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Food Security Policy in Developing Countries

Awudu Abdulai and Christian Kuhlgatz

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Abstract and Keywords

This article reviews the concept of food security and the various approaches developing countries have used to promote food security in their countries. The discussion therefore involves both direct and indirect policy interventions that are used to ensure food security in developing countries. It presents a simple microeconomic model of food security that explains individuals' demand for food ingredients as well as the different channels through which they become food-insecure. It examines the food security policies of developing countries as they relate to the theoretical model. It discusses food market intervention policies and focuses on the indirect food security measures normally employed to attain a sustainable social and economic environment over the long term. This article shows the efforts several policy analysts have put into research to examine policy options and their impacts on food security.

Keywords: food security, policy interventions, microeconomic model, food market, developing countries

1 Introduction

Recent food price hikes and the global economic crisis left their mark, as the number of hungry and malnourished people increased worldwide, particularly in developing countries. Evidence shows that about 902 million people in the developing world were malnourished in 2008, reflecting an increase of about 65 million since 2000–2 (FAO 2009). The impact of the declines in household income from the global economic downturn has been compounded by the relatively high food prices in many developing countries, resulting in further increases in the number of undernourished households in

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these countries. Preliminary estimates for 2009 indicate that the cutbacks in food expenditure have resulted in the number of undernourished rising above 1 billion people in developing countries (FAO 2009). This development makes it increasingly difficult to achieve the first millennium development goal (MDG) of halving the number of hungry people by 2015. Fanzo et al. (2010) identify lack of political will at both global and national levels as the major cause of the growing divergence from this important MDG. Although food insecurity had attracted little attention in the media and political agendas of developed countries during the last decades, the situation changed in 2008 as riots over higher food prices occurred throughout the developing world (Falcon and Naylor 2005; Fanzo et al. 2010). The rising numbers of food-insecure persons and the clearly established linkages between food security, national security, and global security have contributed to renewing international interest in food security policies of developing countries.[1]

(p. 345) Food security involves ensuring both an adequate supply of food and access of the population to that supply, mostly through generating adequate levels of effective demand via income growth or transfers. Food security in developing countries therefore tends to be influenced by both micro and macro factors that include adoption of new technologies, support for institutions available to farmers, and food price policy, as well as monetary, fiscal, and exchange rate policies that affect overall economic growth and income distribution. The policies that are normally associated with food security usually involve structural changes in relative prices, the general economic environment, as well as other measures such as targeted food subsidies, improving technologies, and institutions available to farmers and consumers (Weber et al. 1988).[2]

Policymakers are often confronted with the dilemma of higher food prices to induce increased food production and the food security of low-income consumers, as higher prices impose a heavy cost on this group of consumers. A variety of short-and long-term policy options have been used by governments to promote food security in the developing world. Some measures affect food availability on local markets, others the individuals' entitlements to obtain food, while others tend to influence food utilization, i.e., how many nutrients an individual obtains from a given supply of food.

This chapter reviews the concept of food security and the various approaches developing countries have used to promote food security in their countries. A simple microeconomic model of food security is developed and used to discuss the operational issues on food security strategies. As argued by Mellor 1978, an employment program, or an income transfer program for the poor to improve their food security status, will be inefficient in assisting them unless provision is made for an enlarged supply of basic food commodities. Thus, policies geared at improving food security should include both income generation

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and food production measures. The discussion in this chapter therefore involves both direct and indirect policy interventions that are used to ensure food security in developing countries.

The chapter is organized as follows. The next section presents a simple microeconomic model of food security that explains individuals' demand for food ingredients as well as the different channels through which they become food-insecure. Sections 3 and 4 examine the food security policies of developing countries as they relate to the theoretical model derived in Section 2. Specifically, Section 3 discusses the food market intervention policies, while Section 4 focuses on the indirect food security measures normally employed to attain a sustainable social and economic environment over the long term. The final section sums up the main conclusions.

(p. 346) 2 Microeconomic Food Security Model

Food security exists when all people, at all times, have access to sufficient safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO 2003). Thus, both quality and quantity of diet are important components of food security. Diet quality measures the ability of foods to supply protein of high biological value and adequate supplies of micronutrients such as minerals, trace elements, and vitamins, whereas diet quantity refers to the availability and consumption of total food energy. In general, where the quantity of food is reduced, so is the intake of micronutrients (Abdulai and Aubert 2004). Access to non-food inputs such as clean water, sanitation, and health care has recently been included in the broader definition of food security (FAO 2009).

The complexity of the food security concept makes it difficult for an effective analysis of a policy's effectiveness. Notwithstanding this task, an attempt is made in a simple microeconomic food security model to show how various policy instruments affect the different dimensions of food security. The model is a version of Becker's (1965) model with the modifications proposed by Barrett (2002). To the extent that food security involves both hunger and malnutrition, we incorporate the ingredients of Lancaster's (1971) product characteristics approach to capture individuals' preferences for product attributes. As noted by Barrett (2002), five key elements that a useful food security model needs to incorporate include: (1) the physiological needs of individuals, (2) irreversibilities like death and permanent impairments, (3) behavioral dynamics, (4) uncertainty and risk, and (5) complementarities and trade-offs between food and other

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variables such as care giving and education. These elements are incorporated in the model below.

2.1 Model Definition

The most important elements of the model are that individuals are assumed to maximize utility derived from the consumption of goods and services (c) and health status (h). Total consumed product characteristics (x) are obtained through the consumption of c. Product characteristics include ingested metabolizable ingredients (d), which affect the individual's health status (h), and characteristics that are directly valued by the individual (e), such as taste, texture, and social acceptance. Individuals face a time constraint in producing goods and services within a production function. The health status of an individual is determined by a health production function. Given these assumptions, each individual is assumed to maximize a time-separable utility function of the form (p. 347)

(1)

$$U_t = E_t \sum_{\tau=t}^{T} \gamma^{\tau-t} U(e_\tau, h_\tau, m_\tau) \quad \gamma \in [0, 1]$$

where E_t is the expectations operator given the information set at time t, γ is the subjective discount factor, T is the number of periods, and m is leisure. Utility is non-negative and strictly increasing in the individual's health status (h), which is a vector of non-negative health dimensions such as physical and cognitive capabilities. In addition, utility is generated by the consumption of product attributes that the individual values (e), and by investing time in leisure. As indicated above, each individual faces the following constraints in maximizing the utility function: (2) $x_t = Ac_t$ (3) $h_{t+1} = \Theta(h_t, d_t, l_t, z_t, \varphi^h)$ (4) $p^c(c_t + s_t) = p_t^y y_t + b_t + g_t$ (5) $b_t = \psi(a_t)$ (6) $a_{t+1} = \delta a_t + s_t + \varphi^a \quad \delta \in [0, 1]$ (7) $\Omega(y_t, l_t, h_t, a_t | \varphi^p) = 0$ (8) $l_t + m_t = L$ (9) $c_t, l_t, m_t, a_t \geq 0$ Overall consumed product characteristics (x) are obtained through the consumption of commodities and services (c) according to the linear consumption production technology denoted as matrix A in equation (*2*).[3] A health production function is formulated in equation (3), where the main determinants of health are chemical ingredients of ingested food, labor activity (l), other variables influencing health (z), and health shocks (φ^h).

