

Review

Crops and food security- experiences and perspectives from Taiwan

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Food security is an important issue that is of concern for all countries around the world. There are many factors which may cause food insecurity including increasing demand, shortage of supply, trade condition, another countries' food policy, lack of money, high food- and oil prices, decelerating productivity, speculation, etc. The food self-sufficiency ratio of Taiwan is only 30.6% weighted by energy in 2007. Total agriculture imports and cereals have increased significantly due to the expansion of livestock and fishery industries and improve living standard. The agriculture sector of Taiwan is facing many challenges, such as: low level of food self-sufficiency, aging farmers, large acreage of set-aside farmlands, small scale farming, soaring price of fertilizers, natural disasters accelerated by climate change, and rapid changes in the world food economy. To cope with these challenges, the present agricultural policy is based on three guidelines: "Healthfulness, Efficiency, and Sustainability." A program entitled "Turning Small Landlords into Large Tenants" was launched to make effective use of idle lands. Facing globalization and the food crisis, Taiwan will secure stable food supply through revitalization of its set-aside farmlands and international markets, and provide technical assistance to developing countries, in particular for staple food crops.

Key Words: crop production, food security, food system, self-sufficiency ratio, food policy

OVERVIEW OF THE CROPS AND FOOD SECURITY

Food security has always been the most important issue around the world. For example, in 2005-2006, on average 16 per cent of the population in the Asian Pacific region suffered from hunger and their food intake fell below the minimum dietary energy requirement set by the FAO. In 2007 and 2008, the figures of hunger were even higher due to soaring food prices.¹ Unfortunately, this most important issue is also one of the most complicated. There are lots of factors that may cause food insecurity. The report of ESCAP¹ elaborated the factors which lead to food insecurity:

- A. *Increasing demand.* The rising populations and higher incomes enable consumers to buy more fruits and vegetables, along with meat, dairy products, and eggs instead of carbohydrates.
- B. *Food security through trade.* In the Asia-Pacific region, some countries are net food importers, which means that they should be able to earn sufficient foreign exchange from other exports, such as manufactured goods, so as to be able to import food. As food prices rise, they will need to export more manufactured and other goods to be able to import sufficient food.
- C. *Food policies of developed countries.* Developed countries generally have protected and subsidized their local farmers. As a result, these trade-distortion measures harms the farmers of developing countries due to low agricultural commodity prices.
- D. *Market-based food insecurity.* Even when food is available, people may not have economic access to

food – they may not have the cash to buy food. Farming communities and others can also suffer from food insecurity because of the actions of exploitative intermediaries, including landowners, money lenders and traders.

- E. *Food absorption and utilization.* Even when food is available in the household, some family members may not be able to take advantage of it – hampered by inadequate water supplies and poor standards of sanitation.
- F. *Food price crisis.* The food prices surged in the early 2000s, after world stocks of wheat, maize and rice dropped to 30-year lows. The drop in stocks caused food prices to rise sharply.
- G. *The impact of high oil prices.* Food prices are increasingly linked with the price of oil and gas, partly because natural gas as the principal input for fertilizers. But agricultural production itself has also consumed more fuel, as it has become more energy intensive. In addition, some land has been allocated for the production of bio-fuels.

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Manuscript received 6 July 2009. Initial review completed 24 September 2009. Revision accepted 29 October 2009.

H. *Decelerating productivity.* While the demand for grains has been rising, productivity has failed to keep pace with demand. This is largely the consequence of neglect in terms of investment in agriculture. Extreme climatic events also played their part in disrupting agriculture and food output.

