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THE FOOD SECURITY ROLE OF DOMESTIC AGRICULTURE IN DEVELOPING COUNTRIES AND ITS MEASUREMENT

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Key words: Food Security in Developing Countries, Role of Domestic Production, Achievement of Food Security with Minimum Cost, Indices of Food Security

ABSTRACT

In this paper, the concepts and means to achieve food security with minimum costs are outlined theoretically, followed by the description of public good aspect of food security. Situations and issues regarding food security of developing countries are also explained. Nextly, a list of food security indicators are suggested based on the definition and elements of food security for the purpose of cross-country comparison of food security situation.

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I. Introduction

According to an estimation by FAO, about 790 million people in developing countries currently suffer from undernourishment (FAO 1999). Over three-fourth of undernourished people are located in Asia, the Pacific and Sub-Saharan Africa, and the malnutrition in those countries co-exists with affluence of food in developed countries.

Due to the rapid increases in food demand resulting from the rapid population growth and changes in food consumption patterns shifting toward demanding more livestock products, food imports of developing countries are expected to increase in the next decades. IFPRI estimated that the grain imports of developing countries will be doubled in 2020 compared with 1993 even though the total production will surpass the total demand of the world (Pinstrup-Anderson and et al. 1995). These facts are more than enough to indicate the importance of food security in developing countries, especially in food importing developing countries.

Developing countries are vulnerable to food security since domestic production capabilities are not sufficiently built due to the low level of accumulated investments in agriculture. Furthermore, developing countries lack purchasing powers to import enough food to satisfy domestic demands and are susceptible even to the smallest changes in food prices in the world markets. In this context, domestic agricultural production plays a vital role as an insurance against unstable movements of importing prices. Domestic agricultural production also contributes to food security in the long run by saving foreign exchanges and stimulating investments in manufacturing sectors, which lead to rapid economic growth and increases in the economic accessibility to foods.

In this paper, the concepts and means to achieve food security with minimum costs will be outlined theoretically, followed by the description of public good aspect of food security. In the next section, situations and issues regarding food security of

developing countries will be introduced. Alist of food security indicators will be suggested based on the definition and elements of food security. For the purpose of cross-country comparison of food security situation, a composite food security indicator is developed and problems and economic causality associated with the composite indicator will be explained.

II. Theoretical Approaches to Food Security

1. Definition and Elements of Food Security

Generally, the demand for agricultural commodities is inelastic with respect to the changes in prices since consumers should consume certain amount of food regardless of the level of price. In parallel, the supply of agricultural products is also, especially in the short run, price inelastic since agricultural production cannot quickly respond to the changes in price mainly due to time lags in production. As a result of these characteristics of demand and supply of agricultural products, small changes in agricultural production due to exogenous factors such as changes in natural and climatic conditions could lead to large fluctuation of price. In the case of basic foods, the market prices and thus farmers' incomes are especially unstable. The ever-lasting concerns for food security reflect the high volatility in prices of agricultural commodities and uncertainties in food supplies.

In recognition of the importance of food security, World Food Summit sponsored by FAO in 1996 adopted the definition of food security in its Action Plan as follows: *"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."* Based on this definition, several important elements of food security can be derived.

Availability of Food: Sufficient food supply should be secured in a sustainable manner, in response to the growing world population and changing dietary habits.

Accessibility to Food: Food security can be attained only when both physical and economic access to food are guaranteed. While the factors that influence the physical accessibility such as wars, export embargoes, and problems with transportation are common to both developed and developing countries, the factors to determine economic accessibility are especially serious in developing countries.

Stability of Food Supply: Food should be supplied at reasonable prices in a stable manner. Stability of food supplies is more important to developing countries that depend on foreign imports for the large portion of food supply under the limitation of foreign exchanges.

Food Safety/Quality and Preference: The last, but not least, important element of food security is to provide food that is safe and in good quality, satisfying the dietary needs and preference of consumers.

