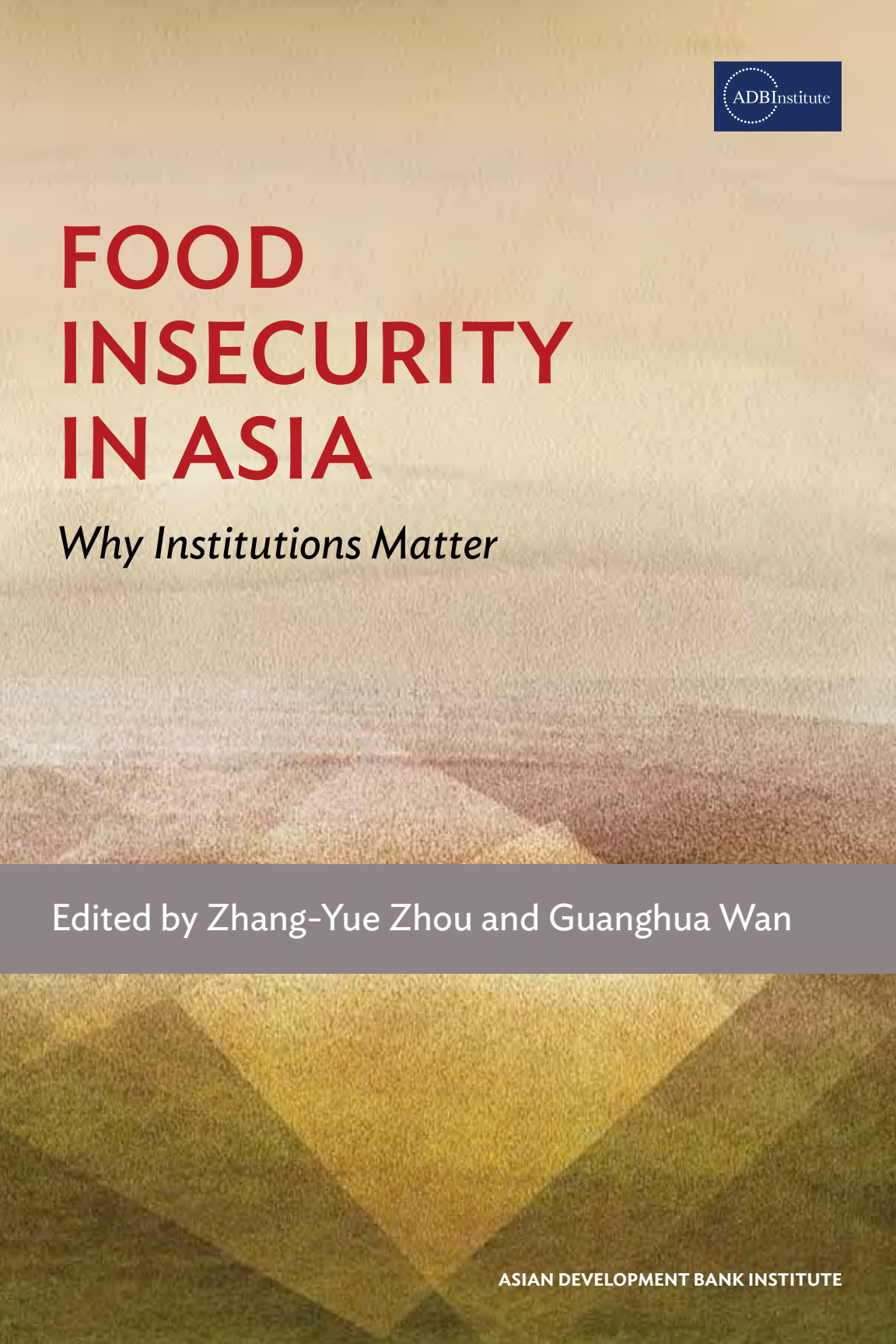
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ASIAN DEVELOPMENT BANK INSTITUTE

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Food Insecurity in Asia

Why Institutions Matter

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The Asian Development Bank Institute, located in Tokyo, is the think tank of the Asian Development Bank. The institute aims to identify effective strategies to improve policy and development management in Asia and the Pacific. We work with an extensive network of partners in the region and globally to influence policies on poverty reduction, inclusive growth, the environment, regional cooperation, infrastructure development, middle-income countries, and private sector development.

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Preface

At the end of World War II, food was insufficient in many Asian countries. Subsequent efforts to repair war damage and to boost food supply gradually resulted in improved food security. The rate of improvement, however, seems to differ drastically across borders. Japan and the Republic of Korea achieved and maintained high levels of food security. The People's Republic of China (PRC) and Indonesia managed to improve the status of food security, although more remains to be done. Nevertheless, the progress in the Democratic People's Republic of Korea and Pakistan was less impressive. The heterogeneity naturally leads to a very important question: why have Asian countries differed so much in terms of improvements in food security levels given that their economic conditions were similar at the end of World War II?

Studies that examine differences in food security performance among Asian countries are sparse. In this book, we fill this gap by providing cross-country comparative perspectives on food security improvements. Such a study can be valuable for Asian countries to learn from each other. After all, over 500 million Asians still suffer from hunger (over 65% of the total hungry people of the world), according to the Food and Agriculture Organization.

Countries included in this book are Bangladesh, the PRC, Indonesia, Israel, Japan, the Democratic People's Republic of Korea, the Republic of Korea, Pakistan, and Singapore. These countries share some similarities but also differ in terms of their institutional settings, natural resource endowments, population size, and level of economic development. Our study concludes that institutional differences are the most fundamental determinants of divergent food security status.

The book is chiefly written for anyone who is interested in Asian food security, including officials of national governments and international bodies, researchers, and university students. Asia's experience can also be valuable in improving the food security of countries beyond Asia.

Our study has benefited enormously from assistance and support of many individuals of various organizations. In particular, we wish to thank our team members for their dedication and valuable contribution, and Iva Sebastian, Samprati Pani, and Ainslie Smith for their skilful support. The study was funded by the Asian Development Bank and the editorial support was provided by the Asian Development Bank Institute, to both we are most grateful.

Zhang-Yue Zhou and Guanghua Wan

Abbreviations

ADB	Asian Development Bank
ADER	average dietary energy requirement
ADESA	average dietary energy supply adequacy
AERR	ASEAN Emergency Rice Reserve
AMS	aggregate measurement of support
ASEAN	Association of Southeast Asian Nations
CBS	Central Bureau of Statistics
CGIAR	Consultative Group on International Agricultural Research
CPC	Communist Party of China
CPI	consumer price index
DES	dietary energy supply
DRI	dietary reference intake
EIU	Economist Intelligence Unit
EU	European Union
FAO	Food and Agriculture Organization
FPW	Food Price Watch
FTA	free trade agreement
G20	Group of 20
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
GFSI	Global Food Security Index
GHQ	general headquarters
GTAP	Global Trade Analysis Project
ha	hectare
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IDR	import dependency ratio
IEG	Independent Evaluation Group
IFI	international financial institution
IFPRI	International Food Policy Research Institute
kcal	kilocalorie
kg	kilogram
km^2	square kilometer
KOTRA	Korea Trade–Investment Promotion Agency
KREI	Korea Rural Economic Institute
M&E	monitoring and evaluation
MAF	Ministry of Agriculture and Forestry

MAFF	Ministry of Agriculture, Forestry and Fishery
MDER	minimum dietary energy requirement
MDG	Millennium Development Goal
mt	million tons
NGO	nongovernment organization
OECD	Organisation for Economic Co-operation and Development
PDS	public distribution system
PRC	People's Republic of China
PSE	producer support estimate
R&D	research and development
RDA	Rural Development Administration
RDI	reference daily intake
SARS	severe acute respiratory syndrome
SOFI	State of Food Insecurity
SSR	self-sufficiency ratio
TFA	Totally Fuzzy Approach
TFP	total factor productivity
TFR	Totally Fuzzy and Relative Approach
TPP	Trans-Pacific Partnership
TRQ	tariff rate quota
UN	United Nations
URAA	Uruguay Round Agreement on Agriculture
US	United States
USAID	US Agency for International Development
WFB	World Food Board
WFP	World Food Programme
WFS	World Food Summit
WHO	World Health Organization
WTO	World Trade Organization

PART I

Introduction

1

Introduction: Food Insecurity in Asia

Guanghua Wan and Zhang-Yue Zhou

1.1 Why This Book?

This book explores the issue of food security in various Asian countries, with a special emphasis on the role played by institutions.

Achieving food security is of utter importance in any nation. However, food insecurity still prevails in many developing countries. According to the latest report by the Food and Agriculture Organization of the United Nations (FAO), during 2014–2016, the number of undernourished people in the world was as large as 794.6 million, with the vast majority—779.9 million—living in developing regions (FAO 2015a).

Asia is still home to almost 65% of the world's undernourished, totaling 511.7 million (FAO 2015a), despite some progress in food security since World War II. This is disturbing and unacceptable, and calls for urgent action.

At the national level, however, the status of food security or insecurity varies dramatically. For example, the proportion of undernourished in the Democratic People's Republic of Korea amounted to a high 41.6% over 2014–2016, but it was less than 5% in the Republic of Korea. This proportion is 16.4% for Bangladesh and 22% for Pakistan in the same time period, above the Asian average of 12.1%. In the People's Republic of China's (PRC) the proportion is low, but the total number of undernourished remains sizable at 133.8 million (FAO 2015a). Some other Asian countries, such as Japan and Singapore, have done well in improving their food security, with the proportion of undernourished being less than 5%.

The difference in the status of food security across countries over the past 6 decades cannot be explained by some of the conventional arguments, such as resource endowments, country and/or population size, level of economic development, and cultural or social differences.

- **Resource endowments.** Japan and the Republic of Korea have limited agricultural resources; Singapore and Israel also have limited resources. Yet, at the national level, these countries do not suffer from food insecurity problems. Ironically, as far as food security is concerned, these countries top Asia as measured by the Global Food Security Index compiled by The Economist Intelligence Unit (EIU 2015). Within Asia, Singapore ranks the first, followed by Israel, Japan, and the Republic of Korea. They all ranked high globally as well, with Singapore being the highest ranked in second position (EIU 2015). Many countries in Asia and beyond have better resource endowments, yet some of them have serious food insecurity problems. Another convincing example refers to the PRC. The world's most populous nation suffered from serious food shortages before 1980, but today the food supply is abundant even though the country is endowed with less land and farming labor, compared with the years before 1980.
- **Country and/or population size.** India and the PRC are the most populous countries in the world. From 1958 to 1962, the PRC suffered from a large-scale famine resulting in tens of millions of deaths (Becker 1996; Yang 2008; Dikötter 2010). India has also experienced several famines since its independence in 1947, but the death tolls were minimal. Clearly, the size of population is not a determining factor of a country's level of food security. In the 1960s, the PRC had a smaller population size, but it suffered from food shortages chronically. Today, the PRC's population has more than doubled, yet its food security has dramatically improved.
- **Level of economic development.** Many Asian countries suffered from the effects of World War II including Japan, the Republic of Korea, and the PRC. However, Japan and the Republic of Korea quickly improved food availability after the war. For the PRC, it took 30 years to do so. The sharply contrasting stories of the Republic of Korea and the Democratic People's Republic of Korea are even more convincing. When Korea was divided in 1945, both countries were at a similar level of economic development (with the Democratic People's Republic of Korea being even better). Since then, the Democratic People's Republic of Korea has been struggling to feed its people, while the Republic of Korea quickly improved its food supply and has remained at a high level of food security. (In 2012–2014, the Democratic

People's Republic of Korea's average dietary energy supply adequacy was 92, being one of the few countries in the present times whose adequacy is below the threshold of 100. For the Republic of Korea, this adequacy indicator stood at 137 in 2012–2014.) (FAO 2015b).