The budget constraint formulated in equation (4) shows the relationship between the value of goods purchased for consumption and stocks and household total income, where s represents a vector of stockpiled goods, c is as defined earlier, p^c is a vector of prices of consumption goods; p^y represents the vector of prices for the household's own produce, including wage labor, and production inputs (vector y of netputs). This full-income relation ensures that the value of consumption does not exceed the sum of net income, the value of borrowings (b), and the value of non-labor income (g), such as rents and transfers received by the individual. A borrowing constraint is formulated in equation (5), so that the amount of borrowed money b cannot exceed the willingness to lend that is captured by the function $\Psi()$, which increases in asset stocks (a). Equation (6) represents

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the law of motion for asset stocks, with δ as the depreciation factor and current stock-building quantities and asset shocks (φ^a) as explanatory variables. In equation (7), the production technology is captured as the function $\Omega()$, which is (p. 348) determined by netput quantities, labor activity, health status, asset stocks, and production shocks (φ^p). Household human resources constraint is expressed in equation (8), where the total time endowment L is allocated between leisure m and hours of work for pay l. Non-negativity constraints for labor activity, consumption quantities, and assets are formulated in equation (9).

2.2 Food Security: Nutrient Provision and Food Safety

Modeling product characteristics has two advantages. First, miscellaneous positive and negative effects of food ingredients on human organisms are exactly captured. This allows a more realistic description of complex human metabolism. For example, the effects of vitamin A deficiency (food attribute) on sight (health dimension) can be explicitly modeled, and clearly differs from the effects of iodine deficiency (food attribute), which causes—among others—impairment of intelligence (health dimension).[4] The incorporation of health dimensions takes into account the fact that impairments in different parts of the human body are likely to affect labor productivity differently in equation (7), and may also be differently valued by the individual.

Second, food insecurity can be modeled in greater detail by analyzing the extent to which health dimensions are impaired by nutrient deficiency (or unhealthy food ingredients). Formally, for every health dimension k in vector h, there are three possible degrees of nutrition levels (NS), captured as thresholds for every element in d:

1. "healthy nutrient threshold" $\mathbf{NS}^1_{k,t}(\mathbf{l}_t, z_t, \boldsymbol{\varphi}^h)$: the minimum nutrient requirement (upper limit for unhealthy ingredients and overconsumption) to maintain proper functioning of the health dimension;
2. "non-permanent impairment nutrient threshold" $\mathbf{NS}^2_{k,t}(\mathbf{l}_t, z_t, \boldsymbol{\varphi}^h)$: the minimum nutrient requirement to prevent permanent impairment; and
3. "survival nutrient threshold" $\mathbf{NS}^3_{k,t}(\mathbf{l}_t, z_t, \boldsymbol{\varphi}^h)$: the minimum nutrient requirement for survival.

Nutrient requirements increase in current labor activity level (l_t), and change with other health-influencing factors (z_t) such as age, gender, pregnancy status, and stature. Furthermore, negative health shocks (φ^h), involving illnesses such as diarrhea and measles or worm infections, lead to less nutrient absorption and higher nutrient requirements (WHO 1982). Thus, lack of nutrients that support the immune system, e.g.,

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vitamin A, may trigger a vicious cycle by causing higher vulnerability to illnesses, which in turn raises required nutrient intake. This approach is also able to explicitly model hunger, which is defined as the "physiological sensation associated with insufficient food intake" (American Dietetic Association 1990). Along an individual's health (p. 349) dimension "energy requirement," a decline below the $\mathbf{NS}_t^1$ threshold implies lack of caloric intake, resulting in the negatively perceived health output hunger.

For the human organism as a whole, formal degrees of healthy $(\mathbf{NS}_t^1)$, non-impairment $(\mathbf{NS}_t^2)$, and survival $(\mathbf{NS}_t^3)$ nutrient states are determined by nutrient thresholds of those health dimensions that impose the tightest constraints on food ingredients (highest minimum nutrient requirements/lowest upper limit for unhealthy ingredients). If at some time t^{d}, any element in the vector of ingested food d falls below the required $\mathbf{NS}_t^3$ level, at least one vital function of the organism breaks down and the individual dies, which is formally expressed as $h = 0, \forall t \rangle \quad t^D$.

The analysis of nutrient requirements and food ingredients given above has been rather deterministic. However, food security as an *ex* ante concept of exposure to undernutrition or malnutrition requires the incorporation of decisions under uncertainty. These include health shocks, shocks to asset stocks (φ^a), and production shocks (φ^p), as well as uncertainty regarding prices and transfers. In addition, imprecise knowledge on nutrient requirements and food ingredients is likely to drive risk-averse individuals even further away from consumption bundles in proximity to nutrition state thresholds.