2. Means to Achieve Food Security

In relation to food security, there is a widely accepted argument that trade liberalization will stabilize the world agricultural market, which will, in turn, contribute to the stabilization of prices and food security in food importing countries. The logic of the argument is that all the participating countries regardless of trade status contribute to share the burden of lessening price fluctuation arising from exogenous factors in the world agricultural market as markets are further liberalized. It is further claimed that free trade will secure food security by increased trade gains and purchasing powers through economic development. However, in countries which depend heavily on food imports, there are strong concerns over the fact that the future prospects of food supply and demand are not very optimistic and that there is no guarantee that free trade will naturally lead to the stabilization of food supply and prices (Ohga 1998). Stockholding is an effective measure for sudden food shortages, but it is not effective in the long run. These arguments led to the recommendation of the FAO Plan of Action in 1996 which states *"increased production, including*

traditional crops and their products, in efficient combination with food imports, reserves, and international trade can strengthen food security and address regional disparities."

To achieve food security at the minimum cost, the optimum combination of domestic production, stock management, and international trade is essential if risky aspects of international trade are also taken into account (WTO 2000b). The optimum solution for each country varies according to its peculiar agricultural and economic condition and cannot be found by relying only on the market mechanism. External effects of domestic agricultural production and public good aspects of food security must be recognized in the determination of an optimal solution for food security. The mechanism to determine optimal solution for food security is explained in Figure 1.

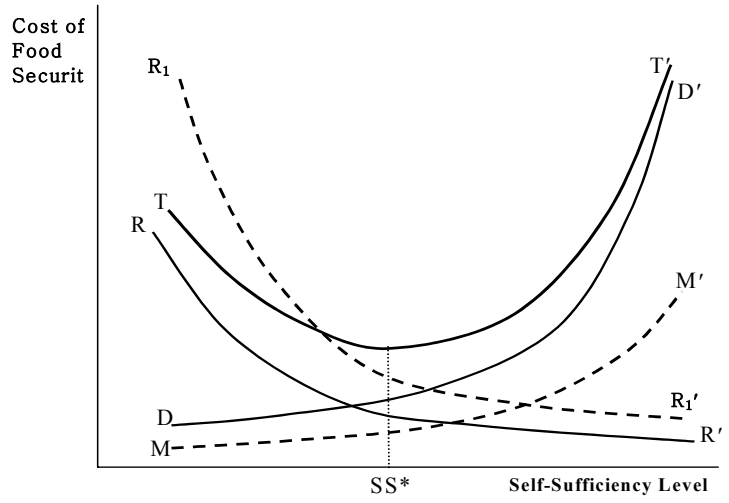
In the Figure, the horizontal axis represents self-sufficiency level and the vertical axis represents the costs of securing food security. Here, the concept of costs includes both economic costs of domestic production and risks related to food accessibility and availability in the international market.

DD': The opportunity cost curve of domestic production, that is quantity of domestic production multiplied by the price difference between domestic products and the best alternative of imported products on the assumption that increases in imports will not affect the world market price. As the self-sufficiency level increases, the opportunity cost increases rapidly since less productive resources have to be used to produce food.

If the net positive externalities produced jointly with agricultural production such as environment protection and maintenance of viability of rural areas are taken into account, the DD' shifts downwards to MM'.

RR': As the self-sufficiency level declines, the risk to physical and economic accessibility to food, arising from import interruption and highly increased food prices, increases rapidly depending on the risk averse attitude of consumers. The RR' curve represents the risks reflecting insurance premium which consumers and taxpayers are willing to pay to avoid risks and ensure food

FIGURE 1. A Conceptual Illustration of Food Security



security. The more unstable the world market is, and the more risk-averse importing country's consumers are, then the RR' curve shifts upwards to R_1R_1'. However, because of the public good aspect of food security, people's revealed appreciation of the risks to food security is lower than its real value.