- **Cultural or social differences.** Cultural traditions and social settings can affect food security to some extent; however, again, they are not determining factors. Before the separation in 1945, the Republic of Korea and the Democratic People's Republic of Korea were part of the same country, with the same cultural traditions and social settings. Today, while food availability is no longer an issue in the Republic of Korea, the number of undernourished in the Democratic People's Republic of Korea is still large, ranging from about 30% to 40% of the total population. The PRC is another example where people, culture, and the society remain the same, but the food security status has changed enormously. In the pre-reform period, tens of millions of people died of hunger or suffered chronically from undernourishment during the the famine (1958-1962) and the Cultural Revolution (1966–1976). This is no longer the case.

These observations appeal for a deeper analysis to identify determining factors of food security elsewhere. It is postulated that differences in institutions between countries are responsible for the differences in the levels of food security between nations.

It is noted that poverty is a root cause of malnutrition, especially micronutrient deficiencies, which primarily affect the poor and disadvantaged. Over the last 20 years, the distribution of income has worsened with economic growth in many, especially developing, countries, leading to rising inequality and poverty. If left unchecked, they could lead to social unrest, thus undermining food security. However, in many cases, it is the poorly equipped institutions that result in poverty and inequality.

1.2 Institutions: What Do We Mean?

"Institutions are systems of established and embedded social rules that structure social interactions" (Hodgson 2006: 18). Five primary institutions are found among all human groups: (1) in determining kinship, (2) in providing for the legitimate use of power, (3) in regulating the distribution of goods and services, (4) in transmitting knowledge from one generation to the next, and (5) in regulating our relation to the

supernatural (Sociology Guide 2015). These five basic institutions can be called family institutions, political (or governmental) institutions, economic institutions, educational institutions, and religious institutions, respectively.

While all five institutions can affect the food security of a country, we hold that two of them, government and economic institutions, are the most influential. In this book, we focus on the impacts of these two sets of institutions on food security of selected countries.

More specifically, an economic institution is the set of rules and norms that govern the production and distribution of goods and services, e.g., laws governing property rights and commercial transactions, court systems, and policy organizations such as regulatory agencies. A government or political institution is the set of rules and norms within which governments operate, including the right to vote, responsible government, and accountability. Governments create, enforce, and apply laws; mediate conflicts; and make policies on the economy and social systems.

To verify that government and economic institutions are most important in affecting a country's food security, we postulate:

(i) A country achieves a higher level of food security if all the following three conditions are met:
   (a) the government is elected by the citizens and is accountable to the citizens,
   (b) the government policy process is transparent, and
   (c) government operations are efficient.

When these three conditions are met, a country is most likely to achieve food security. If any one of the three is not met, a country is unlikely to achieve its food security along all dimensions, although partial improvement may be possible, e.g., improved food availability.

(ii) A country achieves a higher level of food security if the market is allowed to play a major role in coordinating food production and distribution (except during extreme emergency food shortages).

Many aspects of a country's economic institutions can affect food security. However, whether the market is allowed to play a major role is most important. In countries where the market is allowed to work and market failures are monitored and corrected, food security is likely to be achieved at a higher level.

1.3 Objectives

This book examines how institutions, especially government and economic institutions, affect food security in various countries. It will draw policy implications for national governments and international bodies, through improved institutions, to reduce poverty and inequality and to achieve higher levels of food security nationally and globally. The specific objectives are:

- to investigate whether and how institutions of selected countries have affected their food security status;
- to assess the role of institutions on food security compared with other possible major factors in selected countries;
- to examine the impact of institutional arrangements on poverty and inequality, and subsequently on food security; and
- to demonstrate how countries can learn from each other in terms of setting institutional arrangements conducive to achieving higher levels of food security.

A cross-country comparative approach will be used to address our research questions and to achieve the research objectives. Representative countries selected for in-depth case study include the PRC, Israel, Japan, the Democratic People's Republic of Korea, and the Republic of Korea. References will also be made to Bangladesh, Indonesia, Pakistan, and Singapore. The findings of the country case studies will be synthesized to demonstrate how institutions affect food security and what lessons and experiences countries can learn from each other.

1.4 Overview of the Book

This book is divided into three parts. Part I has three chapters that set the scene for the book. Chapter 2 reviews literature concerning food, food security, and food security evaluation techniques, together with other issues of Asian food security. Chapter 3 presents Asia's food security achievements and current and emerging challenges for improving food security.

Part II contains six chapters, providing in-depth discussions and comparisons of food security experiences of 9 selected countries: the PRC (Chapter 4); Japan (Chapter 5); the Republic of Korea and the Democratic People's Republic of Korea (Chapter 6); Israel (Chapter 7); and Indonesia, Pakistan, Bangladesh, and Singapore (Chapter 8). Chapter 9 compares country experiences.

Three-fifths of the global population lives in Asia. Changes in the status of food security in Asia, especially in the PRC and the Subcontinent (which account for 37% of the world's population), can have a significant impact on global food security. It is thus useful to project how their future food security efforts may affect food security in other parts of Asia and the rest of the world. It is also important to examine how Asia can learn from other countries.

Part III of the book, consisting of three chapters, assesses how the PRC and the Subcontinent can affect global food security under various scenarios by 2030 and 2050 (Chapter 10). It explores how Asia can further improve its food security by learning from experiences elsewhere (Chapter 11). The last chapter, Chapter 12, concludes the book.

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2

Review of Literature

Zhang-Yue Zhou, Meenchee Hong, and Guanghua Wan

2.1 Food and Food Security

This chapter first examines the meanings of food and food security. Some key studies on food security in Asia are then reviewed. Finally, Section 2.3 presents several major frameworks to evaluate food security.

According to the World Health Organization (WHO) and the Food and Agriculture Organization (FAO), food is defined in a physiological sense as "nutritive material taken into an organism and which fulfils needs for maintenance, growth, work, and tissue repair" (WHO and FAO 1974: 10); staple food is defined as "a food which is regularly consumed in a country or community and from which a substantial proportion of the total calorie supply is obtained, especially by the poorer population sector and in times of food shortage" (WHO and FAO 1974: 11). As such, food is any nutritional material consumed by human beings that provides calories, protein, fat, and other essential micronutrients, including both animal and vegetable products such as cereals, meat, eggs, dairy products, vegetables, and sugar.

Food has distinctive features. It has an immediate appeal to deeply rooted human feelings because food is a matter of life and death. The major features of food include

- **Time dimension.** Without food, one cannot live for too long. Food has to be obtained within stricter time constraints than other necessities of life.
- **Nutritional dimension.** The human body does not effectively store some essential nutritional elements, which then need to be taken as part of the diet.
- **Sociocultural dimension.** Not all edible and nutritionally satisfactory food is socially, culturally, or psychologically acceptable.
- **Economic dimension.** For most food items, one has to pay to obtain them in the market (Spitz 1985).

Food security is a term to designate a condition related to food supply and access, which has been a concern throughout human history. Famine, hunger, food scarcities, and starvation were several common nouns used to describe food problems prior to a formal introduction of the concept of food security (Simon 2012). While some studies suggest that the notion of food security did not come into being until the 1970s, Gibson (2012) argued that the concept can be traced well before that time. The notion of food security "borrowed, regurgitated and built on numerous age-old ideological and philosophical foundations" (Gibson 2012: 511). Indeed, before World War I, there were already numerous instances concerning food security (Shaw 2007).

However, food security was perceived as a universal issue only after World War I (Shaw 2007). According to Shaw (2007), the League of Nations (an intergovernmental organization founded in January 1920 after World War I to provide a forum for resolving international disputes) recognized the need for a multilateral world food security arrangement in rationalizing food production and exchange for the benefits of both consumers and producers. However, most governments were preoccupied with post-war recovery. Consequently, international collaboration on food problems did not succeed during the short after-war era. Nevertheless, the great depression in consumer purchasing power and declining incomes of primary producers in the early 1930s roused awareness of a commitment for international participation in staple problems. At the same time, the negative impacts of chronic malnutrition on children and vulnerable people were revealed. Chronic malnutrition, a problem even in high-income countries, drew world attention to issues of food security (Gibson 2012).

The League of Nations disseminated world hunger statistics for the first time in the 1930s. Subsequently, the Health Division of the League of Nations produced a report on nutrition and public health in poor countries. This report also contributed to an initial stage of international collaboration in nutrition policies. Since then, hunger and nutrition issues have been perceived as global issues (Shaw 2007).

In 1945, the FAO was formed under the United Nations. It was the end product of a series of food security-related conferences held during World War II. The most prominent conference was the United States (US) Nutrition Conference for Defense, which determined that conquering hunger was the most important mission to achieve by democratic nations. This corresponded with the Four Freedoms initiated by the US President, Franklin D. Roosevelt, which urged

for an establishment of a United Nations program for "freedom from want of food" (Phillips 1981: 4).

In 1946, the FAO produced its first *World Food Survey* report. The report revealed that at least one-third of the world population was starving. This showed that world hunger did not improve even after establishing the FAO. Henceforth, the Director-General of the FAO, John Boyd Orr, proposed the establishment of the World Food Board (WFB), whose objective was to eradicate hunger through the integration of nutrition, health, agriculture, and trade. As a moral obligation, he believed that a civilized world should be able to feed hungry people even without profit. Simultaneously, trade would play a bridging role to bring food from surplus areas to insufficient ones. Hence, world surpluses could be utilized (Shaw 2007).

In the same period, the International Trade Organization was set up to encourage a reduction in trade barriers, and the International Monetary Fund was designed to facilitate the solution of financial problems at the international level. However, the WFB was not successful due to the absence of political support from leading economies, such as the US and the United Kingdom. Until 1953, numerous proposals were put forward to solve food insecurity and food surplus problems by national governments and the United Nations, but none was seriously taken by the FAO (Shaw 2007).

From 1950 to 1960, world food production increased by 50%, while the world cereal market continued to suffer with surpluses (Simon 2012). However, the food insecurity issue remained unresolved. Hence, a concept called the "World Food Reserve" (WFR) was popularized and was seen as the most appropriate solution to fix transitory food insecurity. With the WFR, mobile resources could be delivered to aid emergency needs during disasters. However, considering it would drastically reduce world food stocks that would lead to market price increases, some national governments did not accept the WFR proposal (Shaw 2007).

In 1955, the FAO concluded that poverty lies at the root of hunger, and the remedy of poverty is economic development (Paulino and Mellor 1984). When an economy is underdeveloped, consumer purchasing power is weak. In such a situation, food for the poor would have to be subsidized. This is not a sustainable solution, considering the cost of subsidies. Hence, world governments rejected both proposals of the WFB and the WFR. This called on the US to promote the establishment of the World Food Bank. The World Food Bank proposed to poor food-importing countries buying food through loans from the World Food Bank. The World Food Bank roles also included improving food supply with better nutritional

standards, preventing famine, and functioning as a food reserve. By the end of the 1960s, the cereal market continued to be in surplus, however. The US and Canada implemented plans to reduce cereal production (Shaw 2007).

The food surplus situation ended in the early 1970s. Drastic climate change had hampered agriculture production in many exporting countries. World food supply reduced instantly, and many food exporters turned into importers. Commercial imports became more expensive for developing countries, while food aid dropped from about 17 million tonnes of cereals per year in the 1960s to 7 million tonnes in the early 1970s (Simon 2012). The international food crisis had called for an international conference to review the food deficit conditions and decide on possible solutions. With this aim, the first World Food Conference was organized in 1974 (Shaw 2007).

The term "food security" emerged during the global food crisis in the 1970s (Smith, Pointing, and Maxwell 1992) and was put forward to a wider audience at the first World Food Conference in 1974 (FAO 2015). The conference defined food security as "availability at all times of adequate world food supplies of basic foodstuff to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (Clay 2002). The quantity and stability of food supplies lay at the center of this notion, based on the belief that increasing production and improving consumption distribution could resolve food insecurity (Paulino and Mellor 1984).

