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Status of World Food Security and its Future Outlook, and Role of Agricultural Research and Education

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The world produces sufficient food to meet the need of everyone at present. Yet, despite of our continued efforts, progress in eradicating hunger has been slow in general. The world is still a home of 805 million chronically hungry people and the vast majority of them live in developing countries. One in every nine people on the planet suffers from chronic hunger, and one out of every four children under age five in developing worlds are stunted. Looking at the future, the world would likely face serious challenges in future food security. Present world population of 7.2 billion is predicted to exceed 9 billion by 2050, and the per capita average food consumption would exceed 3,000 kcal/day by 2050 from 2,770 kcal/day in 2005/07. To meet the rapidly increasing food requirements, the world food production needs to be increased by 60% worldwide by 2050. If the world fails to achieve this target, there would be a high risk of food shortage, food riots, social and political unrest, and other negative consequences as witnessed during the food price crisis in 2007−08. On the other hand, there are number of serious challenges and uncertainties which would negatively influence future food production and productivity increase such as very limited arable land expansion potential, increasing scarcity of water resources, negative impacts of climate changes and increasing competition on the use of land and water between food crops and bio-energy crops. FAO predicts that it would be possible to increase food production by 60% by 2050 on the assumption that nearly 90% of food production increase should come from existing arable lands through yield increase and agricultural research. Therefore, agricultural research and education is expected to play an extremely important role in feeding the world in the future and achieving world peace and stability.

Key words: food security, hunger, climate change, research, education

Introduction

At present, the world produces more than sufficient food to meet the demand of everyone, and maintains adequate food stocks. The cereal supply as at July 2014 was over 1% above the estimated utilization (demands) is expected to reach 2.49 billion tones (Fig. 1; FAO, 2014a).

Despite of the positive situation in supply side, FAO's estimation in 2014 indicated that, globally, 805 million people were unable to meet their dietary energy requirements in 2012−14, down from 842 million reported for 2011−13 (Fig. 2; FAO 2014b).

Thus, around one in nine people in the world were suffered from chronic hunger, not having enough food for an active and healthy life. The vast majority of these chronically hungry people – 98% – live in developing world, where the prevalence of undernourishment was estimated at 13.5% (FAO 2014b).

Indeed, the fundamental cause of chronic hunger is not food production itself, but due to largely lack of accessibility to adequate and quality food by the poor and disadvantaged groups in society due to economic reasons such as poverty and low income, and due to physical access problems resulted from lack of adequate roads, markets and storage facilities. Proper utilization of food by individuals and lack of nutrition awareness towards a need for balanced diet, as well as

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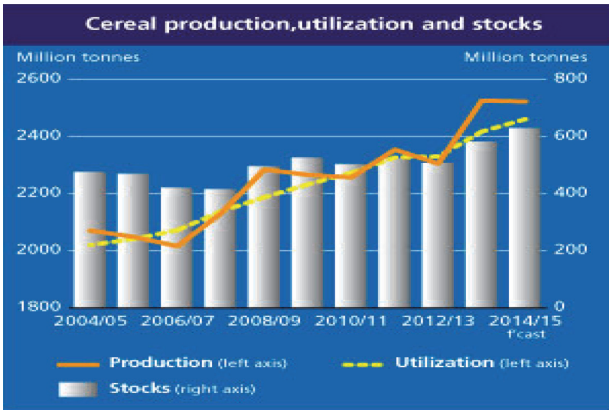

Fig. 1. FAO cereal supply and demand brief, October 2014 (adopted from FAO, 2014a).