TT': The total cost of securing food security (sum of the opportunity cost incurred by domestic production and the risk aversion cost concerning imports; DD'+RR').

- Food security will be achieved at the minimum cost at the level of self-sufficiency rate of SS*, where TT' becomes minimized;
- As explain in the above, we should take into account other positive externalities which domestic agricultural activities provide jointly. This means that the opportunity cost curve of domestic production shifts downward to MM' supposing positive externalities are greater than negative externalities. In this case, the optimal self-sufficiency level is determined at the higher level than SS*;
- If people's risk averting tendency become higher, shifting curve RR' to R_1R_1', the optimal self-sufficiency level move to a higher

level than SS*. In contrast, if people do not fully appreciate the risk of imports, RR' curve will shift downward resulting in a lower self-sufficiency level;

- The exact features of various curves as well as how changes in each curve affect the optimum level of food self-sufficiency rate depend on each country's agricultural condition and the degree of risk-aversion of consumers and taxpayers.

3. Public Good Aspects of Food Security

In addition to its primary function of producing food and fiber, agriculture also provides non-food services to our societies that are jointly produced from agricultural activities. Non-food services of agriculture that have characteristics of externality and public good include the viability of the rural economy, environment protection, food security, and preservation of landscapes and traditional culture among others.

Maintaining domestic agricultural production contribute to food security which is most important concern in food deficit countries by increasing availability and accessibility to food in times of crisis although there may be alternative means of supplying food more cheaply through foreign imports. Food imports cannot be regarded as a perfect substitute for domestic production in their effects on food security, especially in the cases where a severe and prolonged destabilization of international markets occurs.

In most cases, the non-food services of agriculture are public goods or have public goods aspects-that it is difficult to exclude individuals from benefiting from the services once they are produced ('non-exclusivity') and that zero marginal social costs of production occurs if additional consumption involves ('non-rivalry'). Due to the two main characteristics of public goods, consumers may not be willing to pay for a sufficient amount of the services to ensure the socially optimal level of supply. Accordingly, in the presence of public goods, the market mechanism will lead to an inefficient allocation of resource ('market failure'), which provides a justification for government intervention in the economy.

The possibility to let the consumers pay for the non-food services that has public goods aspects depends on the specific characteristics of the service, including the number of producers and consumers involved, the transaction costs of bargaining, and the underlying property right structure. In the case of food security, since a large number of producers and consumers are involved and it is thus not easy to let the farmers internalize the benefits of food security into their decision making processes, policy measures are needed to provide producers with proper incentives to ensure food security.

4. Contribution of Domestic Agricultural Production to Food Security

The role of domestic agricultural production for food security is to hedge against possible shortages of food supply in the case of import interruption and highly increased importing prices and thus to lower total cost of securing food security. In this context, it is important to maintain a certain level of domestic production and its potential with sustainable farming methods along with an appropriate combination with imports and stockpiling. Domestic agricultural production also contributes to food security in the long run through saving foreign exchanges and stimulating investments in manufacturing sectors which lead to rapid economic growth and increases in the economic accessibility to foods. In addition, domestic agricultural production also contribute to other multi-functions such as land conservation, fostering water resources, protection of the environment, maintenance of socio-economic viability and development of rural areas, and preservation of landscapes and traditional cultures. In most developing countries, agricultural sector accounts for a large share of GDP, employs a large proportion of labor force, represents a major source of foreign exchange, supplies the bulk of basic food, and provides income for large rural populations. Accordingly, it is needed to develop more fully the potential capacity of agricultural production in order to reduce poverty and to enhance food security.