In the early 1980s, the concept of food security evolved from the sole focus on self-sufficiency. In 1983, the FAO expanded the concept to emphasize the importance of the balance between the demand and supply sides of food, and a new definition of food security arose "ensuring that all people at all times have both physical and economic access to the basic food that they need" (FAO 2003).

The concept of food security continued evolving with inspiration from an impactful World Bank report, *Poverty and Hunger* (World Bank 1986). The report distinguished between different situations of food insecurity and proposed appropriate eliminating measures. It categorized food insecurity into chronic food insecurity caused by poverty and transitory food insecurity ensuing from natural disasters or economic failure. According to the report, the deficient diet portion in chronic food insecurity only represents 5% of the national food supply. However, chronic food insecurity would not be eliminated with 5% increases in the food supply. This showed that food supply is merely one reason for chronic food insecurity. Instead, purchasing power and access rights to adequate food supply are important for malnourished people to maintain active and healthy lives.

The World Bank report, complemented by Sen's theory of famine in relation to "rights and entitlement" (Sen 1981), showed how famines thrive even without food shortages (CISS 2013; Maletta 2014). The World Bank report and Sen's theory provided an underlying conceptual approach to a broader food security concept by the end of the 1980s. Both highlighted the need to incorporate the ideas of access to sufficient food and nutritional balance into the food security concept. The mid-1990s also saw a linking of food security with food safety and preferences (Grover 2010).

In 1996, the World Food Summit redefined food security, considering definitions used in official documents by the FAO and the World Bank in 1970–1995 (FAO 2003). The purpose was to precisely include and reflect on the complexities and diversity of food security problems and changes in official policy thinking of the time (Clay 2002).

The reconstructed definition of food security, agreed upon by leaders of 186 participating countries at the 1996 World Food Summit in Rome reads as follows:

> Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (World Food Summit 1996).

After the 1996 World Food Summit, various definitions of food security continued to emerge. The FAO (2003) suggested that hundreds of definitions of food security exist. Globally, the most widely accepted definition is the one that was adopted at the 1996 World Food Summit. Many writings have used this definition in addressing food security issues on various occasions.

In 2009, world leaders convened at the FAO headquarters for the World Summit on Food Security, pledging their renewed commitment to eradicate hunger. At this convention, the definition of food security used was almost identical to the one adopted at the 1996 World Food Summit except for a few minor differences in wording as highlighted below:

> Food security exists when all people, at all times, have physical, *social* and economic access to sufficient, safe and nutritious food *to* meet their dietary needs and food preferences for an active and healthy life. (World Summit on Food Security 2009, emphasis added).

These changes in wording make little difference to the definition. The meaning of "social" is vague. In this book, we follow the definition adopted at the 1996 World Food Summit.

The 1996 definition adequately reflects the distinctive features of food as noted earlier (in passing, any definition of food security should reflect the major features of food). It also embraces and highlights several important aspects or dimensions of food security:

- **Food availability.** This is the most fundamental aspect of food security. Without adequate food availability, there is no need to address other aspects of food security. ("all people ... have sufficient ... food")
- **Supply sustainability.** Having food to eat at present is important, but having food to eat in the future is equally important. If "food availability" cares more about food supply today, then "supply sustainability" cares more about food availability in the future. ("all people, at all times, have ... sufficient ... food")
- **Food quality and safety.** Food needs to have an acceptable quality with basic required nutrition and should be safe to consume. Otherwise, the functions of food are not fulfilled or they may even cause health problems. ("safe and nutritious food that meets their dietary needs")
- **Cultural acceptability.** Some food may be not accepted by some groups of people due to different preferences. Apart from availability, food also needs to be culturally acceptable. ("food that meets their ... food preferences")
- **Access to food.** Food needs to be available within a reasonable distance. It also need to be affordable for all people, especially low-income groups. ("all people ... have physical and economic access to ... food")

2.2 Studies on Food Security in Asia

Food security has been a longstanding issue throughout Asian history. However, compared with research efforts on food security issues of North America and Western Europe, studies on Asia's food security issues have been fewer and have emerged later. In the 1970s, only a small number of studies demonstrated hunger and the food production situation in Asia's developing countries, most of which concentrated on food aid issues. (Due to the international food crisis in the beginning

of the 1970s, emergency food aid was channeled to needy countries in Asia.) For example, Maxwell and Singer (1979) conducted a survey on food aid to developing countries including India.

With the World Food Summit in 1974, the idea of food security was promoted widely at the international level and became an important "organizing principle" in the development sector. Klatt (1975) was one of the pioneers who studied the food situation in Asia after the first World Food Conference. In his paper, "Asia after the World Food Conference," Klatt described the differences between food shortages of the immediate future (immediate food emergency) and long-term food problems caused by inefficient farm production and food supply. He also revealed the changes in agriculture and food supply structures in Asia and the consequences of food production and food price changes on the population—issues that were lacking in the literature produced in the 1970s. Unlike most of the existing literature, Klatt presented some positive sides of the food security situation in Asia.

2.2.1 Economic Growth and Food Security

Economic growth and the resultant consumer income increases are important factors that have contributed to a higher level of food security in Asia. Rapid economic growth in Asia has equipped many countries with stronger capabilities to cope with external shocks that affect their food security. During the Asian financial crisis between 1997 and 2000, the economies of some countries in Asia, especially in East Asia, were badly hit. Yet, their food security situation was not much affected due to their accumulated economic strengths (von Grebmer et al. 2008). It has been argued that food security and economic growth mutually reinforce each other (Timmer 2005). Economic growth improves human development, increases the public's purchasing power, and reduces poverty, thereby increasing access to food and reducing hunger (Noordwijk et al. 2014).

Peng, Findlay, and Stringer (1997), in *Food Security in Asia*, reviewed the past trends and future prospects in access to and availability of food in Asia at the national level. They concluded that through economic structural changes, poverty had been reduced. Hence, Asia could achieve a sustainable balance between food production and demand. They were optimistic that food security would be achieved if Asia sustains its comparative advantage in the industry economy, establishes wider international trade relationships, and continues to grow its economy, as well as keep its population growth under control. Timmer (2005), however, was less optimistic, believing many

people in Asia, especially those in South Asia, have not managed to escape from chronic hunger. Teng et al. (2012) also held that Asia's food security is still under pressure due to rapid urbanization, natural resource constraints, slow transformation of traditional agriculture, and unsustainable trade practices.

2.2.2 Urbanization and Food Security

Asia's economic rise, and the subsequent growth in urbanization, adds to pressures on land, water, and energy resources (ADB 2013b). Asia is currently home to half of the world's urban population, and its urbanization is predicted to continue growing. Urbanization results in various changes to society—the change in the composition of food intake and the change in food supply chains to cater to the needs of the urbanized diet are significant in the context of food security. The latter has led the food supply chains in Asia to undergo a "supermarketization" (Quizon 2011; Teng et al. 2012). Subsequently, modernized food consumption trends have brought changes in the food security landscape, which in turn have posed greater challenges to Asia's ability to feed itself. It has been widely observed that the dietary pattern in Asia is shifting from staples toward livestock and dairy products, fats, and oils. In particular, Asian urban households spend more on meat, fish, and sugar, and less on rice than rural households (Thapa and Gaiha 2011). Changes in the dietary composition and supermarketization of food supply chains in Asia have increased the demand for food of animal origin in the global market. This adds further pressure on livestock and livestock feed industries to increase their output level to meet the growing demand (ADB 2013b). Unfortunately, increased demand for food of animal origin might negatively affect the food security of low-income consumers due to competition for more land and feed resources (Godfray et al. 2010).

2.2.3 Growing Population and Food Security

In addition to the changes in consumption patterns, the continuing rapid population increase is another major deterrent for Asia to achieve a high level of food security (Quizon 2011; Mukherjee 2012; ADB 2013b). More food has to be made available to the additional population, exerting pressure on already limited food production resources. Asia's population is projected to be 5.16 billion by 2050, about one-fifth higher than today (United Nations 2015). With such a large population, Asia would have to increase its food supply by 20% more than today to ensure adequate food availability in 2050.

2.2.4 Environment Degradation, Climate Change, and Food Security

Environmental problems such as pollution of air, water, and soil negatively affect Asia's food production, both in terms of reduced quantity and quality (ADB 2010; Godfray et al. 2010; Teng, Caballero-Anthony, and Lassa 2015). There have been studies on the impact of climate change on agriculture and food production in Asia (for example, Luo and Lin 1999). Some researchers believe that changes in the average climate conditions and climate variability have already significantly affected crop yields in Asia (Wahlqvist et al. 2012). Signs of declining or stagnating yields have started to emerge in some parts of East, South, and Southeast Asia (CISS 2013).

In addition to studies on issues that are closely related to food security, there are also studies that look into Asia's food security from other perspectives. Teng et al. (2012) held that significant investment in agriculture in Asia is urgently needed, while Teng, Caballero-Anthony, and Lassa (2015) argued that food security strategies need to be more "pro-poor." Food expenditure has the highest share in poor households' consumption. In Bangladesh, Cambodia, and India, poor households spend 60% of their income on food (ADB 2013a). During global food price hikes in 2007–2008, the food share of the poor in Thailand increased to over 60%, while that in Viet Nam rose to about 80% (ADB 2014). Thapa and Gaiha (2011) argued that small farmers are the backbone of Asian agriculture and support for them will help improve Asia's food security.

Existing studies contribute to an understanding of the broad issues concerning Asia's food security. However, available studies are unable to pinpoint the root causes that are responsible for food insecurity in many Asian countries. They are unable to explain why huge differences in the level of food security exist among Asian countries. Exploring the root causes and clarifying such differences would help individual countries understand their strengths and weaknesses in their quest for improved food security and enable them to learn from each other. This study investigates why such differences exist from an institutional perspective. Before we delve into food security experiences in several selected Asian countries in Part II of this book, we will first explain how food security can be evaluated.

2.3 Evaluating Food Security

To appropriately evaluate a country's food security, we need a framework. Ideally, this framework should give attention to not only the features of food itself (Section 2.1), but also the entire range of factors determining the security of food availability and access (Section 2.2). Currently, there are a number of evaluation frameworks available: such as, Oshaug, Eide, and Eide (1994); Riely et al. (1999); Suresh and Ergeneman (2005); IFRC (2006); EIU (2014); and FAO (2014). Four of the major frameworks are presented below.