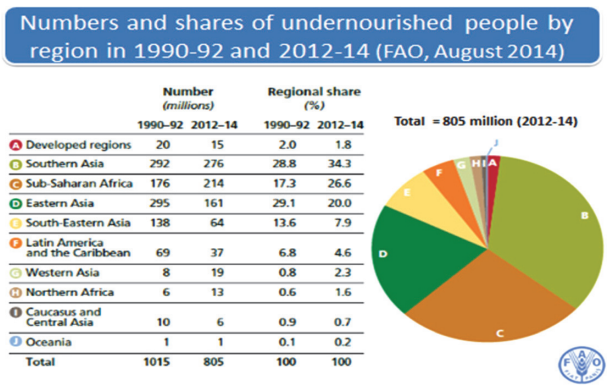

Fig. 2. Changing distribution of hunger in the world, 1990–92 and 2012–14 (adopted from FAO, 2014b).

a lack of stability for access and supply caused by food price hike, natural and manmade disasters, and other external impacts would also contribute to food insecurity.

In addition to 805 million chronic hunger populations, there are over 2 billion people suffering from micro-nutrient (vitamins and minerals) deficiency, and 2.1 billion people suffering from overweight and obesity leading to diet related non communicable diseases.

Surprisingly, there is almost 2.5 times more population suffering from overweight and obesity than those suffering from hunger.

The question before us in this challenging time is what is the food requirement to meet the needs of growing population and what is the future prospect of production and challenges in food production to ensure food security for our children and future generations. FAO has been looking at this question analytically for many years and has produced a series of perspective studies projecting the state of world food and agriculture in the future. The most recent study makes projections to the year 2050.

This presentation delivered as a key note speech at the UNESCO-APEID 2014 International Symposium on Agricultural Education for Sustainable Development (Ag-ESD Symposium 2014) held in Tsukuba, Japan on 10−14 November 2014 is based on FAO's study which assessed the future outlook of global food security. The presentation further discussed and elaborated the role and importance of agricultural research and education as one of the most fundamental solutions to meet the future food security challenge.

World food security and future outlook towards 2050

The world population is projected to increase from present level of 7.2 billion, and would reach around 9.2 billion by 2050 (Fig. 3; UN, 2011). Thus, more food will be needed to feed the rapidly increasing world population, especially for next 30−40 years towards 2050 when the population growth continue to keep high pace. The annual population growth rate is projected to slow down from present level of 1.2% to less than 0.5% after the year 2050.

Another challenge is a rapid urbanization and change in dietary habit which would result in increased demand of meat, milk, eggs, fish, etc. At present, a half of world population live in cities. It is estimated that 60% of world population would live in urban centres in 2030 and nearly 70% by 2050. For Southeast Asia, nearly 63% of total population is expected to live in urban areas in 2050. This implies a rapid decline of agricultural labour force, changes in dietary habits, growth in the importance of urban and peri-urban agriculture to meet food needs of urban population.

With the advancement of economy, per capita food consumption per day has increased and reached 2770 kcal/person/day in 2005/07, while it was only of 2370 kcal/person/day at the beginning of the 1970s. There are identical differences among the regions. In our most recent (provisional) projections, the world average consumption is expected to be just over 3000 kcal/person/day in 2050. Per capita consumption in East Asia is expected to approach saturation levels, reaching 3225 kcal/person/day in 2050.

According to UNDP's recent study, the middle income class is estimated to increase by 2.5 times be-