Risk is incorporated in the model by assuming that individuals make consumption decisions conditional on a subjective joint density function $\Phi()$ over exogenous variables (Barrett 2002). Given this density function and control variables x_t, s_t, and l_t, food security can be defined as the marginal probability at time t of exceeding any of the three nutrition states in time $t + s$ (where $s \geq 0$):

1. "healthy food security":
$FS_t^1 = \Pr\left(d_{t+s} \geq NS_{t+s}^1 \forall\ d \in N \wedge d_{t+s} \leq NS_{t+s}^1 \forall\ d \in UN\right)$
2. "non-permanent impairment food security":
$FS_t^2 = \Pr\left(d_{t+s} \geq NS_{t+s}^2 \forall\ d \in N \wedge d_{t+s} \leq NS_{t+s}^2 \forall\ d \in UN\right)$
3. "survival food security":
$FS_t^3 = \Pr\left(d_{t+s} \geq NS_{t+s}^3 \forall\ d \in N \wedge d_{t+s} \leq NS_{t+s}^3 \forall\ d \in UN\right)$

where N is the set of nutrients and UN is the set of unhealthy ingredients. To distinguish "food-secure" from "food-insecure" individuals, a threshold that allows a classification according to the three food security probabilities outlined above needs to be defined. In case of the current period ($s = 0$), food security degrees are binary variables that are directly or indirectly observable. Given the formal model of hunger above, it can be easily seen that the aim of

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decreasing hunger is positively correlated to that of increasing food security, but only as far as an individual's energy requirement represents one of the constrained health dimensions. Even if nutrients themselves do not give any direct utility, they indirectly influence food consumption decisions owing to their effects on physical well-being. In cases (p. 350) where individuals cannot afford consumption bundles that simultaneously provide enough amounts of different nutrients (e.g., iron and vitamin A), the consumption decision definitely transforms into a trade-off between the various health conditions related to those nutrients (e.g., physical and cognitive incapability due to iron deficiency versus inability to see due to vitamin A deficiency).[5] Given that the individual is aware of this mechanism, consumption decision is likely to be influenced by the personal valuation of the affected health dimensions (equation (1)) and their expected contribution to the individual's labor productivity (equation (7)).

In some settings, temporary nutrient deficiencies may be accepted by individuals in order to help other family members improve their nutrition, thus ensuring future income generation opportunities, or just for deriving utility from non-nutrition characteristics. As is evident from Table 13.1, nutrition deficiency—e.g., of iodine and vitamin A—is widespread in both developing and developed countries. Remarkable differences between the regions, for example, exceptionally low malnutrition rates in America, a high prevalence of inadequate iodine nutrition in the eastern Mediterranean, and a prevalent vitamin A deficiency in pre-school-age children of Southeast Asia and Africa, justify different food policy approaches to improve food security in the different regions.

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Table 13.1 Malnutrition in different world regions

Region	**Inadequate iodine nutrition: millions of affected persons (percentage)[a]**	**Vitamin A deficiency: millions of affected persons (percentage)[b]**	
		Pre-schoolage children	Pregnant women
Africa	312.9 (41.5)	56.4 (44.4)	4.18 (13.5)
Americas	98.6 (11)	8.68 (15.6)	0.23 (2.0)
SouthEast	503.6 (30)	91.5 (49.9)	6.69 (17.3)
Asia			
Europe	459.7 (52)	5.81 (19.7)	0.72 (11.6)
Eastern	259.3 (47.2)	13.2 (20.4)	2.42 (16.1)
Mediterranean			
Western	374.7 (21.2)	14.3 (12.9)	4.9 (21.5)
Pacific			
Tota	2008.8 (30.6)	190 (33.3)	19.1 (15.3)

(a) Estimates for iodine nutrition are based on surveys from 1994 to 2006.

(b) Vitamin A deficiency indicator is a serum retinol threshold of 〈 0.70 μmol/l. WHO estimates for vitamin A deficiency are based on surveys from 1995 to 2005.

Source: De Benoist et al. (2008); WHO (2009).

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(p. 351) 2.3 Analyzing Food Security Policies

The microeconomic model presented above illustrates the various dimensions of food security as expressed by the three components of nutrition availability, nutrition access, and food utilization, and can be employed to show how government policies affect the food security status of individuals.

Nutrition availability may be improved by the supply of sufficient foodstuffs at the local markets to ensure that food meant for consumption and storage (i.e., food in c_t and s_t) is not in limited supply. Besides ensuring higher productivity and output levels, major food security policies in this area generally include improving market integration through infrastructure, private trade supportive policies, state trading, as well as public buffer stocks (Abdulai 2000). Governments in developing countries therefore invest in research and development (R & D), farm infrastructure (irrigation and soil-conservation technologies) and extension services, and early warning systems, or subsidize farm inputs to shift the individual's production function Ω () for food upward or decrease food supply fluctuations (φ^p). Public investment programs in storage facilities such as rat-proof granaries that reduce asset shocks (φ^a) and depreciation (δ) are direct policies that tend to influence private assets. An indirect but significant policy for preventing negative asset shocks is the provision of institutions for a stable legal environment. This is particularly important because the occurrence of food insecurity itself may negatively affect regional security since food-insecure households are more likely to act against the law in order to improve their access to food (Falcon and Naylor 2005). Privately stored food (a_t), which can be employed to overcome food shortfalls, also contributes to the household's (future) nutrition availability.

Given that nutrient availability remains a chronic problem in developing countries and crisis-prone regions, the issue of improving food availability continues to attract attention in these countries. This is in contrast to the discussion of food security in the developed world, where food production and availability are generally at higher levels, markets are well integrated, and the institutions are stable over time, contributing to lower levels of food insecurity. Moreover, measures for improving farm productivity are not that relevant for achieving food security in developed countries, given that relatively small proportions of the populace are engaged in farming. As argued by Coates et al. (2006), food insecurity in developed countries mostly arises from shortcomings in food access, which partly explains why relatively more attention is given to examining and explaining this complex concept in research work related to the food sector (see also Wilde, Chapter 12 in this volume).

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Nutrition access is solely derived from equation (4), i.e., food buyers are dependent on food prices as well as food availability, and on any of the right-hand-side elements that determine their purchasing power. Government policies related to food availability (c_t and s_t) have been discussed above. Policies that help in lowering and/or stabilizing consumers' food prices (p^c) and/or stabilizing producers' food prices (p^y) have been generally employed to improve nutrition access in developing countries. In particular, (p. 352) improving the non-farm earnings of individuals is a way of enhancing their "entitlement" over an adequate amount of food (Sen 1999).[6] Policies that have been generally used to address non-farm earnings possibilities include education policies to enhance the human capital of individuals, promoting credit institutions to improve access to credit, as well as policies that foster market integration through trade incentives and better infrastructure, which provide both extended rural-urban linkages and spatial income diversification (Abdulai and Delgado 1999).