III. Situation and Issues of Food Security in Developing Countries

1. Situation and Prospects of Food Security in Developing Countries

In 1999, developing countries produced 1,030 million tons of grain equivalent to 55 percent of the world production while accounted for 61 percent of the world grain consumption (Table 1). In order to fill the gap between production and demand, developing countries imported 231 million tons of grain, 72 percent of the world imports. These statistics reflects the fact that developing countries plays major roles in international agricultural trade and are highly susceptible to the changes in the condition of the

TABLE 1. Major Indicators of World Cereal Market

	1996/1997 (A)	1999/2000 (B)	B/A
World Production(million tons)	1,892	1,876	0.99
Developing Countries	1,025	1,030	1.00
LIFDCs	803	812	1.01
Developed Countries	867	845	0.97
World Consumption(million tons)	1,849	1,890	1.02
Developing Countries	1,107	1,146	1.03
Developed Countries	742	744	1.00
World Imports(million tons)	212	231	1.08
Developing Countries	150	166	1.10
LIFDCs	69	73	1.05
Developed Countries	62	65	1.04
Food Aids(million tons)	5.6	10.0	1.78
Closing Stocks as a Percentage of Total Consumption(%)	15.9	18.0	1.13

Source: Food Outlook(Number 4, 2000), GIEWS FAO.
Note: LIFDCs: Low Income Food Deficit Countries identified by FAO.

world agricultural market in terms of their food security. The level of world grain stock as a percentage of total consumption rose from the lowest level of 15.9 percent in 1996 to 18.0 percent in 1999, which is within the minimum safeguard range. recommended by FAO. However, it is forecasted that the level of the world grain stock will decrease due to the stringent regulation of the WTO regarding subsidies related to stockpiling activities The decreasing trend in food aid between 1993 and 1996 has been reversed due to low international prices and increasing stock levels in traditional exporting countries (Shapouri and Rosen 1999).

IFPRI forecasted the world food situation up to the year 2020 and suggested some of the major developments that will characterize food security of the world (Pinstrup-Anderson and et al. 1999). According to IFPRI, food production in developing countries is increasing much faster than in the developed world by 2020. Nevertheless, cereal production in the developing countries will not keep pace with demand, and net cereal imports by developing countries will almost double between 1995 and 2020 to 192 million tons. In response to the strong demand for livestock products, demand for cereals for feeding livestock will double in developing countries. Since increases in cultivated land are limited, improvements in crop yields will be required to bring about the necessary production increases. However, it is expected that the growth in farmers' cereal yields will be declining from the current trends. Food prices are forecast to remain steady or fall slightly between 1995 and 2010. While per capita food availability in the developing countries will increase, food insecurity and malnutrition will persist in 2020 and beyond. IFPRI identified six critical issues that could significantly influence the world food situation in the future including new information on nutrition, the next round of trade negotiations sponsored by the WTO, and the role of modern biotechnology and new information technology.

USDA predicted that food insecurity in many low-income, developing countries will be intensified unless steps are taken to reverse the performance trend of key factors including agricultural productivity, foreign exchange earnings, and population growth

(Shapouri and Rosen 1999). For the poorest countries, an increase in agricultural productivity is the key to improving food security. Domestic food production will contribute to more than 90 percent of consumption in the most food-insecure countries. In these countries, imports play a small role in the domestic food supply because of the limited availability in foreign exchange. The food gap to maintain per capita consumption at the base level of 1995-97 in 66 developing countries is estimated to be 18.8 million tons in 2008. The food supplies needed to meet their minimum nutrition requirements are projected to be more than 28 million tons in 2008.

2. The WTO/DDA Negotiation on Agriculture

Among the various factors that will influence the situation of food security of the world, the next round of WTO/DDA negotiation on agriculture is the foremost concern of developing countries since the result of forthcoming negotiations will have a direct bearing on development, trade and food security in those countries.

