role in adapting to the changing climate. The project Heat Tolerant Maize for Asia (HTMA), supported by USAID under Feed the Future (FTF) initiative of the US Government, is a public-private alliance that targets resource-poor farmers of South Asia prone to weather extremes and climate-change effects. Accelerated development and deployment of heat resilient maize gives these farmers a chance to thrive in the face of increasingly volatile weather conditions. The stress-resilient hybrids were developed by using elite maize germplasm from CIMMYT and partners, novel maize breeding tools, such as genome-wide association studies (GWAS), rapid-cycle genomic selection (RC-GS), and double haploidy, supported with precision phenotyping network in the region. Within a period of past four years a total 35 heat-resilient hybrids were licensed to partners in South Asia from public sector, SMEs and MNCs for evaluation, seed scale-up and deployment in vulnerable target agro-ecologies/markets.

Can agricultural biotechnologies address the challenges of climate change?

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Climate change is an urgent challenge facing farmers in the Asia-Pacific region. As our world warms, many farmers are already experiencing devastating consequences, including storms, drought, floods, heat waves

and extreme weather events. The implications for food security are severe, with the Intergovernmental Panel on Climate Change (IPCC) projecting that wheat, rice and maize production will be negatively impacted by local temperature increases of 2°C or more above late 20th century levels. Coupled with a predicted reduction in renewable surface water and groundwater resources in most dry subtropical regions, the prospects for agriculture are worrying. Agricultural biotechnologies may offer potential for increasing adaptation and resilience to climate change, but would need to be assessed for their feasibility, affordability, safety and sustainability. In this regard, several agricultural biotechnologies such as genetic engineering, conventional breeding with marker assisted selection and agroecology, will be briefly compared. Whether any particular technological path can rectify the causes of problems will be an important question to be answered, given the current unsustainable trajectory of industrialized agriculture systems, which themselves are a major contributor to climate change.

Development of crops tolerant to adverse environments using agricultural biotechnologies

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There are concerns that global strains on food supply could occur in the medium to long term due to global population rise, chronic malnutrition in developing countries, projected economic growth in emerging countries, and increased frequency of abnormal weather events. Thus, it is necessary that sustainable agricultural production activities are carried out especially in developing countries where the production potential of the agricultural sector has not been fully harnessed. In order to establish stable and sustainable production of agricultural crops in developing countries that are vulnerable to climate change impacts such as droughts, high temperature, and high salinity, we work on developing breeding materials and breeding technologies including agricultural biotechnologies to produce crops that are highly productive yet adaptable to such adverse environments.

We developed rice near-isogenic lines (NILs) with early-morning flowering trait that mitigates high temperature-induced sterility and soybean NILs with high salinity tolerance using marker assisted selection. Recently, we have shown that overexpression of an Arabidopsis galactinol synthase gene improved drought tolerance in transgenic rice and increased grain yield in the field. By promoting the research to develop environmental stress-tolerant crops using agricultural biotechnologies, we hope to contribute to enhancing and stabilizing agricultural productivity in developing regions.

Plenary Session 6: South-south cooperation

Perspectives from China on South-South Cooperation in agricultural biotechnologies

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South-South Cooperation (SSC) involves mutual exchange of development, solutions and resources among countries in the South. SSC has been formally recognized as being complementary to the North-South Cooperation, and as being an instrument in supporting the implementation of the *Sustainable Development Goals*. Recognizing the importance of SSC, the Chinese government places SSC in high priority. Under the Belt and Road initiative, China pays a lot attention to the development of South countries. In the most recent BRICS Forum in Xiamen (September 5, 2017), the Chinese President Xi Jinping announced that China will provide $500 million to the Assistance Fund for SSC. Under the fast development in plant molecular genetics, biotechnology provides new possibilities for agricultural innovation. By seeing these opportunities, the Chinese Academy of Agricultural Sciences (CAAS) has made many progresses in the field of agricultural biotechnology, in particular, technologies of genome editing, transformation, maker-assisted selection (MAS), molecular crop design and doubled hyploid (DH) technology. Many new traits with possibilities to be used in plant breeding are created by mutagenesis. With the support of Bill &Melinda Gates foundation and IAEA, 21 Green Super Rice cultivars have been developed and released in the target Asian and African countries. More than 120 young scientists and graduate students most from Asian countries have been trained through PhD/MSc programs in crop sciences in CAAS.

An overview of the Asian Food and Agriculture Cooperation Initiative

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Asian Food and Agriculture Cooperation Initiative (AFACI) is an inter-governmental and multi-lateral cooperation body aiming to improve food production, realize sustainable agriculture and enhance extension services of Asian countries by sharing knowledge and information on agriculture technology.
AFACI is composed of 14 member countries, namely: Bangladesh, Cambodia, Lao PDR, Indonesia, Kyrgyzstan, Mongolia, Myanmar Nepal, Philippines, Sir Lanka, Thailand, Vietnam and Republic of Korea. It was officially inaugurated on 03 November 2009, in Korea with the full participation of government representative from the member countries in Asia. 9 of agriculture sector project are working: Animal Science, Construction of Asian Network for Sustainable Farming Technology, Integrated Management System of Plant Genetic Resources, Dissemination of Seed Potato Systems, Rice Migratory, GAP, Postharvest, Agriculture technology information network and Seed-extension.
On AFACI Animal Science project conducted a workshop in last June with the cooperation of FAO and ILRI. The workshop was attended by 10 Member countries with 12 locally adapted populations belonging in members' counties; its main objective is to identify the genetic characteristics of the cattle with Microsatellite Marker information. Result of this workshop, participants are building up for molecular genetics technology capacity, in a view of science results, 12 population are consisted with *Bos taurus* and *Bos indicus*.

The rice blast research network for sustainable rice production

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Blast **(***Pyricularia oryzae* Cavara) is one of the most serious diseases for rice **(***Oryza sativa* L.) in world wide. JIRCAS collaborative research project, "Blast Research Network for Stable Rice Production", have been conducted for aiming the developments and distributions of differential systems for resistance in rice and virulence genes in blast fungus, with Asian countries, and CG centers, such as International Rice Research Institute and Africa Rice Center. Under the network research, the differentiations of blast races and rice cultivars, and interaction of them, have been clarified in global level, by the sharing of information among participated countries.

Based on these achievements, genetic improvement of promising rice cultivar in each county are ongoing using the differential system and novel gene sources, and then exchanges of the materials are also planning for evaluations of resistance in rice developed under different environmental conditions among the collaborative counties.

Sharing of the materials, genes' sources, methods for identification of virulence and resistance genes, and selection methods for resistance plants, will be important for enhance to develop the durable protection system against the disease, among Asian and African countries.