Public work programs are employed to stabilize income shocks, while supplementary feeding programs normally target vulnerable groups (e.g., pregnant women, children) that need special diets (with the targeting criterion in z_t). Market failures in financial markets have also been addressed to enhance borrowing conditions (b_t) and provide better insurance and hedging possibilities that help stabilize income (φ^p). Commodity and cash transfers (g_t) are measures that are mainly used in the framework of food safety nets, emergency food aid, schooling services, and input starter packs, as well as providing incentives for schooling or health services.

Finally, food utilization is incorporated through the consumption technology A in equation (2) and through φ^h in equation (3), which includes health shocks that reduce the nutrient absorption capability of an individual's organism. The former can be influenced by policies altering the overall food quality, e.g., through micronutrient fortification and better access to clean water, or by individual nutrition education programs on food preparation. The latter is commonly handled by enhancing sanitation conditions, health education programs, and better access to medical treatment (e.g., placement of and access to medical facilities, and trade and distribution of medicine).

3 Food Market Policies in Developing Countries

Given that food constitutes a substantial share of the expenditure of both rural and urban populations, developing countries tend to employ diverse policy measures to influence

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agricultural prices.[7] These policies, which normally have direct impacts on food prices and food availability, are discussed below.

(p. 353) 3.1 Price and Trade Regulation Policies

In this section, we briefly discuss the main price and trade regulation policies that are commonly used in developing countries with the goal of improving food security.

The rationale behind government-administered consumer prices for staple food (issue prices) is either to improve food access through lower market prices for consumers, or to stabilize consumption in times of upward price shocks by imposing price ceilings. The majority of developing countries have historically maintained low food prices to help urban consumers and to foster industrialization through lower wages. In pursuing these objectives, two paths of food price subsidies have generally been followed. These include universal price subsidies that benefit net food buyers, and limited access subsidies, where rationed quantities are granted at concessional prices. Universal price subsidies have generally been criticized as inefficient since all individuals profit from general food subsidies. The greater share of rationed food grains has generally been distributed to the politically vocal and well-organized groups, which include the urban population, government employees, and industrial workers.[8] While these beneficiaries have normally supported the cheap price policies, escalating fiscal expenditures for food subsidies and occasional political pressure from multinational donors have compelled most developing countries to liberalize food markets over time.

Discrimination against the agricultural sector through non-compensated cheap food price policies has been continually criticized because of its negative impact on farm households' welfare and farm investments, thus harming the current and future food security of most rural households (e.g., Schultz 1964). To encourage domestic food supply and improve local food availability, some governments of developing countries have offered producers higher than market prices, determined producer price floors, or subsidized farm inputs. Higher procurement prices have the ability to lift food-insecure farmers above the food security threshold, while price floors are designed to prevent farmers just above the food security threshold from falling into insecurity through declines in farm incomes. In particular, Asian countries with rice as the main staple food have effectively employed price stabilization policy as a food security tool (Timmer and Dawe 2007).

An issue that usually accompanies procurement price increases is the extent to which these higher prices are passed on to domestic consumers. If no sufficient compensation is given to consumers, rising food expenditures tend to impair the food security of net food

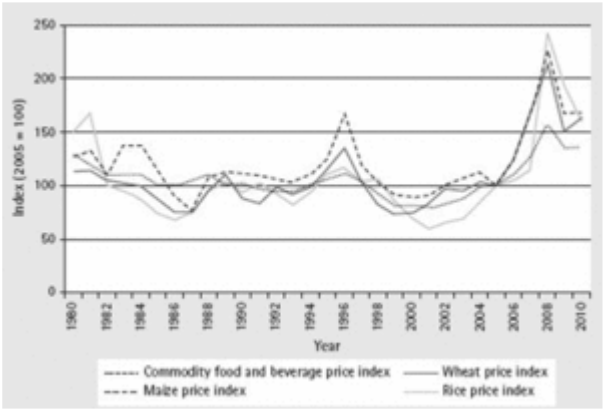
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buyers such as the urban population and rural workers not engaged in food production. This negative impact may be low in the case of foods that have small relevance to dietary requirements and contribute less to households' expenditure. For example, while Kenyan consumers have had to face higher retail prices for sugar, price increases in staple foods, such as rice in Asia or wheat in (p. 354) northern Africa and the Middle East, have commonly not been fully passed on to consumers.

Efficient price stabilization policies should normally incorporate factors that affect a country's specific price and production risks, e.g., if it is landlocked or prone to droughts and floods. Given that decision makers are usually subjected to rent-seeking activities of special-interest groups, it is not surprising that the procurement and issue prices that are chosen tend to be suboptimal (Dixit and Josling 1997; Rashid, Cummings, and Gulati 2007).

Trade restriction regimes have commonly been employed in the form of quotas and tariffs. Import and export trade restrictions for the food sector have historically been implemented to reduce dependency on foreign imports. Current import restrictions such as quotas and tariffs generally offer net-food-importing countries the opportunity to respond to world market price fluctuations.



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Figure 13.1 Food price indices, 1980–2010

Source: IMF (2009).

For example, developing countries recently had to deal with the sharp increases in world food prices, particularly for staple cereal foods (see Figure 13.1). These price increases resulted in food crises in some regions, as the number of undernourished persons increased significantly (see Table 13.2). The trend of a declining proportion of undernourished people in the developing world has been reversed in the late 2000s. In Latin America and the Caribbean, where absolute numbers of undernourished persons had previously been reduced, the number of malnourished people increased (p. 355) significantly. Declining global food prices in 2009 could not prevent a further increase in the number of undernourished, which indicates massive income losses due to the global economic recession (FAO 2009). These estimates only capture part of the food-insecure

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population since food insecurity also includes people who are not currently suffering from malnourishment but are at risk of falling below the healthy nutrient state thresholds (NS) in future periods (Barrett 2002).

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Table 13.2 Prevalence of undernourished people by region

Region	**Millions of undernourished (% share in total population)**				
	1990–92	2000–02	2004–2006	2008[a]	2009[a]
Asia and Pacific	585.7 (20)	552.1 (16)	566.2 (16)	581.0 (16)	642 (18)
Latin America and Caribbean	52.6 (12)	49.4 (9)	45.3 (8)	46.7 (8)	53 (9)
Near East and North Africa	19.1 (6)	31.6 (8)	33.8 (8)	37.2 (8)	42 (9)
Sub-Saharan Africa	168.8 (34)	205.5 (32)	212.3 (30)	237.0 (31)	265 (34)
Developing world	826.2 (20)	838.0 (17)	857.7 (16)	902.0 (17)	1002 (18)

Source: FAO (2009).