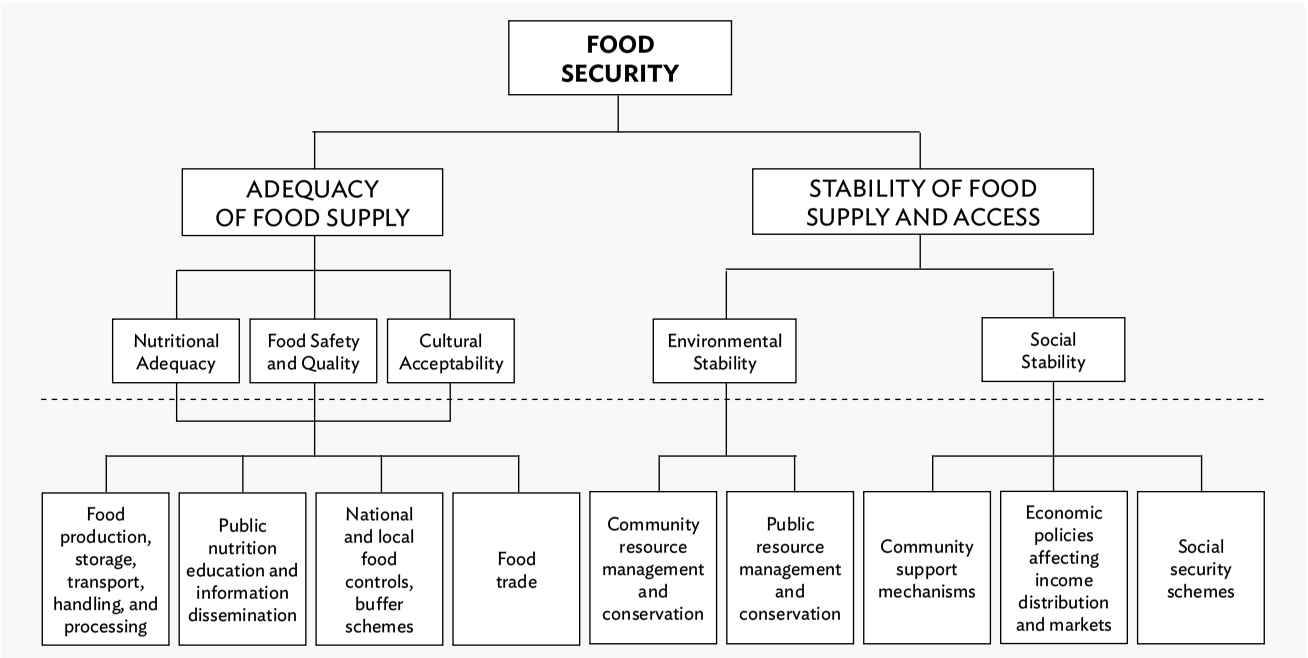
Oshaug–Eide–Eide framework. In an article published in *Food Policy*, Oshaug, Eide, and Eide (1994) proposed a normative food security framework, in which food security is expressed in terms of the adequacy of food supply and the stability of both food supply and access.

The adequacy of food supply means that (i) the overall supply should potentially cover all nutritional needs in terms of quantity (energy) and quality (provide all essential nutrients); (ii) the food is safe (free of toxins and contaminants) and of good quality (taste, texture, etc.); and (iii) the types of foodstuff commonly available (nationally, in local markets, and eventually at the household level) should be culturally acceptable (fit the prevailing food or dietary culture).

The stability of supply and access to food implies environmental sustainability and economic and social stability. Environmental sustainability implies that there is judicious public and community management of natural resources that have a bearing on the food supply. Economic and social sustainability addresses conditions and mechanisms securing food access. This concerns just income distribution and effective markets, together with various public and informal support and safety nets. It includes public social security schemes and community transactions, self-help, and solidarity networks.

Subsequently, Oshaug, Eide, and Eide (1994) proposed a normative food security framework (Figure 2.1). In this framework, above the dotted line are targets to achieve a country's food security; below the dotted line are examples of policies, strategies, and means that help achieve the targets. Food trade is an important means to help a country achieve food security. Figure 2.1 is a modified version of Oshaug Eide, and Eide (1994) with the trade component added.

Figure 2.1 A Normative Food Security Framework



Note: above dotted line = guiding principles; below dotted line = examples of policies and strategies.

Source: Based on Oshaug, Eide, and Eide (1994).

The FAO framework. The FAO, as a major international body charged with the primary responsibility of ensuring global food security, monitors food supplies and provides food supply estimates at the global, regional, and country levels where reliable data are available. Since 1974 when the term "food security" became widely used, and in particular since the 1996 World Food Summit when a target to reduce the number of hungry people was set, FAO has been devising and improving approaches that can help monitor the global food security status. The FAO has thus continuously revised its methodology over the past decades. One recent major revision was carried out in 2011–2012 and introduced in the 2012 *State of Food Insecurity* (SOFI). In the SOFI 2014 edition, further refinements were introduced. A note on the food security methodology that the FAO has developed and changes it has made are found in FAO (2014). According to the FAO methodological framework, food security is evaluated along four dimensions: availability, access, utilization, and stability. Under each of these four dimensions, there are specific indicators to be measured against (Table 2.1). Using this framework, since 2012, the FAO has provided updates of the status of global food security in its annual SOFI publication.

The Economist Intelligence Unit framework. The Economist Intelligence Unit (EIU) started publishing the Global Food Security Index (GFSI) in 2012 to determine which countries are most and least vulnerable to food insecurity. The index is a dynamic quantitative and qualitative benchmarking model constructed from 28 unique indicators, which measure drivers of food security across 109 countries. The indicators are placed in three categories or dimensions (Table 2.2). The definitions of the indicators and other details about the framework used by the EIU are in the *Global Food Security Index 2014* (EIU 2014).

The USAID framework. In 1999, the US Agency for International Development (USAID) and Food and Nutrition Technical Assistance published *Food Security Indicators and Framework for Use in the Monitoring and Evaluation of Food Aid Programs* to assist in the identification of food security indicators for US food aid programs (Riely et al. 1999). This framework contains three dimensions: availability, access, and utilization. Figure 2.2 highlights the nature of the relationship of the three dimensions to one another, as well as a brief description of their determinants.

Table 2.1 Food Security Indicators used by the FAO

Dimension	Food Security Indicators
Availability	Average dietary energy supply adequacy
	Average value of food production
	Share of dietary energy supply derived from cereals, roots, and tubers
	Average protein supply
	Average supply of protein of animal origin
Access	Percentage of paved roads over total roads
	Road density
	Rail line density
	Gross domestic product per capita (in purchasing power equivalent)
	Domestic food price index
	Prevalence of undernourishment
	Share of food expenditure of the poor
	Depth of the food deficit
	Prevalence of food inadequacy
Stability	Cereal import dependency ratio
	Percentage of arable land equipped for irrigation
	Value of food imports over total merchandise exports
	Political stability and absence of violence/terrorism
	Domestic food price volatility
	Per capita food production variability
	Per capita food supply variability
Utilization	Access to improved water sources
	Access to improved sanitation facilities
	Percentage of children under 5 years of age affected by wasting
	Percentage of children under 5 years of age who are stunted
	Percentage of children under 5 years of age who are underweight
	Percentage of adults who are underweight
	Prevalence of anemia among pregnant women
	Prevalence of anemia among children under 5 years of age
	Prevalence of vitamin A deficiency in the population
	Prevalence of iodine deficiency

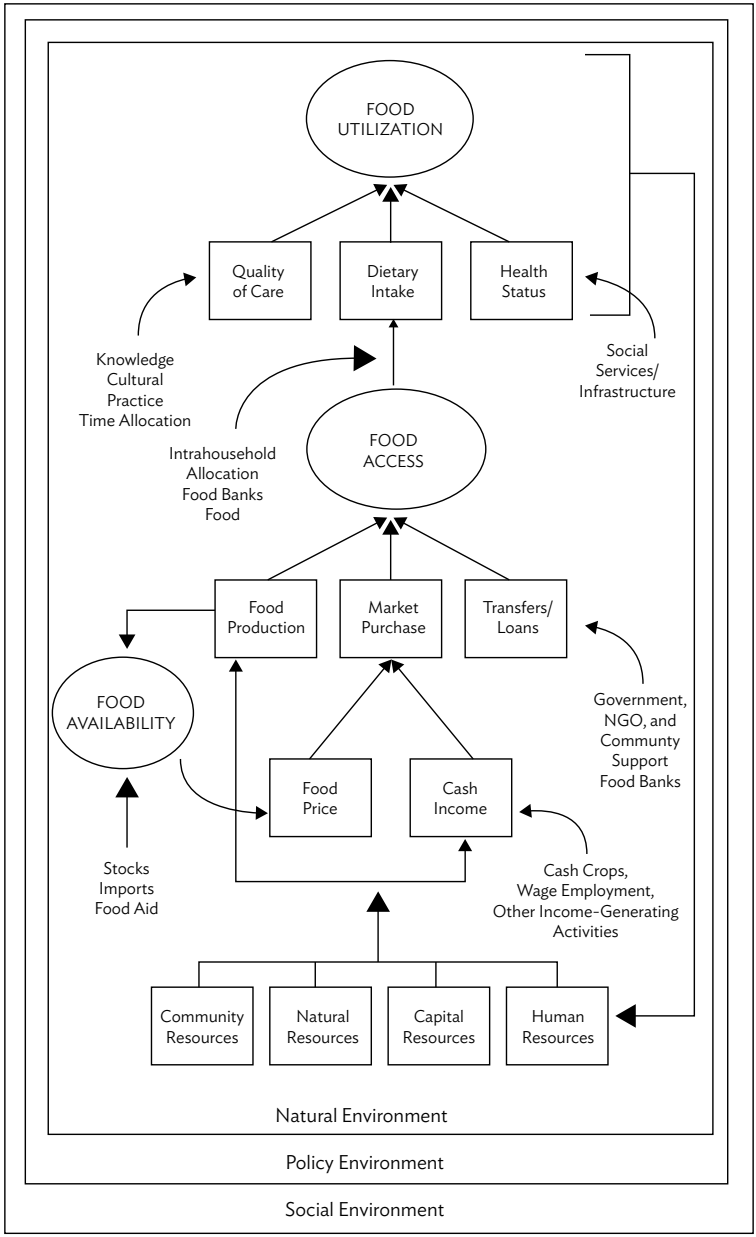
FAO =Food and Agricultural Organization.
Source: FAO (2014).

Table 2.2 Food Security Indicators used by the EIU

Dimension	Food Security Indicators
1. Affordability	1.1 Food consumption as a share of household expenditure
	1.2 Proportion of population under the global poverty line
	1.3 Gross domestic product per capita (PPP)
	1.4 Agricultural import tariffs
	1.5 Presence of food safety net programs
	1.6 Access to financing for farmers
2. Availability	2.1 Sufficiency of supply
	2.1.1 Average food supply
	2.1.2 Dependency on chronic food aid
	2.2 Public expenditure on agricultural research and development
	2.3 Agricultural infrastructure
	2.3.1 Existence of adequate crop storage facilities
	2.3.2 Road infrastructure
	2.3.3 Port infrastructure
	2.4 Volatility of agricultural production
	2.5 Political stability risk
	2.6 Corruption
	2.7 Urban absorption capacity
	2.8 Food loss
3. Quality & Safety	3.1 Diet diversification
	3.2 Nutritional standards
	3.2.1 National dietary guidelines
	3.2.2 National nutrition plan or strategy
	3.2.3 Nutrition monitoring and surveillance
	3.3 Micronutrient availability
	3.3.1 Dietary availability of vitamin A
	3.3.2 Dietary availability of animal iron
	3.3.3 Dietary availability of vegetal iron
	3.4 Protein quality
	3.5 Food safety
	3.5.1 Agency to ensure the safety and health of food
	3.5.2 Percentage of population with access to potable water
	3.5.3 Presence of formal grocery sector

EIU = Economist Intelligence Unit; PPP = purchasing power parity.
Source: EIU (2014).

Figure 2.2 Food Security Conceptual Framework Used by USAID



NGO = nongovernment organization; USAID = United States Agency for International Development.
Source: Riely et al. (1999).

2.4 Observations and Comments

Based on the above four frameworks, it is clear that the two most important dimensions of food security are availability and access. Extending from these two dimensions, each of the four frameworks emphasize other dimensions as well, such as utilization. It is noted, however, that even for the same dimension, indicators used to measure or evaluate that dimension vary between the four frameworks.

The Oshaug–Eide–Eide framework was published in 1994 and represents an early attempt to construct a food security framework. Interestingly, many frameworks developed in later years largely reflect the essence contained in the Oshaug–Eide–Eide framework, although it is uncertain whether acknowledgments have been attributed to Oshaug, Eide, and Eide (1994).

Later developed frameworks are more "complicated" or "fancier." They include a large number of indicators in evaluating food security. While nothing is wrong in being more comprehensive, when there are too many indicators (let alone whether they are directly related or significant), some important aspects might get overlooked when evaluating a country's food security. The other problem with these complicated frameworks is that they are "usable" only by well-resourced institutions. It is not practical for individual researchers with limited resources to make use of them.