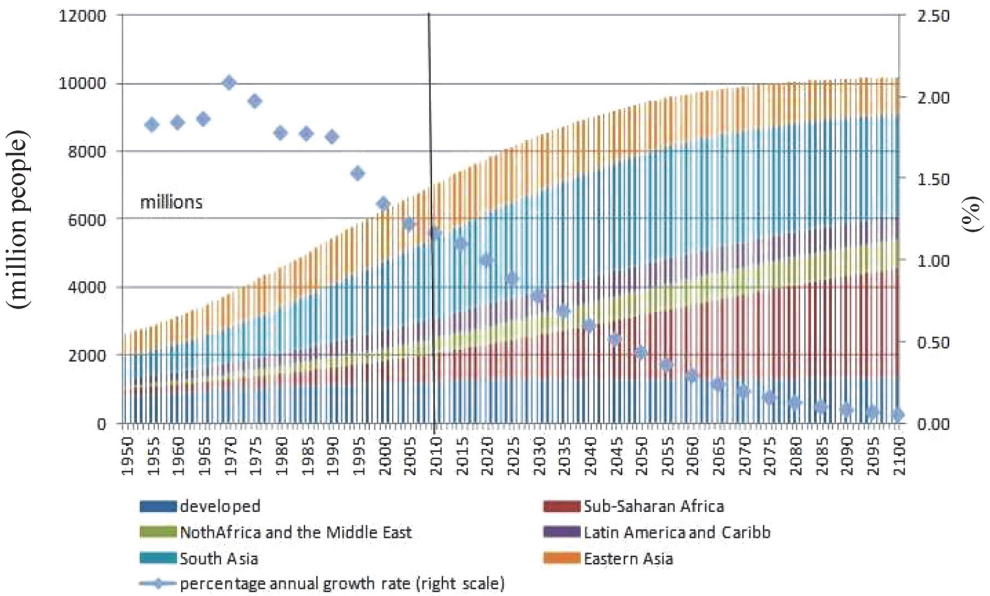

Fig. 3. World population trends (adopted from UN, 2011).

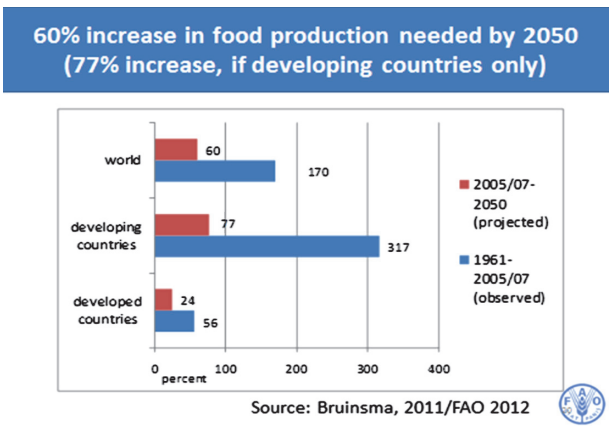

Fig. 4. Estimated world food production increase to meet the demand in 2050 (adopted from FAO 2012b).

tween 2009 and 2030. For Asia and the pacific region, it would be increased by 6 times by 2030, largely contributed by China, India and Indonesia. This would imply to rapid increase of demand for high value food commodities such as meat, dairy products, fish, etc. (UNDP, 2013).

Overall, FAO estimates that the world food production would need to increase by about 60% (77% for developing countries alone) between 2005/07 and 2050 to meet increasing demands (Fig. 4; FAO, 2012b).

However, if we compare these expected developments with the past, we realize that this is a slowdown: in terms of growth rates, as world agricultural production has recorded an increase of about 170% between 1961−63 and 2005−07, largely contributed by green revolution. For Asia alone, the green revolution facilitated cereal production increase of 300% during the same period, which pushed the cereal prices down by 40% in real term and halve the proportion of chronic hunger from 34% to 17% during the same period.

In summary, FAO's baseline projections to 2050 indicate that it should be possible to meet the food (including feed) demand of the projected world population of year 2050, making reasonable assumptions about growth in yields and in land and water use. However, achieving the projected increase in production, it will require meeting several significant challenges, and may have side-effects that need to be addressed (FAO, 2012b).