(a) Figures on proportion of undernourished in 2008 and 2009 are calculated using data from FAO (2009) and UN 2009. FAO estimates for 2009 are preliminary.

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The food price increases resulted in some countries reexamining their liberalized agricultural trade policies and intervening by imposing food price controls and trade restriction policies. For instance, Argentina, China, India, Russia, and Thailand restricted food exports in the wake of the price increases, while food-importing countries reduced their tariffs and taxes on food and agricultural imports to improve domestic food supply (Wodon and Zaman 2008). Timmer and Dawe (2007) argue that such measures helped in stabilizing domestic rice prices in Bangladesh and as such circumvented high levels of inefficient public procurement.

Some authors have argued that tightening export restrictions tends to discourage local food production and also intensifies the burden on the food-importing countries. For example, von Braun 2008 points out that the elimination of export bans could reduce international grain price fluctuation and reduce price levels by 30 percent.

3.2 State Engagement in Storage and Trade

This section discusses the specific consequences arising from state and parastatal agencies that are legal monopolies or act as competitors in stockholding, national food trade, and/or international food trade.

Government engagement in holding strategic food reserves may be justified on food security grounds and probably market failures in domestic private stockholding. Two (p. 356) strategic objectives of public buffer stocks can be derived from these justifications: (1) to reduce year-to-year domestic harvest fluctuations, in which government stocks are mostly substitutes for international trade flows, and (2) to smooth sconsumption in the presence of significant seasonality in agricultural markets (Siamwalla 1988). Available evidence reveals that public buffer stocks are in most cases more expensive than procuring food from international markets. If prices of public grain reserves are stickier than prices on the open markets, public storage authorities have to cope with large consumer switches between publicly provided food and food from the open market (Krishna and Chibber 1983). Thus, measures to prevent supply gaps at all times require inefficiently large precautionary food inventories, with large opportunity costs.

Although grain price fluctuations have not increased since the 1970s and the traditionally thin international rice market has considerably expanded and become more stable since the 1990s, the significant impact of a few key players, such as China, the United States, and European Union, on the world market has raised new doubts on the reliability of international trade (Calpe 2004; Byerlee, Jayne, and Myers 2006). During liberalization periods, public buffer stocks have in some countries proved to be hardly dispensable. To

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be effective, modern public grain reserves generally require a well-informed, as well as professional, management with good analytical capacities. The empirical evidence suggests that mismanagement and decisions based on wrong production estimates have led to catastrophic outcomes in the past (e.g., Charman and Hodge 2007). Although advanced information technology may provide more efficient tools for data handling, public buffer stock authorities need to deal with decreased information spillovers they obtained from the former public and now privatized state trading enterprises. In markets where private stockholders do not have significant market power, probably a more efficient way to achieve consumption smoothing during the marketing season is to subsidize private grain storage (Siamwalla 1988).

The objectives of state trading enterprises (STEs) usually include pursuing cheap food policies, supporting farm gate prices, stabilizing domestic prices through food transport between regions, subsidizing lower-income groups, and in some cases providing farms with needed inputs. Direct participation of the state in agricultural markets is mostly a means to support and complement administered pricing policies. The operation of STEs can be economically justified in the presence of market failures. Rashid, Cummings, and Gulati (2007) discuss four commonly accepted types of market failure in this context; (1) weak infrastructure and limited flow of information, (2) risk mitigation for technology diffusion, (3) thinness and volatility of international markets, and (4) inability to participate in international markets, e.g., due to low foreign exchange reserves. They demonstrate for six Asian countries (Bangladesh, India, Indonesia, Pakistan, the Philippines, and Vietnam) that all of these justifications of STEs have become less persuasive over time. This stems from the fact that other implemented policy measures, such as public work programs for building road infrastructure, investment in agricultural research and prospective macro policies, as well as exogenous developments such as reduced price volatility in international rice markets and advances in information technology, have substantially reduced the market failures (p. 357) that costly STEs were initially meant to circumvent. In contrast, private traders have become more and more effective in coping with food crises.

STEs have commonly operated at significantly higher unit costs than the private sector (e.g., Rashid, Cummings, and Gulati 2007). This inefficiency partly stems from services to remote areas that may not be adequately covered by private traders and hence may have to rely on safety net support in a privatization scenario. A major political incentive to further operate STEs is the flexibility to enact political mandates promptly without parliamentary scrutiny (Dixit and Josling 1997). With this quick and direct government response tool, governments have, however, been tempted to solve food crises with unforeseen and immense food transport activities. Such STE actions, as well as abruptly adjusted preferential arrangements for STEs, have the potential to seriously discourage

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private traders from participating in food trade. For example, the reduction of food import tariffs for STEs during the food crises in 2004 in Madagascar resulted in a dramatic breakdown of commercial food imports, which substantially worsened the food supply situation at local markets (Dorosh 2008).

On the other hand, domestic food distribution systems have shown to be prone to fundamental design errors. For instance, the shift in India's Public Distribution System from universal food rations to targeted food rations has reduced the access of poor households to public food rations, probably because private ration shop owners store fewer public food rations owing to less expected demand (Kochar 2005).

3.3 Agricultural Market Liberalization

Given the drawbacks mentioned in the above sections and the disappointing results of expensive regulation policies on food security in the 1960s and 1970s, many developing countries have made efforts to liberalize their agricultural markets. Support for trade liberalization is based on conventional welfare analysis, which shows that price controls undermine the functioning of prices as indicators of scarcity and, thus, result in welfare losses. Regulatory limits on trade, privately held stocks, and food processing furthermore discourage private investments and prevent private actors from pursuing their optimal strategies.

However, Timmer and Dawe (2007) point out that price stabilization policy can help ensure food security when access to credits and insurances is incomplete. Myers 2006 also asserts that when the theoretical welfare model is extended by allowing for discontinuous jumps in the utility function at low nutrition levels, welfare gains can be obtained through price stabilization policies. These gains can be of considerable magnitude, especially for the poor with nutrition intake close to the food security threshold. Nevertheless, the inability of these policies to overcome the fundamental problems of market failures, their obstruction of efficient private entrepreneurs' engagement, and excessive rent-seeking behavior have usually made them an increasingly expensive instrument.