While these complicated evaluation frameworks include many indicators, they are not necessarily comprehensive. For example, food security would need to take into account food availability for the present day, near future, and also longer term. In this sense, a country's food buffer stocks or reserves are important (for the near future) and a country's environment and resource sustainability are also important (for food production in the longer term). Surprisingly, on one hand, the FAO and EIU frameworks do not give any clear weight to reserve stocks and production sustainability. The USAID framework, on the other hand, acknowledges both these important aspects and is comprehensive in terms of key indicators that need to be included, although it is also challenging for individual researchers who do not have sufficient resources to make use of it.

The Oshaug–Eide–Eide framework has included all key aspects that are important for evaluating a country's food security. It is more pragmatic and easy to apply. It also allows researchers, especially less well-resourced individual researchers, flexibility to tailor their evaluation, to the extent that they can include the most important elements in their analysis, but can omit minor aspects that available resources do not permit. What we can thus do is treat the five

subgoals in the Oshaug–Eide–Eide framework as the major aspects against which food security evaluation should be carried out. Specific indicators can be attached under each of these five aspects.

When assessing the food security status of the chosen countries in the second part of this book, individual authors have used different evaluation frameworks judged as the most appropriate.

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3

Asia's Food Security in the Past 50 Years: Achievements and Challenges

Zhang-Yue Zhou, Guanghua Wan, and Meenchee Hong

3.1 Introduction

Food insecurity has been a longstanding issue throughout Asia's history. Asia is still home to two-thirds of the world's undernourished population, and approximately two-fifths of Asia's children go to bed hungry at night (ADB 2013; FAOSTAT 2015). Nonetheless, since World War II, the achievements in Asia's quest for improved food security are also notable, although many old and emerging challenges exist. This chapter highlights such achievements and challenges, which serve as a background for the remaining chapters of this book.

3.2 Achievements

Asia's food supply has increased remarkably since the late 1980s with all major food items experiencing a multifold increase in supply between 1961 and 2011 (Table 3.1). In fact, the world's increased food supply during the same time period chiefly came from increased production in Asia.

From 1961 to 2011, Asia's population increased from 1.7 billion to 4.2 billion. This increase of 248% is below the increase of any of the major food items shown in Table 3.1, except pulses. Figure 3.1 demonstrates that the growth in total food production is far greater than that in population.

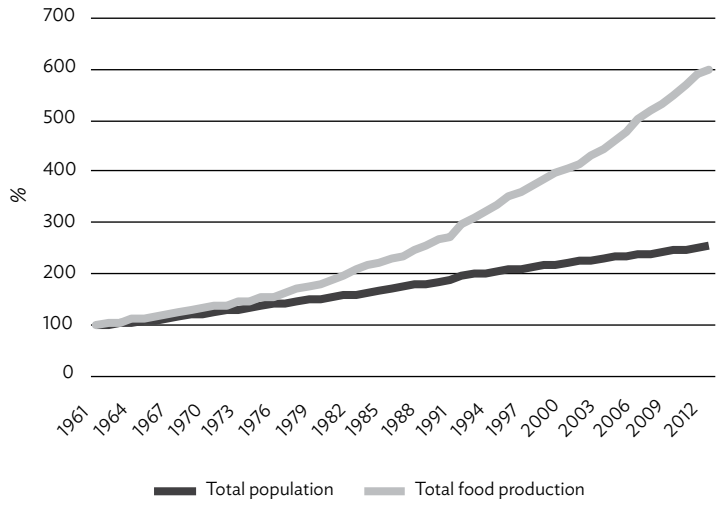
Compared with other continents, Asia's achievements in improving food availability are impressive. From 1961 to 2011, the growth in total food production ranked the highest among five continents (Figure 3.2, Panel A). The fast growth in Asia's food production combined with a

Table 3.1 Changes in Food Production and Supply in Asia (1,000 tons)

	1961					2011					2011 over 1961	
	Production	Imports	Stock Variation	Export	Total Supply	Production	Imports	Stock Variation	Export	Total Supply	Production Increase (%)	Supply Increase (%)
Cereals—Excluding Beer	260,709	26,623	−4,487	5,625	277,217	1,071,518	144,629	−29,742	54,019	1,132,382	411	408
Starchy Roots	135,035	333	−344	1,717	133,309	342,365	32,202	−49	29,750	344,762	254	259
Sugar Crops	178,924	5	−300	75	178,554	744,824	1	5,030	25	749,830	416	420
Sugar & Sweeteners	17,828	4,572	−1,559	2,699	18,143	76,621	26,735	−2,984	15,767	84,610	430	466
Pulses	24,887	318	275	344	25,136	33,204	7,352	−90	3,427	37,025	133	147
Tree Nuts	899	170	−3	292	774	9,498	2,770	127	2,881	9,514	1,057	1,229
Oil Crops	42,955	3,671	−151	7,337	39,142	186,136	79,976	−4,471	5,580	256,059	433	654
Vegetable Oils	5,494	390	−94	569	5,222	90,294	36,354	−1,348	46,160	79,132	1,644	1,515
Vegetables	112,256	589	−3	600	112,241	832,166	14,383	8	24,191	822,369	741	733
Fruit—Excluding Wine	42,672	758	−134	2,271	41,025	324,336	24,219	194	28,122	320,619	760	782
Stimulants	1,083	174	−9	631	614	7,177	3,882	287	5,442	5,898	663	961
Spices	1,254	84	0	143	1,191	7,693	1,139	−102	1,763	6,969	613	585
Alcoholic Beverages	5,509	65	−15	26	5,537	90,015	4,194	−109	2,255	91,845	1,634	1,659
Meat	8,985	132	−12	49	9,059	122,574	13,523	−66	4,349	131,676	1,364	1,454
Offal	976	4	0	4	976	7,477	2,058	0	492	9,050	766	927
Animal Fats	1,473	439	−8	130	1,772	10,588	2,114	−16	425	12,262	719	692
Eggs	3,478	42	0	73	3,447	43,221	545	0	599	43,171	1,243	1,252
Milk—Excluding Butter	42,723	2,381	10	26	45,087	273,213	25,049	399	5,166	293,492	639	651
Fish, Seafood	14,717	797	−158	752	14,602	103,368	23,683	337	20,231	107,148	702	734
Aquatic Products, Other	755	69	0	29	794	22,331	431	0	391	22,368	2,958	2,817

Source: FAOSTAT. http://faostat3.fao.org/download/FB/FBS/E (accessed 25 March 2015).

Figure 3.1 Growth in Food Production and Population in Asia



Sources: FAOSTAT. http://faostat3.fao.org/download/O/OA/E and http://faostat3.fao.org/download/Q/QI/E (accessed 25 March 2015).

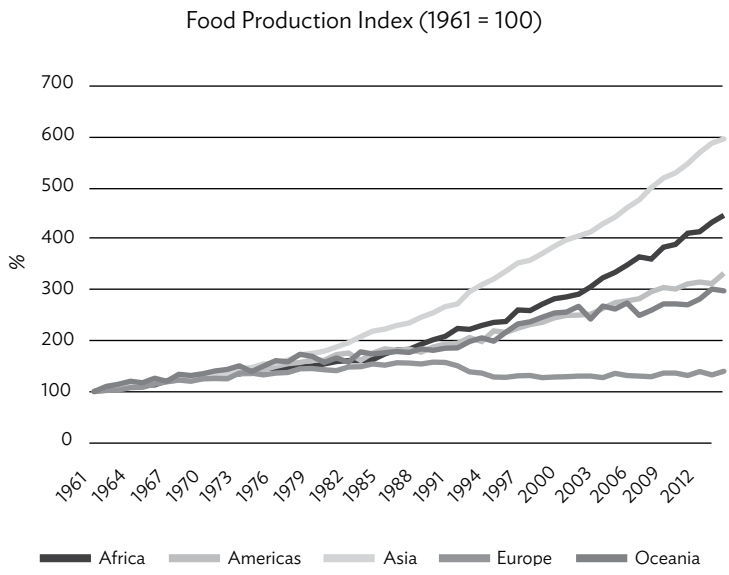
comparatively slower growth in population, not surprisingly, led to significant improvements in per capita food availability (Figure 3.2, Panel B).

Figure 3.3 shows that the supply in dietary energy, protein, and fat has all increased and was around or above average requirements by the early 2010s. In the early 1960s, Asia was hungry. The dietary energy supply (DES) was just slightly above the minimum dietary energy requirement (MDER),[1] just sufficient to keep people alive (Figure 3.3, Panel A). The supply of protein and fat was also well below

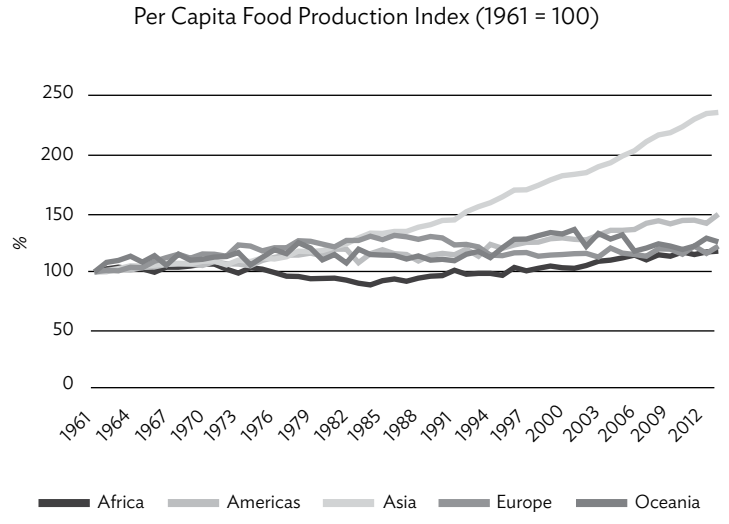
[1] DES is the national average energy supply expressed in calories per capita per day. MDER is the weighted average of the minimum energy requirements of the different gender-age groups in the population, expressed in calories per capita per day. It is a crucial factor in the Food and Agriculture Organization's undernourishment methodology as it establishes a cut-off point, or threshold, to estimate the prevalence (percentage) of the undernourished population in a country. Average dietary energy requirement (ADER) is the average of the individual's dietary energy requirement, a proper normative reference for adequate nutrition in the population. Its value can be used to calculate the depth of the food deficit, which is the amount of dietary energy that would be needed to ensure that, if properly distributed, hunger would be eliminated. DES, MDER, and ADER are all calculated on 3-year averages to reduce the impact of errors in the recording of annual stock variations (FAO 2015a).

Figure 3.2 Food Production Growth in Asia Compared with Other Continents

Panel A



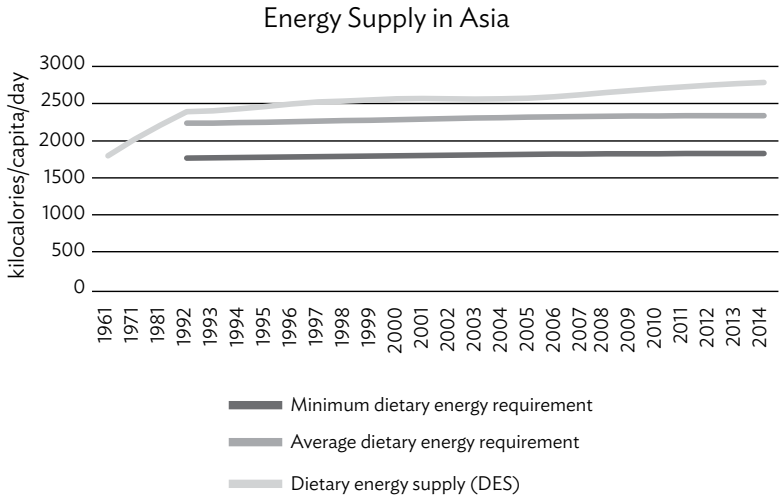
Panel B



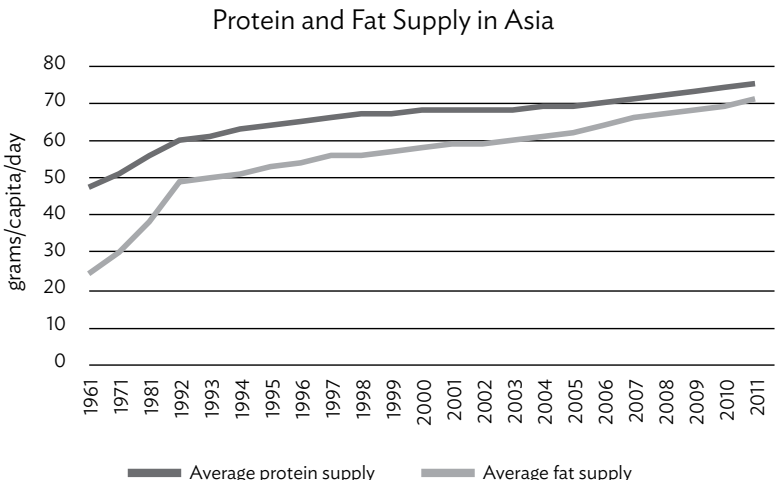
Source: FAOSTAT. http://faostat3.fao.org/download/Q/QI/E (accessed 25 March 2015).