Challenges and uncertainties

The question is how the world can increase food production by 60% (or by 77% in developing countries) by 2050 to meet the needs of growing population which would likely reach 9.2 billion, from almost fully exploited arable lands and advancing water scarcity. The answer, as outlined in the FAO's World Agriculture Towards 2030/2050, is that majority of it has to come from existing arable lands through agricultural research and yield increase (Fig. 5; FAO, 2012c). At world average level, nearly 90% of the growth in pro-

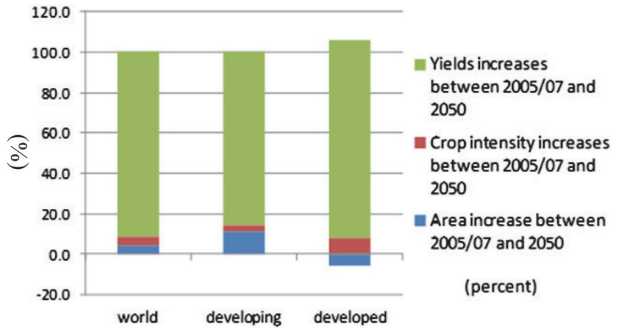

Fig. 5. Sources of production growth from 2005/07 to 2050 (adopted from FAO 2012c).

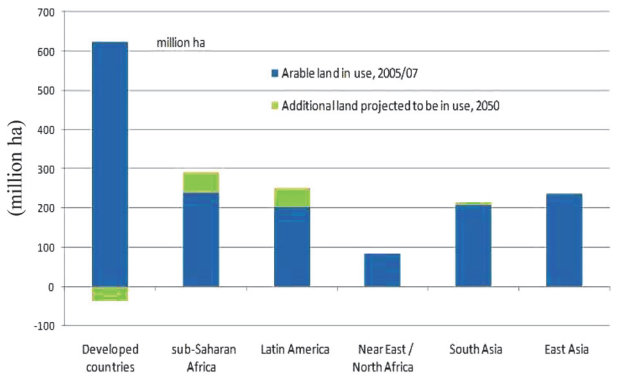

Fig. 6. Limited scope for the expansion of arable lands (adopted from FAO 2012c).

duction is expected to derive from increases in yields, while about 5% would originate from area expansion and another 5% from an increase in crop intensity. In developing countries, 12% of the projected growth in crop production would come from an increase in arable land, while higher cropping intensities would account for 3% and about 85% would originate from increased yields. The projected intensification will carry increased environmental pressure that needs to be addressed through improved and more eco-friendly and climate-smart cultivation techniques. This also necessitates that greater attention be accorded to the development of food crops of high productivity that can grow well on marginal lands, adopt to climate changes and that can tolerate growth in unique habitats such as fresh water swamps and saline conditions.

In addition to the constraints on land and water, there are several other critical challenges and uncertain factors which would influence food security. The world has to attain the target under existing constraints such as decline of productivity growth affected by lack of investment in agriculture and agricultural research in recent decades, and various uncertainties such as future crude oil prices, food price hike and volatilities, negative impact of climate changes and natural disasters, and uncertainty of bio-fuel development. The details of each constraint can be explained below:

Concerning arable land, according to FAO data in 2005/07 (FAOSTAT), about 12% of the globe's land surface was used for crop production, corresponding to little more than 1.5 billion ha. In 2050 arable land is expected to expand by some 70 million ha, or less than 5% (Fig. 6, FAO, 2012c). Such expansion would happen mainly in Sub-Saharan Africa, Latin America and part of Asia. Most of the projected increase in arable land use is concentrated in a small number of developing countries, including Brazil, Indonesia, Nigeria, Ethiopia. The size of arable land in some of Asian counties such as China and Vietnam started to decline. Water resources are becoming more and more scarce. Do we have enough water to support the projected increase in production? Historically irrigation has been a major determinant of increased production and productivity. Agriculture uses about 70% of the water resources of the planet. If we aim to increase agricultural production by 60% towards 2050, increase in demand for water use for agriculture is predicted and the pressure on water resources would be increased considerably. Therefore, another major challenge will be water saving agricultural production and improving irrigation technology and increasing the efficiency of irrigation systems. Annual productivity growth rate of cereals has been slowed down considerably since past one decade if compared to the time of green revolution. Indeed, in recent decades, the average annual productivity growth of wheat and rice recorded at around 0.6−0.8%, which was below population growth rate of 1.2% (Table 1; FAO, 2012a). There is a concern over a lack of sufficient agricultural research capacity in the future resulted from the decline of the investment to agricultural research in past few decades.