The Uruguay Round (UR) Agreement on Agriculture (AOA) acknowledges the need for special and differential treatment (SDT) for developing countries and has a number of provisions related to SDT considering the difficulties faced by developing countries. However, developing countries are emphasizing that the results of agricultural liberalization and of the implementation of the AOA have been varied, but in general, the impact has not been positive to their countries (WTO 2000a). While there was a little change in the volume exported and in the diversification of products and destination, food imports were rising rapidly in most developing countries. Key agricultural sectors that were vital for the economy in terms of food supply (food security), employment, economic growth and poverty reduction were seriously eroded because of the inability to compete with cheap imports. In this context, developing countries asserted at the DDA negotiation on agriculture that more flexibility in agricultural trade policies must be allowed for reasons of food security that is ultimately related to political and

national security in developing countries. Key products, especially food staples, should be exempted from liberalization, and the domestic production capacity of developing countries must be encouraged to become more competitive. Developing countries proposed that a 'Development Box' should be created in the agreement that aim to enhance developing countries' domestic food production capacity particularly in key staples and to increase food security and food accessibility for especially the poorest.

As stated in the previous chapter, each country has the right to pursue the optimum combination of domestic production, importation and public stockholding in order to ensure food security. A desirable international framework should be prepared to allow each country to pursue its respective goals based upon specific agricultural situation. In the case of developing countries, in addition, an increase in people's purchasing power of food is essential, as well as an increase in domestic food production in a sustainable manner. It is, therefore, crucial that much flexibility is allowed for the maintenance of a certain level of domestic production and its potential through a proper combination of appropriate domestic support measure and border measures. In addition, the problems and needs of developing countries should be duly taken into account in the negotiation, inter alia: 1) helping developing countries to participate in the world market and the WTO system considering their exporting interests; 2) adequate food aid for countries in need, avoiding negative impacts on the enhancement of their domestic production; and 3) sufficient assistance and capacity building to enhance domestic food production in developing countries.

IV. Measurement and Indicators of Food Security

1. Indicators developed for the Measurement of Food Security

Several researchers and institutions have developed indicators to measure the status and vulnerability of food security. Among others, Campbell (1991) and Braun et al. (1992) suggested a broad

and complex food security indicators including agrophysical, socioeconomic, and biological factors. Watt and Bohle (1993) and Kendall et al. (1995) introduced the concept of vulnerability of food security which is determined by the factors of food availability, food access, and food utilization. Webb and et al.(1993) established a conceptual framework of food security and generic indicator categories which was also based on a triad food security concepts: food availability, food access, and food utilization. The U.S. Agency for International Development (USAID 1995) identified a range of important factors that lead to the food insecurity of households and individuals in the developing countries. These factors include chronic poverty, rapid population growth, declining per capita food output, poor infrastructure, ecological constraints, limited arable land, disease, poor water and sanitation, inadequate nutritional knowledge, civil war, and ethnic conflicts.

FAO which has played a leading role in developing and applying food security indicators, has used seven food security indicators to measure global food situation since mid-1970s. In 1999, FAO adopted two food security indicators (average dietary energy supply per capita and GNP per capita) for the measurement of longer-term trends in food security and nutrition wellbeing which are directly related to food availability and food access (FAO 2000). In addition, FAO selected seven vulnerability indicators (share of rural population in total, arable land per capita, share of agriculture in GDP, proportion of roads that are paved, yields per hectare for major cereal crops, proportion of countries that experienced an emergency situation, and under 5 mortality rate). They represent five major domains considered relevant for food security: demographic conditions, environmental conditions, economic conditions, political conditions and social conditions. For the purpose of cross-country comparison, FAO developed eight indicators that could be used for monitoring purpose at global level. Those indicators include dietary energy supply per person, GNP per person, percent of income spent on food, index of variability of food production, access to safe water, percent of

population undernourished, under 5 mortality rate, percent of under 5 children underweight.

2. Indicators Based on the Elements of Food Security

In this paper, a list of indicators of food security is derived principally based on the elements of food security described above considering economic causality among variables. An illustrative list of indicators in line with the elements of food security is as follows.

