In Memory of Sano Touzaburo

Niigata International Food Award

Summary of Commemorative Lectures by the Winners

Feeding the billions:
Africa's role in meeting the needs of the growing global population

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The global demand for food will continue to rise rapidly to meet the needs of about two billion more people and at the same time improve the food security of the 1 billion who are already enduring severe food shortages and insecurity. Paradoxically Africa is both the cause for most concern and the best hope for its resolution, because while it has the highest proportion of extremely poor and hungry people and fastest growing population it also has the greatest gaps between the actual and potential crop and livestock yields and the most under used arable land.

To realise the hope Africa is making great effort to reform its agricultural institutional structures that will underpin and drive improved agricultural production that will be derived from improved farm productivity, better information, communication and learning systems and strengthened human and institutional capacity.

These actions depend on a realisation of the mutual interests for continental and global collaboration in African agricultural research, development and capacity strengthening, which Africa is fostering by developing and implementing guidelines and principles for collaboration and benefiting from development assistance.

Africa is making progress towards the goal of 6% growth per annum in production which is required to achieve sustainable improvements in food security while also meeting the needs of a rapidly expanding population.

The Comprehensive Africa Agriculture Development Programme (CAADP) and the Framework for African Agricultural Productivity (FAAP) set out how the stakeholders in agricultural research and technology dissemination and adoption should address their tasks to maximize their effectiveness. This depends on all agricultural research development, research and capacity strengthening institutions focusing on how they can add value most effectively to each other's efforts. Both African and non-African institutions must collaborate as effectively as they can because it is in both their vested interests to do so.

Japan has led the way in such collaboration initially through bilateral rice development projects but more recently through the international Coalition for African Rice Development (CARD).

The Forum for Agricultural Research in Africa (FARA) has been at the forefront of such collaboration by catalyzing, facilitating and supporting mutually beneficial collaboration between African institutions themselves and with non-African partners in development, science and capacity strengthening. The Forum and its Secretariat will continue to advance mutually advantageous collaboration.

Development of Hybrid Rice for Food Security in the World

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The current world population is over 6 billion and will reach 8 billion in 2030. Meanwhile, the annual loss of land to other use is 10 to 35 million hectares, with half of this lost land coming from cropland. It is expected that 60% more rice should be produced in 2030 than in 1995. Currently, 1 ha for rice production provides food for 27 people. By 2050, 1 ha will have to support 43 people. Facing such severe situation of population growth pressure plus cropland reduction, it is obvious that the only way to solve food shortage problem is to greatly enhance the yield level of food crops per unit land area through advance of science and technology.

Rice is a main food crop. It feeds more than half of world population. Therefore, to increase production of rice plays a very important role in food security and poverty alleviation. Theoretically, rice still has great yield potential to be tapped and there are many ways to raise rice yield, such as building of irrigation works, improvement of soil conditions, cultural techniques and breeding of high yielding varieties. Among them, it seems at present that the most effective and economic way available is to develop hybrid varieties based on the successful experience in China.

It has proved practically for many years that hybrid rice has more than 20% yield advantage over improved inbred varieties. In recent years, hybrid rice covers 57% or 16 million ha of the total rice area in China. The nationwide average yield of hybrid rice is 7.2 t/ha, about 1.4 t/ha higher than that of inbred varieties (5.8 t/ha). The yearly increased grains in China due to growing hybrid rice can feed 70 million people each year. Therefore, hybrid rice has been playing a critical role in solving the food problem of China thus making China the largest food self-sufficient country.

China makes increasing progress in development of hybrid rice technology. Especially, good results have been achieved in developing super hybrid rice varieties since the initiation of the super rice research program in 1996. Several pioneer super hybrids have a yield advantage of around 20% over current high yielding hybrids on commercial scale. In recent years the area planted to super hybrid rice is 2 million ha with an average yield of around 8.5 t/ha. In addition, a two-line super hybrid P64S/E32 and a three-line super hybrid II-32A/Ming86 created a record yield of 17.1 t/ha and 17.95 t/ha, respectively. In the meantime, grain quality of super hybrid rice varieties is very good. After the successful development of the first generation super hybrid rice (yield level at 10.5 t/ha), efforts were focused on breeding the second generation super hybrid rice (yield target is 12 t/ha) and good results have been obtained. For example, in 2003, the second phase super hybrid rice varieties yielded over 12 t/ha at five 6.7-ha locations in Hunan Province. In 2004, twelve 6.7-ha or 67-ha locations in the southern provinces reached the yield level of 12 t/ha. These hybrids have been released for commercial production since 2006. The area under them was 300,000 ha in 2009 and the average yield was over 9 t/ha. The above facts indicate that the super hybrid rice shows a very bright future. If super hybrid rice covers an annual area of 10 million ha in China and calculating by a yield increase of 2 t/ha, it is expected that the annual increased grains will reach 20 million tons, which means another 70 million more people can be fed every year.