I. *Speculation.* While speculation is not a driver of commodity prices, it can nevertheless accelerate and amplify price movements driven by fundamental supply and demand factors.

hood for a broad base of farmers.²

The share of agriculture in the gross domestic product (GDP) had accounted for 32.2% in 1952. Along with the rapid growth of other economic sectors, the share of agriculture in the economy has been declining. In 2008, agriculture generated a mere 1.5% of GDP, 1.5% of total exports, and 5.3% of total employment. However, agriculture still plays an important role in terms of food security, rural development and nature conservation.³

THE CROPS AND FOOD SYSTEM OF TAIWAN

Taiwan is a mountainous subtropical island-country with limited natural endowment. The country has one of the world's highest population densities with a population of more than 23 million and only a total area of 36,000 km². In the very beginning of Taiwan's economic development, agriculture played an indispensable role in providing sufficient food for domestic consumption and enough employment opportunities for the densely populated rural communities. Agriculture and food industry stood as the foundation of the national economy and provided a liveli-

The supply and demand of food

In Taiwan, the per capita food consumption in terms of energy was 2,821 kilocalories per day in 2007. This level of energy for a population of 23 million was equivalent to 22,357,000 metric tons food and was composed of cereals 88 kg (including rice 47 kg), vegetables 103 kg, fruits 128 kg, meats 74 kg, milk 20 kg, eggs 17 kg, sea-food 37 kg, and oil and fat 25 kg. It also showed that the consumption of rice decreased, and the consumption of meat and milk increased. (Figure 1)

Among the food supply, the net import of food amounted to 12,142,000 metric tons while domestic pro-

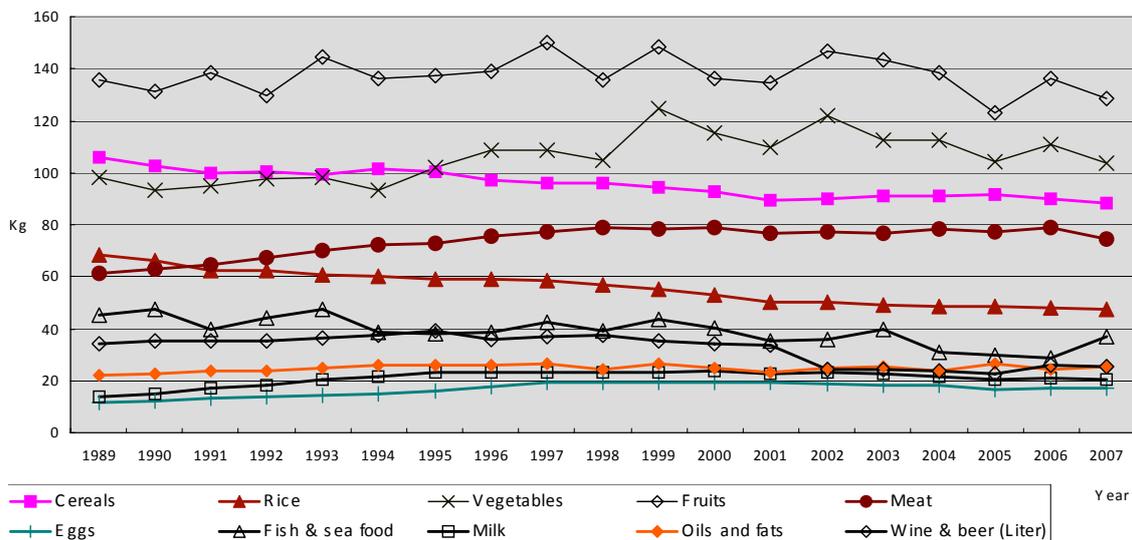


Figure 1. Per capita per year food available for consumption in Taiwan. source: food supply and utilization year book, 1989-2007, Council of Agriculture