Food Availability

1) Natural condition of agriculture
   - average temperature, rainfall level, daylight hours
   - number of cropping seasons
2) Factor endowment;
   - agricultural land : fertility, proportion of irrigated land
   - intermediate inputs: capacity of producing fertilizer, pesticide, and agricultural machines
   - agricultural labor forces : average age and education level of farmers
3) Production function
   - economies of large scales : average farming size
   - management skills
   - production technologies : investments in R&D, manpower and extension of agricultural technologies
   - institutional system of agricultural production : ownership of land, collectivism
4) Infrastructure
   - telecommunication, E-commerce system, transportation

Accessibility

1) Economic accessibility
   - GDP per capita, balance of payments
   - consumer prices and importing prices
   - economic accessibility of household; GINI coefficient, nonfarm income of farmer

2) Physical accessibility
   - imports; monopolistic nature of the world agricultural market (proportion of the exports of top 5 exporters), exports embargoes, export tax
   - domestic production; transportation system and cost, storage facilities, civil wars and conflicts

The factors and variables which are believed to influence the elements of food security are closely related to each other and the effect of each variable on the food security is quite different according to the peculiar production function and agricultural situation of each country.

3. An Example: Calculation of the Contribution of Additional Domestic Production to Food Security

Exact measurements of the contribution of domestic agricultural production to food security for the purpose of cross-country comparison are challenging tasks because the effects of each individual factor (indicator) on food security illustrated above are quite different depending on the agricultural situation in each country. Furthermore, food security has such a public good aspect that it is not exactly revealed in the free market and people tend to undervalue food security as free riders. One more difficulty is regarding the integration of the indices of food availability and accessibility to derive a composite indicator that might reflect the overall situation of food security in each country. Despite these difficulties, we are able to calculate the degree of contribution of marginal increases in domestic agricultural production to food security with an approximation and some assumption on economic causalities.

If an additional domestic production takes place in an importing country where the prices of agricultural products are higher than in the world market, the opportunity cost associated with the production will increase, while the risks associate with imports will decrease. The degree of increase in opportunity costs depends upon the curvature and the location of the opportunity

curve. Similarly, the degree of decrease in the importing risks is decided by the curvature and the location of risk curve. With simplification, we can rearrange the factors which influence the curvature and location of the two curves as follows (In the parentheses, representative indices are suggested for the actual calculation of food security):

Opportunity Cost Curve

1) Curvature: the slackness of agricultural inputs(especially idled arable land)
2) Location: agricultural technologies(amounts of R&D investments and number of scientists), the positive external effects of domestic agriculture(proportion of rural population)

Risk Curve

1) Curvature: attitude toward risks associated with imports which largely depend on the living standards(per capita income)
2) Location: uncertainty of international markets(frequency of price hikes in the world market), purchasing power (amounts of foreign exchanges)

Applying separate food security indices, a composite food security is calculated with following procedures.

1) First, classify countries by self-sufficiency rates of food into four categories, then assign the weights(points) with discretion to the degrees of increases in opportunity costs and decreases in importing risks as shown in Table 2. The rationale behind this weight assignment is that the increases in opportunity costs due to additional domestic production is increasing and the decreases in importing risks are decreasing as self-sufficiency rate become higher. The weights assigned to opportunity costs in each range of self-sufficiency rates are negative since food security should be attained with minimum costs.
2) In case of opportunity costs (international competitiveness),

the initially assigned weights(Oi) are adjusted by the factors of the slackness of agricultural inputs(if idled land of a country is large, middle, and small, multiply the initial weight by 0.9, 1.0, 1.1 respectively); agricultural technologies(if agricultural R&D investment of a country is high, middle, and low, then multiply the weights adjusted by the slackness of agricultural inputs by 0.9, 1.0, and 1.1 respectively); and the positive externalities of domestic agriculture(if the proportion of rural population of a country is high, middle, and low, multiply the weight adjusted by the slackness of agricultural inputs and agricultural technologies with 0.9, 1.0, and 1.1 respectively). Using this procedure, we finally arrive at the indicator