Hybrid rice has been proved to be a very effective approach to greatly increase yield not only in China, but also outside China. Vietnam and India have commercialized hybrid rice for years. In 2008, about 600,000 hectares were covered with rice hybrids in Vietnam. On average, the yield of rice hybrids is 6.3 t/ha while that of the inbred varieties is 4.5 t/ha. Because of planting hybrid rice on large-scale commercial production for years, Vietnam becomes the second largest rice export country. Besides, many other countries, such as the Philippines, Bangladesh, Indonesia, Pakistan, Egypt and USA, have also achieved great success in extending hybrid rice technology. For example, in the Philippines, under technical assistance from China National Hybrid Rice R&D Center, hybrid rice has been commercialized since 2002. Especially, a super hybrid rice variety called SL-8 has been developed by my assistant in the Philippines, it was planted to about 3,000 ha in 2003 and the average yield was 8.5 t/ha, more than doubled the country's average yield. In 2009, the area under rice hybrids was expanded to 233,000 ha and the yield advantage is two tons per ha. Based on this achievement, the Philippines government has made an ambitious plan. The target is to expand the area of hybrid rice to one million ha by 2012. Even in USA, the super country, hybrid rice also has greater yield advantage (>20%) over their local varieties. The area under hybrid rice was 350,000 ha in 2009. These facts clearly show that hybrid rice technology developed by China is also effective to greatly increase rice yield worldwide. If 50% of conventional rice IS replaced by hybrid rice, and calculating on a 2 t/ha yield advantage of hybrid rice, it is estimated that the total rice production in the world will be increased by another 150 million tons of rice, which can feed 400 million people each year.

Therefore, I firmly believe that hybrid rice, relying on scientific and technological advances and the efforts from all other aspects, including governments, private sectors, NGO and particularly from FAO and IRRI, will have a very good prospect for commercial production and continue to play a key role in ensuring the future food security worldwide in the new century.

Broad Applications of Database of Mushroom Genetics

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To ensure a stable food supply to accommodate the explosive growth of the world population, we need to accelerate the development of varieties that incorporate genetic markers. Seeking ways to use non-edible plant parts is also important to effectively use limited arable land area. In addition to the food uses of artificially cultivated mushrooms, they also have a wide range of non-food applications, and their non-edible parts have a wide range of uses, making them an ideal model organism for applied food science.

Maintaining a stable shape and taste requires experience and expertise in cultivating mushrooms, but ensuring large quantities and a stable supply of food requires a scientific cultivation plan. Globally, the genomes of many species, including animals, plants, and microorganisms, have been mapped (as of October 2010, according to NCBI data, the genome of 2503 species are completely mapped or in progress). Among them, the common mushroom and the oyster mushroom are the only species of edible mushrooms that have completely mapped genomes, which is very few. Consequently, I have collected the transcriptomes (gene expression data) of five representative species of Japanese edible mushrooms, maitake, king oyster mushroom, brown beech mushroom, shiitake, and matsutake, and built a database for applications such as scientific cultivation plans.

The gene expression database can be thought of as, for example, specifying the gene clusters that form the fruiting bodies known as mushrooms, leading to an understanding of the molecular mechanism of the formation of fruiting bodies, and ultimately leading to the establishment of artificial cultivation techniques for mushrooms species that cannot currently be cultivated. Furthermore, many gene clusters involved in the formation of mutant mushrooms can now be identified, allowing us to begin eliminating variant traits (anomalies) caused by mushroom cultivation in the laboratory and to begin maintaining stable traits. Knowing the gene expression behavior not only allows us to easily control cultivation conditions, but also contributes to non-food applications. As one example, a specific maitake protein that binds to human lipid rafts on cell surfaces has been found using the database. Rafts have an important role in transporting materials in and out of the cell, but until now, analyzing the underlying behavior was difficult. The discovered protein has a low cytotoxicity, and because it can be used to analyze the mechanism of transporting materials inside live cells, applications can be developed in fields such as basic biology and medicine. Thus, the mushroom gene expression database provides immense benefits.