Figure 3.3 Improvements in Food Supply in Asia

Panel A



Panel B



Sources: FAOSTAT. http://faostat3.fao.org/download/D/*/E and http://faostat3.fao.org/download/FB/FBS/E (accessed 25 March 2015).

the requirements (Figure 3.3, Panel B).[2] By the early 2010s, the DES was well above not only the MDER but also the average dietary energy requirement (ADER). While the protein supply is largely adequate for average Asian bodies, the supply of fat seems to have been well above the body's needs (which has resulted in health problems related to overconsumption of fat).

Asia has made impressive achievements in improving food availability, and also made remarkable progress in many other aspects of food security, based on the food security indicators of the Food and Agriculture Organization (FAO). In 1992, the number of people undernourished was 742.6 million. It dropped to 525.6 million by 2014. The prevalence of undernourishment declined from 23.7% to 12.7% during the same period. The depth of the food deficit (kilocalories per capita per day) and the prevalence of food inadequacy have also dropped from 177% to 94% and from 32.6% to 20.3%, respectively. In the meantime, access to improved water sources and to improved sanitation facilities has increased from 70.9% and 30.9% in 1992 to 91.2% and 58.6% in 2014, respectively (FAO 2015a).

3.3 Challenges

While Asia's achievements in improving food security in the past decades are praiseworthy, there remain serious challenges to food security in the future. The number of people undernourished, at 525.6 million, is still disturbingly high. Lifting them out of their current status will require an enormous amount of extra food. The growing disposable income of the more fortunate and the rising urbanized population will also place a demand for more food. In addition, Asia's total population is expected to rise from the current 4.38 billion in 2015 to 5.16 billion by 2050 (an increase of 779 million or 18%), thus requiring more food.

On the supply side, there are many remaining and emerging challenges that Asia has to face in its efforts at expanding future food supply. The amount of natural resources available for agricultural production has been declining due to an increased demand for human residential and infrastructure construction. In the meantime, the quality of natural resources is deteriorating due to increased human activities. The lower quality of resources will lead to lower food output and also lower food quality. It remains to be seen how and to what extent global warming and potential climate change negatively affect

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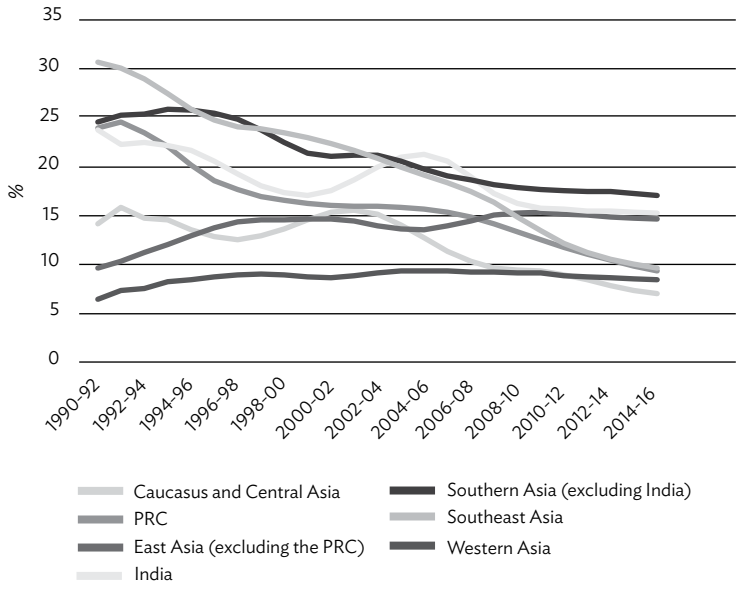
[2] The general low level of food supply in 1961 in Asia could be due to the Great Famine in the People's Republic of China at that time. See Chapter 4 for more details.

agricultural production. Adequate investment in agriculture in general and in research, development, extension, and education in particular can help mitigate the impacts of these challenges. However, the level of such investment in many Asian countries has been low and yet to be improved.

At the regional or national level, food insecurity and challenges for improving food security vary. The FAO data show that improvements in Asia's food security are uneven across regions and across various dimensions (FAO 2015b). As reflected by the prevalence of undernourishment, Southeast Asia and the People's Republic of China (PRC) have made dramatic headway to lessen food insecurity (Figure 3.4). For East Asia (excluding the PRC), there have been fluctuations in the prevalence of undernourishment, and its reduction has been slow. This is due to the dramatic increase in this prevalence in the Democratic People's Republic of Korea, from 23.3% in 1990–1992 to 42% in the mid-2010s.

Figure 3.4 Prevalence of Undernourishment in Asia



PRC = People's Republic of China.
Note: 3-year average; estimates for data since 2014.
Source: FAO (2015b).

The Caucasus and Central Asia experienced major fluctuations in the level of prevalence of undernourishment since separation from the former Soviet Union. The number of hungry in this region rose in the early 1990s. It then declined but increased again up to 2004. Socioeconomic shocks and political instability after the separation, plus geographic conditions, were the major causes of the fluctuations (Babu and Tashmatov 1999; FAO 2011). Nonetheless, the prevalence of undernourishment in this region has significantly dropped since 2004 and is currently the lowest in Asia (Figure 3.4).

South Asia has about 25% of the world's population, and about 400 million live on less than $1.25 per day (FAOSTAT 2015; World Bank 2015a). The prevalence of undernourishment in South Asia has also fluctuated (Figure 3.4).

The world's most populous country, the PRC, is also facing increasing challenges in improving its food security. Since the 1980s, the PRC's achievements in reducing the number of undernourished have been impressive. However, following the increase in consumer disposable income and the consumption of more high-value food since the mid-1990s, pressure to sustain the food supply for the population is also mounting. The widespread and severe pollution of natural resources (water, land, and air) in the PRC will make the challenge even greater (see Chapter 4 for more details).

3.4 Toward Better Food Security: Channeling Efforts in the Right Direction

While the challenges facing Asian nations are formidable, it is not impossible to further reduce the number of undernourished and to improve the level of food security. Indeed, there are successful examples in Asia where some nations have achieved high levels of food security, such as Japan, the Republic of Korea, Singapore, and Israel. According to the Global Food Security Index (GFSI, 0–100 where 100 = most favorable) produced by the Economist Intelligence Unit (EIU), these four countries ranked highly among the 109 countries included in the 2015 Index (Singapore, 2; Israel, 19; Japan, 21; and the Republic of Korea, 26) (EIU 2015). They achieved impressive high levels of food security in spite of their extremely low resource endowment (if population density is used as a rough indication of natural resource endowment, they all suffer from low resource endowment as they have a relatively high population density—the midyear population divided by land area in square kilometers (Singapore, 7,713; Israel, 372; Japan, 349; and the Republic of Korea, 516) (World Bank 2015b).

Table 3.2 Food Security Ranking and Population Density, Selected Asian Countries

Country	GFSI Ranking	Population Density (persons per km^2)
Bangladesh	88	1203
Cambodia	96	86
PRC	42	145
India	69	421
Indonesia	72	138
Myanmar	86	82
Pakistan	77	236

GFSI = Global Food Security Index; km^2 = square kilometers; PRC = People's Republic of China.
Source: EIU (2015); World Bank (2015b).

On the other hand, the GFSI suggests that some other Asian countries have a relatively low level of food security although they are better endowed with natural resources (lower population density) (Table 3.2).

The Democratic People's Republic of Korea was not included in the GFSI, although it is understood that it has a very low level of food security. It is one of the two countries in Asia whose DES is still below the ADER (the other being Mongolia) (FAO 2015a).

Hence, this calls for an examination of food security practices in various Asian countries to identify what forces are ultimately responsible for a country's food security. If such fundamental forces can be established, many Asian countries with a poor food security status can be assisted in channeling their efforts in the right direction to improve their future food security. This is what we do in the next part of the book. We provide case studies of the PRC, Israel, Japan, the Republic of Korea, and the Democratic People's Republic of Korea. We will also look into the food security practices of Singapore, Indonesia, Bangladesh, and Pakistan. Such cross-country comparisons will help us find out what causes the huge differences in the food security status in different countries and how they can learn from each other to achieve better food security for growing Asia.

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PART II

Country Experiences

4

From Food Scarcity to Food Abundance: The People's Republic of China's Quest for Food Security

Zhang-Yue Zhou

4.1 Introduction

This chapter reviews the status of food security in the People's Republic of China (PRC) since 1950 and examines factors that have affected its food security. The Communist Party of China (CPC) established the PRC on 1 October 1949. Since then, the country's food security has experienced two distinct periods. Prior to the 1980s, food availability was limited, and citizens were undernourished. Since the 1980s, food has been plentiful, and extreme cases of starvation are rare. The identification of factors responsible for such a dramatic change in the PRC's food security is not only of academic interest but also relevant to governments in the PRC and elsewhere to devise better policies to further improve their food security in the future.

Section 4.2 reviews the PRC's food security status in the past 60 years.[1] Section 4.3 identifies and elaborates on the major factors that are responsible for changes in the PRC's food security status. Section 4.4 evaluates the current status of food security in the PRC and highlights countermeasures needed to handle the remaining and emerging challenges in the quest for improved food security. Section 4.5 presents the likely food security scenario by 2050 in the PRC. Section 4.6 summarizes the lessons and experiences derived from

[1] Part of the discussion in this chapter is based on Zhou (2010) and Zhou (2015).

the PRC's past food security practices that could benefit the PRC and other countries.

4.2 Food Security Status in the PRC since 1950

4.2.1 Food Scarcity: 1950s–1970s

From the early 1950s to the late 1970s, there was a severe shortage of food in the PRC. Of the limited food available, grain was the major source of nutrition (Table 4.1). The intake of most other food was low. "Food" was not secure at all in the PRC. By 1978, the per capita consumption of most food was still below the level of 1952. In Table 4.1, grain is "traded grain"—a term used in grain statistics of the PRC. Assume that 200 kilograms (kg) of traded grain can yield 88% edible parts, giving 176 kg. On a daily basis, this is less than a 0.5 kg ration per day. For an average adult, with little other protein and oil food, the nutrition intake obtained from this ration could not meet their dietary requirements.

Data confirm that the intake of energy, protein, and fat by the citizens of the PRC between the 1950s and 1970s was below the daily requirement for average adults to perform average-strength work (Table 4.2). According to the Food and Agriculture Organization (FAO), the average dietary energy requirement (ADER) for the PRC is 2,350 kilocalories (kcal) per capita per day (FAO 2014b). The FAO data show that no year before 1980 met this requirement (Table 4.2). Both protein and fat intake were also below requirements.