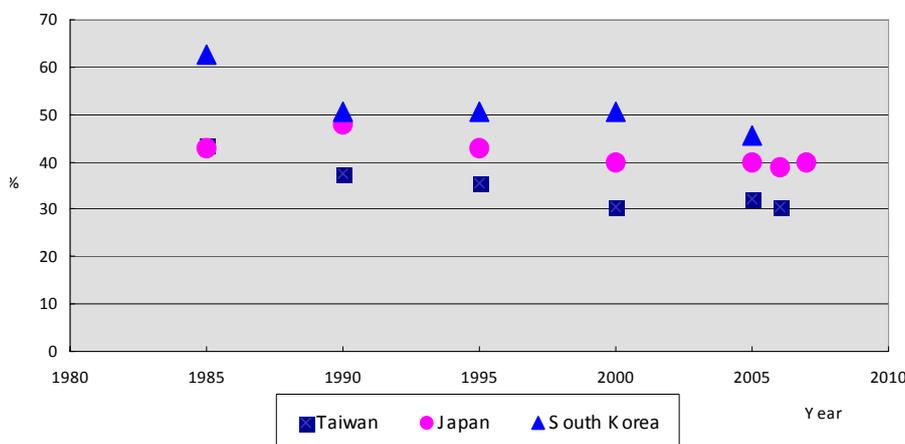


Figure 2. Average food self-sufficiency ratios (weighted by energy). Source: food supply and utilization year book, 1989-2007, Council of Agriculture

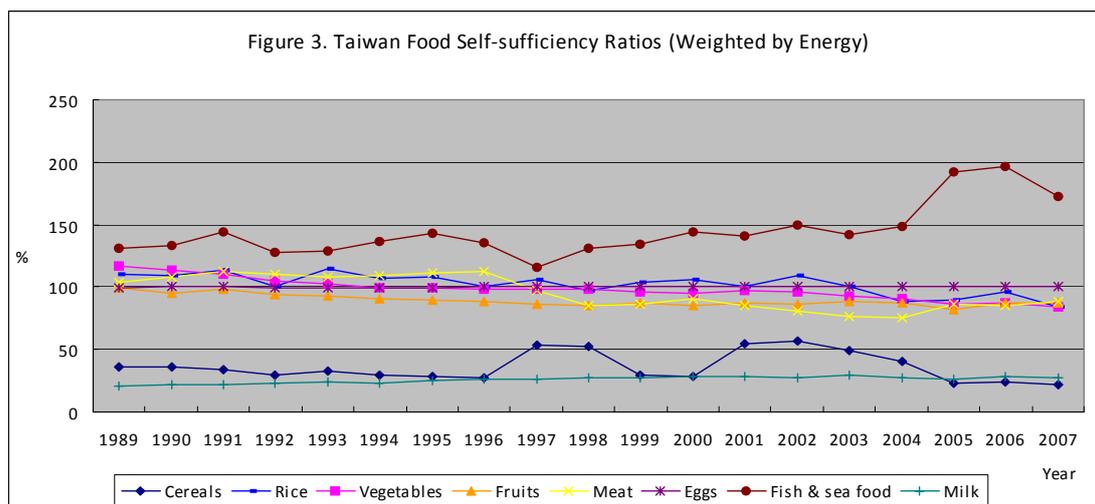


Figure 3. Taiwan's food self-sufficiency ratios (weighted by energy). Source: food supply and utilization year book, 1989-2007, Council of Agriculture