(p. 358) Kherallah et al. (2000) show that the market reforms undertaken by developing countries have largely contributed to food security in these countries, although some of them found themselves stuck in the transition process. For example, private traders in Bangladesh were able to stabilize food markets after the government had fully liberalized the markets for the major crops in the early 1990s (del Ninno, Dorosh, and Subbarao 2007). However, considerable threat to food security was observed in cases where producer subsidies were withdrawn without efforts to diversify the incomes of affected

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producers, and particularly in remote areas where market forces could not fill the gap left by the STEs. This was the case in Malawi at the end of the 1980s, where the abolition of agricultural input subsidies and the closure of many markets of the state marketing board resulted in a national food crisis (Harrigan 2008). On realizing the emergencies that emerge through liberalization, governments have commonly stopped or reversed further transition, so that regulation and government agencies still play a significant role in agricultural markets in many developing countries.

3.4 Public Safety Nets for Food Access

With public actions in food markets on the retreat, the role of the state is increasingly seen as the provider of public insurance, i.e., safety nets for food access and health, and public goods, such as physical infrastructure. This section focuses on public insurance schemes through safety nets. The shift toward approaches that aim at helping households meet their individual nutrition demand also marks a significant shift from supply-side policies to food access policies. Two common instruments for public insurance in developing countries are supplementary feeding and public works programs. Supplementary feeding programs have been widely used in developing countries with significant focus on infants, children, and pregnant or lactating mothers as target groups. They are commonly operated in cooperation with NGOs, and a large share of the employed food comes from international sources, like food aid (Barrett 2002). Intervention designs range from controlled feeding at health facilities, over home-visiting physicians who supervise nutrient intake, to take-home rations.

In a comprehensive meta-analysis, Dewey and Adu-Afarwuah 2008 investigate the effects of a multitude of complementary feeding interventions for children on diverse health outcomes in developing countries. To avoid bias in comparing treatment and control groups, the authors mostly included interventions with randomized treatment assignment, or non-randomized interventions with a low risk of confounding effects. They found that child growth can be considerably improved when programs are employed in a well-controlled environment. Findings on child morbidity have mainly been inconsistent; in three out of ten studies, the morbidity rates even increased in the intervention group. Possible explanations for such adverse effects are reductions in breastfeeding in the intervention groups or unhygienic preparation and storage of supplements at home (Dewey and Adu-Afarwuah 2008). The results of feeding (p. 359) interventions on children's behavioral development are mixed, with two out of four studies reporting significant improvements in the infants' ability to walk by 12 months. Feeding interventions mostly enhanced the children's micronutrient status for iron and vitamin A. These findings suggest that feeding interventions can be effective, but this largely

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depends on how the local context, particularly household behavior, is taken into account. To be effective, large-scale feeding intervention programs thus need a carefully thought-out design, which may involve considerable costs in implementing.

Given the general insufficiencies of physical infrastructure and fluctuating rates of unemployment and underemployment in developing countries, labor-intensive public work programs have been increasingly considered as a promising instrument with few opportunity costs (Dev 1995). For example, the government of Ethiopia has committed to spend 80 percent of their food assistance resources on food for work projects (FDRE 1996). Public work schemes have been used in South Asia since ancient times to ensure food entitlements, and have proved to be relatively successful (Clay 1986; Dev 1995).

Two food-security-related purposes are pursued through the establishment of public work programs. The first, short-run purpose is to smooth food consumption by providing a cash or in-kind wage. The particular domain of public work provision is during the slack season and in the face of covariate shocks like droughts and floods, where market demand for unskilled labor usually breaks down (Barrett 2007). When rightly timed, these programs have the ability to overcome market failures in the financial market. The second is the construction and maintenance of assets that foster future economic growth. The created assets usually include road and social infrastructure, reforestation, or on-farm improvements such as irrigation, water, and soil conservation. Most of these assets have public good characteristics, and are therefore not sufficiently provided by market forces to meet the social optimum. The rationale for building on-farm assets is to overcome market failures that hinder farmers from investing. The choice of what to construct is not trivial, and many top-down planning approaches that did not incorporate local advisers have often resulted in poorly developed infrastructure (Holden, Barrett, and Hagos 2006).

An indirect effect of public work on food access is its potential to drive up market wages because of (1) its characteristic as a reservation wage, and (2) productivity gains through the built assets that increase labor demand (Abdulai, Barrett, and Hoddinott 2005). The design of public work programs is knowledge-intensive and requires proper adjustments to the local economic environment. This requires setting a wage rate high enough to ensure adequate nutrition for the sparticipants but low enough to minimize inclusion errors (attracting food-secure people) and crowding out workers of regular jobs. It is, however, important to mention that if the increase in demand for food accompanying the additional employment of low-income people is not met by an increased food supply, the employment-based increase in real income will be substantially reduced by higher prices (Mellor 1978).

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(p. 360) 3.5 Measures to Optimize Food Utilization

Some developing countries have employed food fortification measures with micronutrients such as iodine, vitamin A, iron, and zinc to optimize food utilization. The advantage of these measures is that they can improve nutrition status without necessarily altering food access. While in most cases nutrient requirements can be met with foodstuffs accessible on local markets, it has been found that enrichment with iron is often the only option to meet the requirements of infants, given the high costs of ironrich food (Dewey and Adu-Afarwuah 2008).

Common approaches in developing countries are the fortification of salt with iodine; wheat flour with iron, vitamin B_1 and B_2, and niacin; milk and margarine with vitamin A and D; and sugar with vitamin A. Fortified food is also often provided in supplementary feeding programs, like the nutrient supplementation of the large-scale Mexican Progresa program (Rivera et al. 2004). In general, micronutrient fortification has proven to be a cost-effective instrument that has the ability to reach large shares of the population at very low costs, as shown by iodized salt, which costs about 5 cents per person per year (Barrett 2002).

Nutrition education programs are an alternative method to micronutrient fortification, and attempt to achieve a more balanced nutrient intake by improving food consumption patterns. This is an especially promising approach when aimed at persons who are responsible for the preparation of food for other household members. In their systematic review on developing countries, Dewey and Adu-Afarwuah 2008 concluded that the impact of nutrition education interventions for mothers had rather modest impacts on child weight and growth. However, while child morbidity was not affected in two studies, an efficacy trial in Brazil reported significant decreases in diarrhea and respiratory infections.