Moreover, there are a lot of food wasted after harvest – as much as 45% for fresh fruits and vegetables, and 30% for cereals. And a lot of food waste is recorded even after foods have reached to dining table. These figures include wastage of foods after they were cooked. About 15−25% of foods are wasted after cooking and they reach dining table in Europe, North America and industrial Asian countries.

One of future uncertainties which might influence

Table 1. Sources of growth for major cereals in developing countries (Source: FAO, 2012a).

Cereals	Year	Annual growth (%)			Contribution to growth (%)	
		Production	Harvested land	Yield	Harvested land	Yield
Wheat	1961–2007	3.62	0.68	2.92	19	81
	2005/2007–2050	0.87	0.01	0.86	1	99
Rice, paddy	1961–2007	2.46	0.54	1.91	22	78
	2005/2007–2050	0.58	−0.05	0.63	−9	109
Maize	1961–2007	3.55	1.05	2.47	30	70
	2005/2007–2050	1.43	0.59	0.83	41	59

food security is crude oil prices. We often forget that the crude oil price was around US$ 15 per barrel in 1990th, which was jumped by over 5 times high at the level of US$ 105–110 per barrel in 2010th. The prices have been volatile. This influenced the drastic increase of production cost of foods associated by the cost increase of chemical fertilizers, transportation cost of farm produce, cost of diesel for irrigation, etc. It also resulted in high cost of bio-ethanol and corresponding cost of raw materials especially maize which is one of the key staple foods for human and feed for animals for meat, milk and associated products. It is still very uncertain how the trend of future crude oil prices will be, which are often influenced by political and social stability of oil producing countries.

According to most credited scientists, key climate variables are likely to change over the coming decades. Global mean surface temperatures are projected to increase between 1.8℃ and 4.0℃ by 2100. This entails higher carbon dioxide concentrations, changes in the pattern of precipitation, increased weeds, pests and diseases. Impacts on agricultural production are likely to be unevenly distributed. Broadly speaking, the Southern hemisphere may suffer damages in terms of declining yields and greater frequency of extreme droughts and floods. The estimated aggregated negative impact on African agricultural output ranges from 15% to 30%. And developing countries are expected to increase their food imports under climate change scenarios. In the Northern hemisphere, instead, higher temperatures may benefit agriculture, expanding potentially suitable crop areas and yields. In the worst scenario in 2080, world would have 39% less harvested areas, while developing countries have 29% less which might result in additional 130 million undernourished people in sub-Sahara Africa.

In Asia and the pacific region, negative consequences of climate change are seen as a frequent occurrence of natural disasters such as floods and droughts which has doubled in past 10 years. These have affected food production and price stability. On the other hand, bio-energy crops compete with food crops on the use of land and water which are already scarce and hence threat food security.

It is projected that the bio-ethanol and bio-diesel production would be doubled in 20 years from 2009, which would influence food security if choices are let entirely to farmers. A comprehensive food security and bio-energy policy is needed to promote appropriate land use planning, harmonize food security and bio-energy development, and to ensure that food security would not be compromised by the excess expansion of bio-fuel production.

Potential risks in future food security

In general, while world would be able to produce sufficient food to meet the needs of growing demands, there are uncertainties which poses great uncertainties on future food security. The potential risks, if the world is unable to meet the production target, and if there would be a food shortage in the future, have to be assessed and proactive measure should be taken to prevent or mitigate the impact. According to the past experiences, there is a need to anticipate the reoccurrence of food export bans by food exporting countries to protect their own consumers, which would result in great uncertainty by food importing countries to secure food import. The situation might result in food price hike, food price volatility, negative impact to the poor consumers, and might lead to social unrest and political instability in some countries as witnessed in recent past in number of countries.