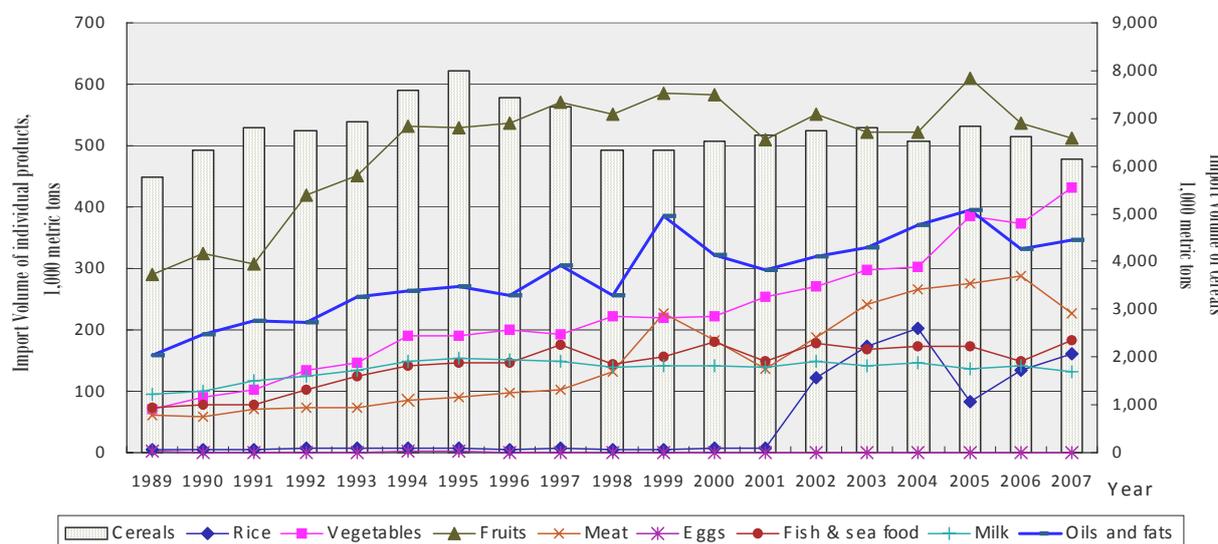


Figure 4. Food import in Taiwan. Source: agricultural statistics year book, 1989-2007, Council of Agriculture

duction was 10,930,000 tons. Taiwan's food self-sufficiency ratio is only 30.6% weighted by energy (72.5% weighted by prices) in 2007, which is almost the lowest among East Asia countries. (Figure 2) The ratios varied among various categories of food. The ratios of fish & sea food, vegetables, and fruits are pretty high while the ratios of cereals are quite low except rice which is the main staple in Taiwan. (Figure 3) The total food supply disposed for feed was 5,267,000 tons; for manufacture, 2,463,000 tons; for gross food, 13,766,000 tons; and for seed and waste, 862,000 tons.

Food trade

Food exports and imports in Taiwan have been growing steadily since the end of World War II. In the 1950s, food products dominated total exports, with a share of over 90%. However, their shares in total exports and imports steadily declined over the past decades. Taiwan's major food exports had been sugar and rice in 1952. In 1970, the major exported products turned out to be sugar, canned asparagus, canned mushrooms, and bananas. However, by

1990 the major food exports had become aquatic products, pork, and preserved vegetables. The development of newly introduced products has been due largely to the successful adaptation of technologies by well-trained and highly motivated farmers.

Total agriculture imports also increased significantly, rising from US\$66.5 million in 1952 to US\$12,122 million in 2008. The rate of increase in agriculture imports is obviously greater than that of exports. The remarkable increase in imports is mainly due to two reasons: 1) The imports of dairy products and beef in response to the rapidly improved living standard in Taiwan, and, 2) Rapid increase in imports of cereals (6.1 million metric tons in 2007), and fishmeal due to the expansion of the livestock and fishery industries.⁴ (Figure 4)

Domestic food production

Land use

At present, about 822,364 ha or 22% of the total area of the island is used for agricultural and food production. Paddy field and dry land account for 52% and 48% of

total cultivated land, respectively. The multiple cropping indices, as an indication of intensity, reached a peak of 190.0 in 1964 and rapidly decreased to 83.6 in 2007. Increasingly more farmlands are now set aside without cultivation.

The average farm size was less than 1 ha according to the 2006 census and only 25% of the farm households had a farm size with area more than 1 ha. The small scale of these farms was a major bottleneck to the enhancement of productivity in Taiwan's agriculture. However, fast development of the agribusiness service industry in the country helped to overcome slightly this constraint in recent years.