4 Policies Influencing the Economic Environment

In addition to the direct policy interventions discussed above, governments normally employ a wide array of measures to influence food production and availability in order to enhance food security in their countries. These measures are discussed below.

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4.1 Public Investment in the Agricultural Sector

The need for public investment in agricultural development stems from the atomistic nature of the sector, whereby small-scale farmers lack the means to undertake (p. 361) long-term investment. Public investment in land-augmenting infrastructure such as irrigation, rural electricity, and transport networks, and in supply-shifting factors such as agricultural research and extension services, can enhance the incentive content of prices facing farmers (Rao 1989; Abdulai and Huffman 2000). Available evidence shows that public investment in agriculture—along with infrastructure spending— generally yields the highest returns in terms of poverty reduction and economic growth (Fan, Yu, and Saurkar 2008; Minten and Barrett 2008; Fan and Zhang 2008). Despite this potential, public expenditure for the sector has declined over the last decades (see Table 13.3).

With public agricultural expenditure per agricultural GDP ratios of below 10 percent in the developing world, support for the agricultural sector appears to lag far behind that of developed countries, which have ratios of over 20 percent (Fan, Yu, and Saurkar 2008). The difference is even greater for public spending in agricultural R & D, which was 0.37 percent for low-income countries, 0.67 percent for middle-income countries, and 2.35 percent for high-income countries (Asenso-Okyere and Davis 2009). Only China, India, and Brazil appear to have extensive research programs in all R & D areas, including gene manipulation technology (Pingali and Raney 2005). In the face of the food crisis, African countries have begun to reiterate their commitment, agreed upon in the Comprehensive African Agricultural Development Plan, to increase their public investment in agriculture to an annual 10 percent share of their national budgets (on average below 5 percent in the years 2000 and 2002).

The view that public investment in agricultural infrastructure is induced by price increases was heavily criticized by Rao 1989. He argued that evidence pertaining to public investment in land-augmenting or supply-shifting factors does not support the argument that agricultural prices play a powerful role in promoting or retarding agricultural growth. Similarly to arguments advanced by the World Bank 2007, Rao 1989 concludes that the weak political power of the rural population and the discriminatory trade and macroeconomic policies of developing countries are among the reasons for the chronic underfunding of agricultural R & D.

Although extension services have proven to be effective, as shown by the median rate of return of 58 percent, they have been increasingly scaled down by many developing (p. 362) countries (Alston et al. 2000). Instruments that have been employed to enhance access to farm inputs include universal input price subsidies, concessional credit

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arrangements with STEs, non-recurring subsidized input packages, and targeted distribution of inputs after natural disasters. An example of a universal free distribution of farm inputs is the Malawian Starter Pack intervention, which emerged as a response to growing soil degradation and successfully addressed the food insecurity of the rural poor (Harrigan 2008).[9] As is the case for food, such input price subsidies are not targeted toward the food-insecure and tend to become a persistent expenditure item, once introduced. These measures therefore need to be carefully targeted to limit leakages.

Table 13.3 Public agriculture expenditures as a percentage of agricultural GDP

Region	**1980**	**1990**	**2000**	**2002**
Africa	7.4 (*2.29*)	5.44 (*1.37*)	5.71 (*1.2*)	6.72 (*1.47*)
Asia	9.44 (*2.96*)	8.51 (*1.71*)	9.54 (*1.35*)	10.57 (*1.23*)
Latin America	19.51 (*1.66*)	6.79 (*0.78*)	11.1 (*0.64*)	11.57 (*0.6*)
Total	10.76 (*2.23*)	8.04 (*1.24*)	9.34 (*1.03*)	10.32 (*1.09*)

Values in parentheses are unweighted shares that are reported because the weighted averages commonly calculated at regional and global levels may bias toward large countries.

Source: Fan, Yu, and Saurkar (2008), using data from International Monetary Fund, Government Financial Statistics Yearbook.

4.2 Financial Sector in Rural and Peri-Urban Regions

Throughout the developing world, poor households lack access to formal financial markets. While informal insurance and credit arrangements can at least partly fill this gap for idiosyncratic shocks, this is typically not the case when covariate risks affect the whole community.[10] What follows is depletion, erosion, and dissaving of physical and human capital as well as the destructive exploitation of the environment.

Owing to their inability to save money, obtain loans, or buy insurance, poor households find it difficult to cope with income shocks, which tend to affect their food security status in different ways. First, the household can afford less food, and may therefore fall into food insecurity. Second, as a response to the risky environment, the household can make

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precautionary savings. This *ex ante* measure to mitigate shocks prevents individuals from investing in income-generating activities, thus reducing their ability to improve their future food security status (Zeller et al. 1997). Third, liquidity constraints favor engagement in economic activities with immediate profits, which usually yield low returns, and hinder adoption of new technologies (Abdulai and Huffman 2005; Barrett 2007; Abdulai, Monnin, and Gerber 2008).

To enhance the functioning of financial markets, developing countries have implemented government lending projects that involve state-owned banks providing loans at subsidized interest rates. The results of these approaches have rather been disappointing. Reasons for these disappointing outcomes include corruption and administrative targeting that excluded large parts of poor households (Armendáriz de Aghion and Morduch 2005). Some governments of developing countries have played an indirect but significant role in the revolution of microfinance, with a focus on microcredits and (p. 363) microsavings. For example, the Grameen Bank started as a special project from the state-owned Bangladesh Bank, and has received loans at concessional rates from that bank. State-owned banks in Indonesia (Bank Rakyat Indonesia) and Thailand (Bank of Agriculture and Agricultural Cooperatives) have also established innovative microfinance programs with a wide range of small-scale customers.

4.3 Transportation and Communication Infrastructure

Improved infrastructure in developing countries affects food security in a number of ways. These include: (1) reduction in search costs and transportation costs of market participants; (2) increase in agricultural productivity as a result of better access to inputs, credits, services, and information; (3) improved access to health services; (4) improvement in human capital as a result of better access to education and health services; (5) better job opportunities. In spite of the empirical evidence on the positive impact of transportation and communication infrastructure on economic and agricultural growth, public expenditure devoted to infrastructure remains quite low in developing countries (Antle 1983; Easterly and Levine 1997; World Bank 2004).