TABLE 2. An Example of a Hypothetical Calculation of the Contribution of Domestic Agricultural Production to Food Security

Self-Sufficiency Rate0 25%	Degree of Contribution of Additional Domestic Production to Food Security					
	Increases in Opportunity Cost			Decreases in Risks		
	Weight	International Competitiveness		Weight	Purchasing Power	
	Oi	**Degree**	**Weight**	**Ri**	**Degree**	**Weight**
0~25%	-1	Strong	0.9	4	Strong	0.9
		Middle	1.0		Middle	1.0
		Weak	1.1		Weak	1.1
25 ~ 50%	-2	Strong	0.9	3	Strong	0.9
		Middle	1.0		Middle	1.0
		Weak	1.1		Weak	1.1
50 ~ 75%	-3	Strong	0.9	2	Strong	0.9
		Middle	1.0		Middle	1.0
		Weak	1.1		Weak	1.1
75 ~ %	-4	Strong	0.9	1	Strong	0.9
		Middle	1.0		Middle	1.0
		Weak	1.1		Weak	1.1

which represents the degree of increases in the opportunity costs due to additional domestic production: Oi * SAIi * ATi * EXTi, where Oi; is the initial weight, SAIi, ATi, EXTi are the adjustments factors of slackness of agricultural inputs, agricultural technologies, and the externalities of agriculture.

3) In case of importing risks, the initially assigned weights (Ri) according to the ranges of self-sufficiency rates are adjusted by the factors of risk averse attitude(if per capita income of a country is high, middle, and low, then multiply 1.1, 1.0, and 0.9 respectively), the degree of uncertainty of the world markets(if the instability of the world market is high, middle, and low, then multiply the weight adjusted by risk averse attitude by 1.1, 1.0, and 0.9 respectively), and purchasing power(if the level of foreign exchange is high, middle, and low, then multiply the weight adjusted by risk averse attitude and uncertainty of the world markets by 0.9, 1.0, 1.1 respectively). Using this procedure, we can derive indicator representing the degree of decreases in risks from importation: Ri * PCIi * UWM * PPi, where Ri is the initial weight, PCIi, UWM, PPi are the adjustment factors of per capita income, uncertainty of the world market, and purchasing power
4) The sum of the two indicators (Oi * SAIi * ATi * EXTi and Ri * PCIi * UWM * PPi) can be used for the assessment of food security role of domestic agricultural production of a country and for the cross-country comparison of food security situations.

V. Summary and Conclusions

Most developing countries importing 72 percent of the world cereal imports in 1999/2000 are forecasted to remain as food deficit countries in the next decades. It is also expected that food insecurity and malnutrition will persist in developing countries in 2020 and beyond unless the current trends of agricultural

productivity, foreign exchange earnings, and population growth are reversed. For the poorest developing countries domestic agricultural production will contribute to more than 90 percent of consumption because of limited foreign exchange availability.

Domestic agricultural production plays a role to hedge against possible shortages of food supply and highly increased importing prices, therefore lowering the cost of securing food security. For developing countries, domestic production also contributes to food security in the long run by saving foreign reserves and stimulating investments in manufacturing sectors where they have comparative advantages resulting in rapid economic growth and increases in the economic accessibility to food.

However, it should be noted that food security must be attained with minimum costs by the optimal combination of domestic production, importation, and stock management. Accordingly, it is not desirable to maintain extremely low or high levels of food self-sufficiency in terms of securing food security with minimum costs. In the longer run, food security with efficiency gains may be better achieved by lowering food self-sufficiency level shifting resources into the production of non-food export crops or manufacturing goods and importing staple food requirements.

Regarding the development of food security indicators, indicators are rearranged based on the definition and the elements of food security. An example to derive composite indicators that reflect the contribution of domestic agricultural production to food security is suggested in this paper. A further deliberation is needed for the refinement of these indicators in the next studies.

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