Labor and other Inputs

The number of farm households according to the 2006 census was about 556 thousand nearly the same as that in 1955. However, full time farm households decreased from 40% in 1955 to 21% in 2007. Agricultural employment decreased from 1,667 thousand persons to 740 thousand persons during the same period, and even decreased to 535 thousand in 2008.

Agricultural machines have been used to replace farm labor in production activities since 1970s. In addition to farm mechanization, inorganic fertilizers and chemicals were also employed as substitutes for labor input.

Agricultural fixed capital formation, in absolute terms, had a trend of increasing, but its percentage contribution in total fixed capital formation has steadily decreased from 6.7% in 1970 to only 0.31% in 2007.

Food production

The total value of agricultural production in 2007 was about NT\$388 billion (US\$11.5 billion). The growth rate of agriculture has slowed down significantly in recent years. The average annual growth rate from 1995 to 2003 was only 0.13% compared to 1.82% during 1985 to 1995 and 3.7% during 1975 to 1985. Of the total value of agricultural products, crops, livestock, fisheries and forestry accounted for 43.4%, 32.1%, 24.4% and 0.1%, respectively in 2007. In relative terms, crops and forestry products have been declining, while fishery and livestock productions are increasing over the years.

THE NEW DIRECTION OF TAIWAN'S CROP AND FOOD POLICY

Agriculture in Taiwan is currently facing various challenges, both at home and abroad. They include trade liberalization, increasing concern about food safety, food security, and environmental conservation.

Domestic obstacles

Low level of food self-sufficiency

Since its accession to the WTO in 2002, Taiwan's agricultural production and trade activities have been linked closely with those of the world. In 2007 and 2008, the prices of imported food and feed grains in Taiwan had risen sharply as those found in international markets. Given that food self-sufficiency ratios have constantly dropped, this has become a severe problem and solutions must be found.

Aging farmers and set-aside farmlands

The average age of the farmers is 58 years old in Taiwan's rice farming sector. Aged farmers tend to be less efficient, and more likely to depend on subsidies from the government.

As a commitment to being a WTO member, Taiwan opens a tariff-rate quota of 144,720 metric tons of brown rice for rice importation each year. In order to keep a balance between the supply and demand of rice, some 220,000 hectares of farmland in Taiwan is currently lying fallow.

The size of farming

The average farm size per farm household in Taiwan is 1.1 hectares compared to the farm sizes in Japan, EU and US of around 1.6, 20, and 190 hectares, respectively.

Global environment obstacles

Soaring prices of fertilizers and other input

Prices of fertilizer and other inputs are inflamed by a high oil price, which may remain constantly high in the foreseeable future.

Natural disasters accelerated by climate change

Natural disasters have contributed to the shortfall in production in recent years. Unstable production resulted from changes in production patterns and frequent floods and draughts.

Rapid changes in world food economy

Under the rapid increases in demand in Brazil, Russia, India and China (BRICs) for high quality foods, Taiwan tends to lose in buying competition. Soaring grain prices due to rapid increases in demand for bio-fuel is damaging dairy and livestock farmers.⁵

New agricultural policies since May 20, 2008

To meet those challenges mentioned above, the present agricultural policy of the Council of Agriculture (COA) is based on three guidelines: "Healthfulness, Efficiency, and Sustainability." The COA will establish Taiwan as a Pesticide-Free Agricultural Island within 50 years, increase per agricultural household income to over NT\$1 million within 4 years, and build 4,000 beautiful rural communities within 10 years.

Structural policy

A program to turn small landlords into large tenant-farmers is being introduced to ease land transfers, boost the utilization of farm land and encourage the long-term leasing of farm land by old farmers not keen on farming. By establishing a retirement system for old farmers and an easy lease payment scheme for both landlords and tenant-farmers, the program encourages small farmland owners who are not interested in or not capable of farming to lease their land on a long term basis. It also provides long-term interest-free loans to facilitate business-style management by tenant-farmers. The program will enable tenant-farmers to lower production costs, enlarge their farming scale, and boost production efficiency and competitiveness.