At the macro level, Torero, Chowdhury, and Bedi (2006) have found a significant positive effect of telecommunications penetration in developing countries on economic growth. An analysis of the garment industry of China, India, Pakistan, and Bangladesh based on firm-level survey data also revealed that better telephone services can increase income through higher wage rates, firm profitability, and growth (Dollar, Hallward-Driemeier, and Mengistae 2005). Gabre-Madhin 2001 analyzed the Ethiopian grain market and argues that, given considerable information deficiencies among traders and brokers, the

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use of information technology can considerably increase interspatial trade flows. Meanwhile, the Ethiopian government supported the 2008 established Ethiopian Commodity Exchange, which uses radio, television, cellular phone technology, and electronic price display boards to spread agricultural commodity prices countrywide. In addition, information asymmetries arising from poor measurement of traded items and lack of trustworthiness have been addressed with warehouse receipt systems, in which food commodities are properly weighed and stored.

4.4 Health Care, Sanitation, and Water Access

Given that many parts of the developing world still face serious problems in the health sector, such as unequal access to medical treatment, lack of sanitation facilities, and scarce and contaminated water, many governments have engaged in providing public health services to reduce the risk of infection and cope with health shocks (Gwatkin et al. 2007). It is encouraging to note that, at the macro level, public spending on health care in developing and transition countries has been effective in improving the health (p. 364) of the poor population (Gupta, Verhoefen, and Tiongson 2003). Thus, public spending has added overall to private and informal health provisions, as well as international health projects. In detail, sanitation, hygiene, water supply, and water quality interventions have mostly been found to be effective in fighting diseases and mortality (Esrey et al. 1991; Fewtrell et al. 2005).

In addition to providing public health services, developing countries have engaged in providing water and sanitation infrastructure. This is because increased water supply through these public goods can improve an individual's food security by ensuring better hygiene conditions and also freeing time that would otherwise be used for water collection (Esrey et al. 1991; Hutton and Haller 2004). While laying water pipes is the most costly intervention for improving water supply, it provides daily access to treated water (Hutton and Haller 2004). Water provided by other interventions, such as building wells or spring protection, is, on the other hand, vulnerable to becoming contaminated when transported or stored at home. Given that measures to improve microbial safety immediately before consumption are very effective in reducing diarrheal infection, water treatment at the point of use is proposed as an effective measure in fighting waterborne illnesses (Fewtrell et al. 2005).

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5 Conclusions

In this chapter, we have argued that food security remains a major concern in the developing countries, and that national governments have employed various policies to address food security concerns of their citizens. Given the broad definition of food security, these policies usually involve direct interventions involving structural changes in relative prices and targeted food subsidies, as well as indirect measures such as improving agricultural infrastructure and the general economic environment, and providing farmers with new farm technologies to increase food production. To the extent that ensuring food security also involves measures that stimulate adequate levels of effective demand through "entitlements," governments have also employed income diversification strategies and cash transfers to achieve food security goals. However, these income support measures for the poor are only efficient when provision is made for an enlarged supply of basic food commodities. This underlines the significance of investing in the agricultural sector to boost food production.

The discussion in this chapter has shown that over time the food policies of developing countries have largely moved from direct state interventions that attempted to circumvent food market failures to a more liberalized market approach, where the state entrusts private entities with the task of adequate provision of food, but still invests in safety nets and public goods to overcome market failures. With the reduction of state activities, significant linkages between governments and private enterprises, NGOs, multilateral organizations, research institutions, and donor countries have been established to improve food security in developing countries. The discussion in the **(p. 365)** chapter also clearly revealed that despite the evidence that public investment in agriculture—along with infrastructure spending—generally yields the highest returns in terms of poverty reduction and economic growth, public expenditure for the sector has declined over the last decades. Governments therefore need to increase public investment in agriculture to promote productivity and overall economic growth.

The voluminous literature on food security in developing countries referred to in this chapter shows the efforts several policy analysts have put into research to examine policy options and their impacts on food security. However, a number of important questions still remain unaddressed. For example, in analyzing the effects of stabilization schemes on food prices, an important issue that crops up is that of determining the adjustments that do the least damage to economic growth and equitable distribution of income in the society. As pointed out by Timmer 1989, addressing such issues normally requires general equilibrium analyses, with dynamic investment functions linked to the impact on expectations of instability in food prices, in credit markets, and in the budgetary behavior

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of government. Most food security analyses remain partial and highly intuitive. Despite this limitation, there is a general consensus that our understanding of the food security policies of developing countries has been significantly enhanced by the carefully conducted theoretical and empirical analyses over the last two decades.

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Notes:

(1) Global security is affected in cases where civil unrest threatens regimes within highly insecure regions, and thereby further destabilizes the whole region and weakens political allies. An additional threat to global security is that increasing food insecurity and global inequality may raise terrorist motivation (Falcon and Naylor 2005).

(2) Sen 1999 points out that hunger relates not only to food production and agricultural expansion, but also to the functioning of the entire economy and the operation of the political and social arrangements that can, directly or indirectly, influence people's ability to acquire food and to achieve health and nourishment.

(3) For simplicity, we assume that food is linearly interrelated with metabolizable nutrients (as does Lancaster 1971).

(4) Detailed impacts of vitamin A and iodine deficiencies on health status are documented in WHO (1982) and Hetzel 1983, respectively.

(5) The impacts of iron deficiency on cognitive function and work capacity are reviewed in Pollitt 1993 and Haas and Brownlie 2001, respectively.

(6) According to Sen 1999, a family's entitlement depends on, among other things, distinct influences such as ownership over productive resources as well as wealth that

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commands a price in the market, production possibilities and their use, as well as the ability to sell and buy goods and the determination of relative prices of different products.

(7) On average, households in low-income countries spent 53 percent of their expenditure on food in 1996; the corresponding figures for middle-income and high-income countries were 35 and 17 percent, respectively (Seale, Regmi, and Bernstein 2003).

(8) For example, India's public distribution system has been found to favor the population in urban districts considerably (Gulati, Sharma, and Kahkonen 1996).

(9) Later, the Starter Pack intervention was scaled down to a targeted anti-poverty program, which, however, could not adequately handle an upcoming food crisis (Harrigan 2008).

(10) Problems in informal markets include significant market power of the best-informed credit lenders, credit rationing due to high default rates, and the importance of social networks for credit access, which discriminates against those with few contacts and ethnic minorities (Zeller et al. 1997; Barrett 2007).

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