Food import countries such as Japan, Republic of Korea and Singapore would likely suffer from such negative impacts not only for importing staple foods but also on domestic meat, dairy and other livestock production which is very much dependent on imported feeds. In order to prevent or minimize such negative consequences, it would be necessary to prepare for the potential risks of food crisis and identify measures to prevent or mitigate them. As the first step, a clear national agricultural policy and food security policy and strategy should be formulated and implemented through multi-disciplinary and inter-ministerial coordination and public-private sector partnership. Reducing food import dependence would be an important step. At the same time, active participation in international effort to strengthen global governance on food security to prevent food crisis would be important. Widening food trade partners to distribute risks, promoting a role as a competitive food processing hub, joining and promoting regional/sub-regional food security agreements such as ASEAN + 6, establishing a cooperation agreement with trustful food exporting countries, etc. would be some of measures might be considered by food importing countries.

Conclusions

- World is facing a great uncertainty in future food security, which would be influenced by the magnitude of the impact of climate change.
- Food is not just a food, but is an essential commodity for survival. It would negatively impact social stability, world security and peace, if a shortage occurs.
- Agricultural research holds a key for breakthrough in future agricultural productivity and production growth to meet future food demands and to adopt and mitigate the negative impact of climate changes.
- There has been a sharp decline in investment in agriculture and agricultural research in past few decades which poses concern over delay in building future capacity in agricultural research.
- Importance of food and agriculture including its research and development (R&D) in general, and agricultural education in particular, should be fully recognized at all levels including policy makers, and corresponding advocacy efforts should be fully promoted.
- Agricultural research and education should strengthen its global approach to build up global/regional knowledge in agriculture and food security, and to facilitate knowledge sharing, exchange and learn from the experiences in global locations (food security and climate change is far beyond the issue of one country and requires global thinking).
- Agriculture must be attractive, especially to young generation aiming to increase young successor farmers, with the inclusion of innovative technology such as ICT in agriculture, climate smart agriculture, bio-technology and value chain approach, and should act as a prime mover for revitalizing rural economy and generating rural employment, and reverse the trend of rapid urbanization.
- Traditional agricultural heritage, rural land scape, traditional farming practices, local knowledge, bio-diversity and indigenous food resources should be conserved and further promoted with value additions and create a premium.
- Agricultural education should flexibly adjust its curriculum to accommodate emerging needs such as Zero Hunger Challenge, Save Food Initiative, Climate Smart Agriculture (CSA), Globally Important Agricultural Heritage System (GIAHS) and Geographical Indications (GI).
- Overall, the role of agricultural education is extremely important as it holds a key role in producing quality young scientists and researchers specialized in agricultural R&D, who will lead the future world, and hold a key role in attaining future food security, and achieving sustainable development, and world peace and stability.
- Pope has expressed his worry at ICN2 in November 2014 that “we enjoy too much individualism and forgotten solidarity; solidarity to all those less fortunate and suffering from hunger.”
- Education can play a great role in advocating the global issues of hunger and poverty, and create a world with a strong solidarity towards equitable and sustainable development.

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I also wish to thank the members of the Organizing Committee and Executive Committee for the effective and successful organization of the event.

Finally, I wish to thank all those contributed to the success of the symposium.

Affiliations

AFRC	Agriculture and Forestry Research Centre, University of Tsukuba
Ag-ESD	Agricultural Education for Sustainable Development
ASEAN	Association of South East Asian Nations
ASEAN +6	ASEAN plus six countries (Australia, China, India, Japan, RO Korea, New Zealand)
CSA	Climate Smart Agriculture
FAO	Food and Agriculture Organizations of the United Nations
GI	Geographical Indications
GIAHS	Globally Important Agricultural Heritage Systems
ICN2	The Second International Conference on Nutrition
R&D	Research and Development
SOFI	State of Food Insecurity (annually published by FAO,WFP and IFAD)
UNESCO	United Nations Education, Social and Culture Organization

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