Improvement of crop and food production efficiency and quality

Efforts would be made to encourage compliance of all rice, fruit, vegetable, fish and livestock products with GAP (Good Agricultural Practices) or CAS (Certified Agricultural Standards) in 4 years. Expansion in outputs of organic agricultural products is planned. In order to ensure food safety and add value, selected farm products are encouraged to adapt traceability systems to win confidence from consumers. Meanwhile, Taiwan's government is also assisting farmers to enhance their crop production efficiency by setting up specialized areas for premier productions of rice, fruit, and vegetables, etc., and aiming at turning Taiwan into a "Global Centre of Sub-Tropical Fruits" and an "Asia Pacific Centre for Seedling, Fishery and Livestock Breeding"

Raising self-sufficiency for rice and corn for feed

An estimated 220,000 hectares of farmland is currently lying fallow due to government policy. Facing the recent global food crisis, Taiwan's government launched a program in 2008 to encourage farmers to grow corn for feed on fallow land. The resulted total area used for this purpose is 12,000 hectares, yielding 60,000 metric tons of feed corn to meet local demand. The purchase prices of rice by the Government were raised by about 10% from the 1st crop of 2008 on to stabilize the production of rice.

Encouraging rational use of fertilizers

To cope with the soaring oil and fertilizer prices in the recent years, Taiwan's government enhanced the management on quality control of commercial fertilizers and the training of farmers to use fertilizers rationally based on soil testing and plant analysis. It was further extend to: proper practices in the use of organic fertilizers and bio-fertilizers, planting green manures during fallow season, improving soil quality, avoiding soil acidification and degradation, and promoting land sustainability.

Improving trade environment

Under easing tension across the Taiwan Strait, Taiwan's government encourages its private sectors to trade and cooperate with the agricultural industry of China to seek mutual benefits, e.g. imports of feed corns and animal feeds from Mainland China and exports of fruits and fish from Taiwan to Mainland China.

TAIWAN'S PERSPECTIVES ON CROPS AND FOOD SECURITY

Taiwan is a net food and energy importing country and heavily relies on the international market. Ensuring a certain level of crop production and boosting production efficiency will always be the key to safeguarding food security of Taiwan. And in order to meet the needs of future generations, the government's investments in R&D of innovative technologies to improve contemporary agricultural practices and to develop better tools in crop production systems are of vital importance.

It is understood that improvement in crop production efficiency requires intensive use of fossil fuels including tillage operations, application of fertilizers and pesticides, and harvesting. Fossil fuels are also required in the manu-

facture and transport of pesticides and fertilizers. Therefore, the energy supply must be secured in advance of the food supply, and changes are needed in terms of the volume and efficiency of fuel use.

Moreover, crop genetics also has a significant impact on the input and output and thus contributes to production efficiency. Quality seeds of major crops have been selected over the years for uniform characteristics in terms of emergence, plant height, yields, increased resistance to pest and disease and tolerance of stress. The full potential of genetics as a tool in improving the effectiveness of crop production systems remain to be further explored.

On the other hand, current crop management regimes have benefited humans by meeting the demand for food, animal feeds and fibers. It is both traditional and dynamic, with subsistence farming supporting the majority of families and innovative commercial enterprises developing export markets. Improvement in both subsistence and export-oriented agriculture requires extension of adequate technologies, and training of farmers as well as related agribusiness.

Agriculture is the foundation of sustainable development in Taiwan. Finding practical and timely solutions to the current problems is crucial for sustainability. These solutions have to be able to reduce the level of inputs such as fossil fuels as well as the amount of wastes generated, and to reduce the impact of crop production on soil quality and biodiversity. At the same time, the genetic attributes of crop varieties must meet the requirements of production efficiency and consumer demand.