One would wonder why the PRC's per capita food intake was so low for so long. Below is a brief account of food availability between 1950 and 1980 and associated policy measures.

Following the establishment of the PRC in 1949, there were many challenges caused by decades of wars. The most urgent challenge was to ensure a food supply to feed the massive population, which stood at 552 million in 1950. Many people were starving.

Boosting grain output is a quicker way to increase the food supply compared with the production of other food. Thus, promoting grain production was high on the agenda of the new government. From 1950 to 1952, grain production gradually expanded, and per capita grain availability also improved correspondingly (Table 4.3). In the meantime, a nationwide land reform campaign took place. The government confiscated land from landowners without compensation, and then redistributed the land to those with no or little land.

Table 4.1 Per Capita Consumption of Major Food Items, 1952–1985 (kg)

Year	Traded Grain*	Vegetable Oil	Pork	Beef and Mutton	Poultry	Eggs	Aquatic Products	Sugar
1952	198	2.1	5.9	0.9	0.4	1.0	2.7	0.9
1957	203	2.4	5.1	1.1	0.5	1.3	4.3	1.5
1962	165	1.1	2.2	0.8	0.4	0.8	3.0	1.6
1965	183	1.7	6.3	1.0	0.4	1.4	3.3	1.7
1970	187	1.6	6.0	0.8	0.3	1.3	2.9	2.1
1975	191	1.7	7.6	0.7	0.4	1.6	3.3	2.3
1976	190	1.6	7.4	0.7	0.4	1.8	3.5	2.3
1977	192	1.6	7.3	0.7	0.4	1.9	3.2	2.9
1978	195	1.6	7.7	0.8	0.4	2.0	3.5	3.4
1979	207	2.0	10.0	0.8	0.6	2.1	3.2	3.6
1980	214	2.3	11.2	0.8	0.8	2.3	3.4	3.8
1981	219	2.9	11.1	0.9	0.8	2.4	3.6	4.1
1982	225	3.5	11.8	1.0	1.0	2.5	3.9	4.4
1983	232	4.0	12.3	1.1	1.2	3.0	4.0	4.5
1984	250	4.7	12.9	1.2	1.4	3.9	4.3	4.9
1985	252	5.1	13.8	1.3	1.6	4.9	4.8	5.6

kg = kilogram, PRC = People's Republic of China.

* "Traded grain" is a term used in the PRC mainly for grain marketing and transfer purposes. The only difference between "raw grain" and "traded grain" is that paddy rice is converted to rice at a ratio of 70%, while the weight of other grain crops, e.g., wheat, maize, millet, and sorghum, remains the same as "raw" grain.

Source: SSB (1986).

Table 4.2 Per Capita Nutrition Intake, 1952–1985

	Energy (kcal/capita/day)			Protein (g/capita/day)			Fats (g/capita/day)		
	Total	Vegetal Products	Animal Products	Total	Vegetal Products	Animal Products	Total	Vegetal Products	Animal Products
1961	1,426	1,370	56	39.1	35.6	3.5	15.1	10.8	4.4
1962	1,538	1,472	66	42.6	38.5	4.1	16.5	11.3	5.1
1963	1,609	1,519	90	44.0	39.1	4.9	19.6	12.1	7.5
1964	1,685	1,577	108	46.0	40.5	5.5	22.4	13.2	9.2
1965	1,816	1,698	118	47.6	41.7	5.9	23.7	13.6	10.1
1966	1,884	1,761	123	48.6	42.6	6.0	25.1	14.5	10.6
1967	1,837	1,710	126	47.5	41.4	6.1	25.3	14.4	10.9
1968	1,779	1,656	122	45.6	39.6	6.0	24.3	13.8	10.5
1969	1,751	1,635	117	44.2	38.5	5.7	23.5	13.5	10.0
1970	1,858	1,744	114	46.2	40.6	5.5	24.1	14.4	9.8
1971	1,862	1,737	125	46.9	41.0	6.0	25.2	14.4	10.8
1972	1,846	1,712	135	46.3	40.0	6.3	25.6	13.9	11.7
1973	1,914	1,782	132	47.6	41.3	6.3	25.8	14.4	11.4
1974	1,910	1,777	133	47.6	41.2	6.4	25.8	14.4	11.5
1975	1,926	1,792	134	47.9	41.4	6.5	26.1	14.6	11.6
1976	1,894	1,764	130	47.1	41.0	6.1	25.3	14.0	11.3

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Table 4.2 *continued*

	Energy (kcal/capita/day)			Protein (g/capita/day)			Fats (g/capita/day)		
	Total	Vegetal Products	Animal Products	Total	Vegetal Products	Animal Products	Total	Vegetal Products	Animal Products
1977	1,933	1,801	132	47.6	41.4	6.2	26.1	14.7	11.4
1978	2,079	1,940	139	51.4	45.0	6.5	28.4	16.3	12.0
1979	2,096	1,935	160	52.3	45.2	7.1	31.1	17.0	14.1
1980	2,163	1,989	174	54.1	46.5	7.5	34.4	19.0	15.4
1981	2,181	2,005	177	55.3	47.6	7.7	35.7	20.1	15.7
1982	2,343	2,157	186	58.3	50.1	8.2	38.2	21.7	16.5
1983	2,413	2,221	191	60.1	51.7	8.4	39.2	22.3	16.9
1984	2,449	2,241	208	61.5	52.3	9.2	41.9	23.6	18.3
1985	2,450	2,217	233	62.4	52.0	10.3	44.7	24.2	20.5

FAO = Food and Agriculture Organization, g = gram, kcal = kilocalorie.
Sources: FAO (2014a).

Table 4.3 Grain Output, Net Grain Imports, and Per Capita Grain Availability

Year	Grain Output		Net Grain Imports	Population			Per Capita Grain Availability
	Total (million tons)	Change over Previous Year (%)	(million tons)	Total (million)	Change over Previous Year (%)	Rural Population of Total (%)	(kilogram)
1949	113			542		89.4	
1950	132	16.8	–1.16	552	1.8	88.8	237
1951	144	9.1	–1.97	563	2.0	88.2	252
1952	164	13.9	–1.53	575	2.1	87.5	283
1953	167	1.8	–1.82	588	2.3	86.7	281
1954	170	1.8	–1.68	603	2.6	86.3	279
1955	184	8.2	–2.05	615	2.0	86.5	296
1956	193	4.9	–2.50	628	2.1	85.4	303
1957	195	1.0	–1.92	647	3.0	84.6	298
1958	200	2.6	–2.66	660	2.0	83.8	299
1959	170	–15.0	–4.16	672	1.8	81.6	247
1960	143	–15.9	–2.65	662	–1.5	80.3	212
1961	147	2.8	4.45	659	–0.5	80.7	230
1962	160	8.8	3.89	673	2.1	82.7	244
1963	170	6.3	4.46	692	2.8	83.2	252
1964	188	10.6	4.75	705	1.9	81.6	273

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Table 4.3 *continued*

Year	Grain Output		Net Grain Imports (million tons)	Population			Per Capita Grain Availability (kilogram)
	Total (million tons)	Change over Previous Year (%)		Total (million)	Change over Previous Year (%)	Rural Population of Total (%)	
1965	195	3.7	3.99	725	2.8	82.0	274
1966	214	9.7	3.55	745	2.8	82.1	292
1967	218	1.9	1.71	764	2.6	82.3	288
1968	209	−4.1	2.00	785	2.7	82.4	269
1969	211	1.0	1.45	807	2.8	82.5	263
1970	240	13.7	3.24	830	2.9	82.6	293
1971	250	4.2	0.55	852	2.7	82.7	294
1972	240	−4.0	1.84	872	2.3	82.9	277
1973	265	10.4	4.24	892	2.3	82.8	302
1974	275	3.8	4.48	909	1.9	82.8	307
1975	285	3.6	0.93	924	1.7	82.7	309
1976	286	0.4	0.60	937	1.4	82.6	306
1977	283	−1.0	5.69	950	1.4	82.4	304
1978	305	7.8	6.95	963	1.4	82.1	324
1979	332	8.9	10.71	975	1.2	81.0	351
1980	321	−3.3	11.81	987	1.2	80.6	337

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Table 4.3 *continued*

Year	Grain Output		Net Grain Imports (million tons)	Population			Per Capita Grain Availability (kilogram)
	Total (million tons)	Change over Previous Year (%)		Total (million)	Change over Previous Year (%)	Rural Population of Total (%)	
1981	325	1.2	13.48	1001	1.4	79.8	338
1982	354	8.9	15.34	1017	1.6	78.9	363
1983	387	9.3	12.38	1030	1.3	78.4	388
1984	407	5.2	7.22	1044	1.4	77.0	397
1985	379	−6.9	−3.32	1059	1.4	76.3	355
1986	392	3.4	−1.69	1075	1.5	75.5	363
1987	403	2.8	8.91	1093	1.7	74.7	377
1988	394	−2.2	8.16	1110	1.6	74.2	362
1989	408	3.6	10.02	1127	1.5	73.8	371
1990	446	9.3	7.47	1143	1.4	73.6	397
1991	435	−2.5	2.59	1158	1.3	73.1	378
1992	443	1.8	−1.90	1172	1.2	72.5	376
1993	456	2.9	−7.83	1185	1.1	72.0	378
1994	445	−2.4	−5.83	1198	1.1	71.5	367
1995	467	4.9	20.12	1211	1.1	71.0	402
1996	505	8.1	12.06	1224	1.1	69.5	422

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Table 4.3 *continued*

Year	Grain Output		Net Grain Imports (million tons)	Population			Per Capita Grain Availability (kilogram)
	Total (million tons)	Change over Previous Year (%)		Total (million)	Change over Previous Year (%)	Rural Population of Total (%)	
1997	494	−2.2	1.30	1236	1.0	68.1	401
1998	512	3.6	−2.45	1248	1.0	66.7	408
1999	508	−0.8	−0.11	1258	0.8	65.2	404
2000	462	−9.1	−0.48	1267	0.7	63.8	364
2001	453	−1.9	7.70	1276	0.7	62.3	361
2002	457	0.9	−0.98	1285	0.7	60.9	355
2003	431	−5.7	0.52	1292	0.5	59.5	334
2004	469	8.8	24.84	1300	0.6	58.2	380
2005	484	3.2	22.28	1308	0.6	57.0	387
2006	498	2.9	25.38	1314	0.5	55.7	398
2007	502	0.8	22.04	1321	0.5	54.1	397
2008	529	5.4	36.63	1328	0.5	53.0	426
2009	531	0.4	43.98	1335	0.5	51.7	431
2010	546	2.8	59.09	1341	0.4	50.1	451
2011	571	4.6	56.65	1347	0.4	48.7	466
2012	590	3.3	71.23	1354	0.5	47.4	488
2013	602	2.0	76.78	1361	0.5	46.3	499

Source: SSB, various issues.

Farmers, who were starving and constituted about 88% of the total population, consumed a large portion of the increased grain output (Table 4.3). Hence, food shortages, especially in urban areas, were still widespread. To have more grain under its own control for urban distribution, the government introduced a "unified grain procurement and sale system" in late 1953. This system was to procure grain from farmers and sell it to consumers through rations (the rations varied according to age, sex, and labor strength). The state grain agencies were the sole buyers and sellers in the market. A compulsory procurement quota and a government-set procurement price were two major instruments in this system. Under this scheme, a grain procurement quota was assigned to each individual farm household with surplus grain. Surplus grain is the quantity left over after a farmer retains grain for home consumption, seed, and feed according to standards set by local governments, and after the farmer pays agricultural tax. The quota accounted for 80%–90% of the surplus amount (Zhao and Qi 1988).

Grain output continued to increase from 1953 to 1957. Initially (1953–1954), farmers formed mutual-aid groups to overcome the inefficiency caused by limited capital, draught animals, or essential farming tools associated with very small-scale operations. In this type of cooperation, productive means were shared among group members, but all assets and harvests still belonged to individual households. This suited them and helped them improve harvests. Soon, however, the government encouraged or pushed farmers to join cooperatives, initially preliminary (1955–1956) and then advanced (1957).