Measures to enhance production efficiency and to reduce impacts on the environment and public health have been undertaken in Taiwan including promoting rational use of fertilizers, breeding of disease- and pest-resistant varieties, developing integrated pest management systems and encouraging Good Agricultural Practices (GAP), etc. However, some conventional agricultural practices, such as the application of prophylactic chemicals for crop protection and the dependency on fossil fuels are still in need of improvement.

In view of global warming and climate change which resulted in extreme weather conditions, it is crucial to develop new crop varieties which can adapt to extreme environments so as to ensure food security for future generations. In this regard, there is an urgent need for countries around the world to strengthen their work on the conservation and utilization of plant genetic resources. Recently, the COA has participated in the Svalbard Global Seed Vault project which aims at preserving seeds of most of the world's crops. Duplicate seeds of existing important varieties are drawn from the collection maintained by the Consultative Group on International Agricultural Research (CGIAR), which holds 600,000 plant varieties in crop gene banks in its centers across the world. The CGIAR collections have helped plant breeders searching for traits to combat destructive crop diseases and pests; such as the black sigatoka fungus, which is devastating banana production in East Africa; and grain borer beetle, which is destroying maize in Kenya. They have also been used to help restore agricultural systems after conflicts and natural disasters. Seed varieties from Afghanistan and Iraq maintained at the CGIAR-supported

International Centre for Agricultural Research in the Dry Areas (ICARDA) in Aleppo, Syria, have helped revitalize crop diversity in these war-torn regions.

Meanwhile, the COA and the United States Department of Agriculture (USDA) agreed to sponsor a project conducted by AVRDC- the World Vegetable Center, namely, "Scaling up activities on indigenous vegetables for nutritional security and sustainable conservation of biodiversity in Asia". This project aims at long-term sustainability of indigenous vegetable conservation and utilization, in order to make a significant contribution to food security and health in rural and urban households, to improve livelihoods of the poor, and to sustain the conservation of biodiversity as a legacy for the present and future generations.

Facing the challenges brought by climate change and the burdens resulting from ever-growing global human populations, more collective efforts from the international community are required to tackle a broad range of problems in agriculture production. Among these problems, nutrition and food security appear to be among the first priorities of agriculture development in many developing countries. Increased movement of goods has changed consumption patterns and increased dependence on cheap and poor quality imported food items, and in addition have eroded traditional food production systems. Healthy diets and household food security need to be addressed by maintaining and encouraging the development of improved techniques for the provision of quality food for domestic consumption, and promotion of healthy life-

styles. To reach this goal, there is need for the stepping up of efforts in international cooperation on R&D with regard to innovative technologies to further improve the production and marketing efficiency of crops, increase investments on infrastructure and capacity building for enhancing self-sufficiency in basic food production in developing countries, as well as assisting farmers of developing countries in diversifying their production of vegetables, fruits and other food commodities.

AUTHOR DISCLOSURES

None declare.

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作物與糧食安全－台灣經驗及觀點

世界各國對於糧食安全的議題都相當的重視。許多因素可能造成糧食匱乏，包括需求的增加、供應短缺、貿易條件限制、其他國家的糧食政策、資金短缺、糧食價格高漲、生產力的降低和投機等。在台灣，2007年糧食自給率以熱量為權數計算僅有30.6%。由於漁牧業的擴張和生活水準的提高，農產品及穀類總進口有顯著的增加。台灣的農產業面臨了許多挑戰，例如糧食自給率低、農民老化、大量農地的休耕、耕地規模小、肥料價格高漲、氣候變遷造成自然災害的增加和世界糧食經濟的快速轉變。為了要因應這些挑戰，目前的農業政策是根據下面三個基本方針：「健康」、「效率」和「永續經營」；另外亦推動「小地主、大佃農」計畫，讓土地利用更有效率。面對全球化和糧食危機，台灣將透過國際市場及活化利用休耕農地以穩定主要糧食供應，並對開發中國家提供農業技術、特別是主要糧食生產方面的協助。

關鍵字：作物生產、糧食安全、糧食體系、自給率、糧食政策