To join the preliminary agricultural cooperatives, farmers surrendered all land to which they were entitled during the land reform to the cooperatives as part of their input contribution. Farmers were paid according to their labor and land contribution. Advanced cooperatives were based on the preliminary ones, but all means of production were collectivized. By now, farmers lost ownership of their means of production, including the land. Under the advanced cooperative arrangements, the results of farming were no longer directly related to one's effort. There were no incentives for farmers to work harder. In 1957, grain output increased only by 2 million tons (mt) compared with the previous year, the smallest increase since 1950.

Despite the continuous increase in grain output, the population was also increasing and at a faster rate. Hence, the extent of the improvement in per capita grain availability was modest during 1952–1958 (Table 4.3). Compared with 1957, total grain output in 1958 only registered a small increase of 5 mt, while per capita grain availability increased by only 1 kg, from 298 kg to 299 kg (Table 4.3). The Great Leap Forward campaign was responsible for the poor performance in grain production in 1958 and the following years, as explained below.

The Great Leap Forward campaign was chiefly based on Mao Zedong's political whim and was launched in January 1958. Its major purpose was to advance the PRC's economy rapidly so that it could quickly transform itself from a socialist society to a communist society, and catch up with the United Kingdom and exceed the United States in 15 years. At that time, it was believed that rapid development in the agricultural and industrial sectors should take place concurrently to advance the PRC's economy rapidly.

To achieve rapid development in the agricultural sector, it was believed that agricultural production should be further collectivized. By the end of September 1958, over 740,000 advanced cooperatives were converted to about 24,000 highly collectivized people's communes. Within a people's commune, there were production brigades at the next level and production teams at the lowest level. There were about 30 households in each production team. A village could be a production team (if the village was small) or two or more teams (if the village was larger). A production brigade could have just one village (if the village was very large) or a number of smaller villages. A people's commune was composed of a dozen or so production brigades. The commune became the principal economic, administrative, social, and political unit in the rural areas.

The establishment of the people's communes allowed government power to reach the grassroots of the rural community. In each people's commune, there was a party committee; in each production brigade, there was a party branch committee. This enabled the government to exercise absolute control over rural areas of the PRC. It also allowed the government to implement any policy or carry out any political whim in rural areas with little resistance—some of these were unreasonable, leading to disastrous consequences for rural society and the whole nation. A few examples follow.

Claiming unrealistic high yields. To please their supervisors and help demonstrate the superiority of the people's communes, some rural cadres inflated their grain yields. On 8 June 1958, *The People's Daily* reported that a production team in Henan Province's Sui Ping County achieved an average yield of 1007.5 kg per mu for wheat on a 5 mu plot (or 15,112.5 kg per hectare [ha][2]) (Guangzhou Archives 2007).[3] Opportunists elsewhere followed suit and became even bolder in inflating the yields. On 13 August 1958, the Xinhua News Agency reported that the paddy rice yield reached 18,450 kg per mu in Xi Jian Yuan People's Commune

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2 1 ha = 15 Chinese mu.

3 The world's highest ever achieved to date is 15,636 kg in New Zealand in 2010.

of Hubei Province's Macheng County (equivalent to 276,750 kg per ha).[4] By 25 September 1958, the reported yield reached 64,395 kg per ha for wheat and 978,263 kg per ha for rice (Guangzhou Archives 2007).[5]

Asking farmers to produce iron and steel. Producing iron and steel is not farmers' business and is not something that everyone can do. Yet, farmers were mobilized, like people in many other sectors, to build small backyard furnaces in every people's commune to produce iron and steel. Records show that some furnaces were even built in crop fields. A huge amount of resources was used. Many agricultural workers, especially strong male workers, were diverted from the harvest to help the steel production. The output consisted of low-quality pig iron, which was of negligible economic worth. Yet, the damage caused by such activities to food production and thus food security of the country was enormous, contributing to the widespread famine in the years that followed.

Wasting food through public dining halls. The public dining hall system was trialed in mid-1958. It soon became widespread across the country. By the end of 1958, there were 3.4 million public dining halls, in which some 90% of the rural population dined for all their meals. Initially, in many dining halls, food was rationed. Later, rations disappeared, and there was no limit on how much a person could eat. This induced overconsumption and led to a huge amount of food waste. Taking into account that the PRC did not produce the large amount of grain that some rural cadres boasted, plus the fact that the government procured more grain for urban supply, the grain available in rural areas could not last for long with such large-scale and unlimited consumption. Soon, many dining halls were short of food.

Following the Great Leap Forward, the total grain output dropped significantly, from 200 mt in 1958 to 170 mt in 1959, and down further to 143 mt in 1960. The 1960 output was even below that of 1951 (Table 4.3). While output dropped significantly and there was little grain stock, the PRC still net-exported grain during 1959–1960 (Table 4.3). Given that the population had increased (by more than 100 million at the end of the 1950s compared with that at the beginning of the 1950s), the consequence was sharply reduced per capita grain availability.

Many people starved, with farmers suffering the most. In many places, farmers' harvests were overprocured to feed urban people, leaving farmers starving. Famine started in pockets of the PRC in 1958 and spread further in 1959 (Yang 2008). It became widespread in 1960

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4 The world's highest paddy yield achieved to date is 22,400 kg per ha in India in 2011.

5 The exaggerated wheat yield in 1958 was four times the world record achieved in 2010, while for rice it was 43 times the world record achieved in 2011.

and 1961. The famine started to reduce in scale by mid-1961, but in some provinces such as Sichuang, it was still serious. By mid-1962, the famine gradually disappeared (Yang 2008; Wen and Liu 2010; He 2012). During this long-lasting, widespread, and severe famine, 37 million people died of hunger (Ding 1996; Dikötter 2010).[6]

Facing the famine and the large number of deaths, starting from 1960, the government allowed farmers some freedom in deciding what to produce. This helped. Grain output increased in 1961 and 1962 compared with the previous years, although only by a small margin. More measures were soon adopted to promote grain production. Some of the major measures included increasing prices for grain procured under the unified purchase system, giving higher prices to farmers who sold grain to the government above their quota, providing farmers with coupons to buy industrial goods as incentives if they sold grain to the government, and reopening rural fairs and allowing farmers to sell grain in the market (Zhao and Qi 1988). These measures worked and helped agricultural production recover.

During 1963–1965, grain output increased each year by an impressive margin. Nonetheless, by 1965, the output was still below the 1958 record level, i.e., 195 mt in 1965 versus 200 mt in 1958. During these years, a net of 4 mt of grain was imported. However, the imports could do little to raise per capita grain availability due to the fast recovery in population growth (from 673 million in 1962 to 725 million in 1965, a net increase of 52 million over 3 years). Per capita grain availability remained low during 1963–1965 (Tables 4.2 and 4.3).

In 1966, the total grain output reached 214 mt, surpassing its previous highest level, 200 mt in 1958. As soon as the grain situation eased, Mao Zedong launched the Cultural Revolution in 1966. The Cultural Revolution lasted for 10 years, with devastating consequences for the country's economy, including agricultural production. From 1967 to 1969, the growth rate of grain output went below that of the population growth rate, leading again to a major decline in per capita grain availability, from 292 kg in 1966 to 263 kg in 1969. Indeed, grain output in 1968 and 1969 suffered a major drop (Table 4.3).

Grain production increased slightly in the later years of the Cultural Revolution (1970–1976). In the meantime, the population increased very fast. The improvement in per capita grain availability was small, from 293 kg in 1970 to 306 kg in 1976.

During the Cultural Revolution, in 8 out of the 11 years, per capita grain availability went below that of 1956 (303 kg). It was only marginally

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[6] There have been disagreements about the actual number.

higher than the 1956 level in the other 3 years (Table 4.3). This is to say, over 20 years, there was little improvement in food availability in the PRC. The FAO per capita nutrition intake data show that from 1966 to 1976, the per capita energy intake had increased by a mere 10 kcal per day (from 1,884 kcal to 1,894 kcal), while protein intake dropped by 1.5 grams (from 48.6 grams to 47.1 grams) and fat intake increased by 0.2 grams (from 25.1 grams to 25.3 grams). The intake of these macronutrients was below daily requirements.

Food availability started to improve during 1977–1979. The end of the Cultural Revolution in 1976, when Mao died, saw an increasing trend in the grain output, from 283 mt in 1977 to 305 mt in 1978 and to 332 mt in 1979. In the meantime, net grain imports also increased, with the 1979 imports almost doubling the annual imports of the previous 2 years. The net imports in 1977 and 1978 were 5.69 mt and 6.95 mt, respectively; the imports in 1979 alone were 10.71 mt, the highest ever since the CPC came to power.

With increased grain output and imports, per capita grain availability saw a major jump. It increased from 304 kg in 1977 to 324 kg in 1978 and 351 kg in 1979 (Table 4.3). The FAO statistics also confirm the increased per capita nutrition intake during 1977–1979 (Table 4.2)

Following Mao's death in early September 1976, Hua Guofeng and later Deng Xiaoping started devoting more attention to economic reconstruction. In December 1978, the CPC's Third Plenum of the Eleventh Congress was held in Beijing. It is commonly held that the plenum officially marked the beginning of the economic reforms era in the PRC.

One important change in rural areas was that the government became less stringent in controlling what farmers could do. In such a slightly relaxed political environment, farmers started trying various methods to link their individual efforts more closely to the rewards that they got. In some places, members of a production team had subdivided the production team's land among themselves. They produced independently but agreed to hand over a set amount of the produce to the production team to fulfill the quota handed down by the higher administration, while retaining the rest. Such trials generated the momentum to revert to household-based farming from highly collectivized farming.

4.2.2 Food Abundance: 1980s to Date

In the early 1980s, many farmers were ready to revert to household-based farming, which had prevailed prior to 1955. During the 1963–1965 recovery, farmers in many areas were allowed to follow that

Table 4.4 Number and Proportion of Production Teams Adopting Agricultural Production Responsibility Systems, 1980–1982

	End January 1980		End June 1981		End June 1982	
	No. of Production Teams	% of Total	No. of Production Teams	% of Total	No. of Production Teams	% of Total
Total	4,795,900	100.0	5,879,778	100.0	6,027,940	100.0
With PRS	**4,070,402**	**84.9**	**5,593,693**	**95.1**	**5,981,133**	**99.2**
Fully household-based	1,087	0.023	661,663	11.3	4,040,629	67.0
Linking output to household only	49,267	1.0	994,890	16.9	297,517	4.9
Other methods	4,020,048	83.8	3,937,140	67.0	1,642,987	27.3
Without PRS	**725,498**	**15.1**	**286,085**	**4.9**	**46,807**	**0.8**

PRS = Production Responsibility System.
Source: Department of Planning (1983).

approach, which soon demonstrated to be most effective in boosting food output. During the Cultural Revolution, extreme leftist ideology again became dominant and more extreme. Household-based production was again banned and treated as capitalist behavior. Following Mao's death and in a less tightly controlled political environment, farmers were eager to go back to household-based operations.

Table 4.4 shows, by the end of June 1982, 99.2% of all production teams adopted various methods that linked effort to reward. Of the production teams, 67% chose to revert to fully household-based farm operations, increasing from less than 1% just 18 months before, in January 1980. By the end of 1983, almost 100% of farmers had chosen to go back to household-based farming. This time, there was no campaign, no coercion, but all farmers did so willingly.

The change had enormous impact on farmers' enthusiasm to work the land harder and smarter. It significantly boosted the PRC's grain output (Table 4.5, Panel A). By 1984, grain had become abundant in the country. Per capita grain availability increased rapidly, reaching 397 kg per capita, a high record (Table 4.3).

In 1985, the procurement side of the "unified grain procurement and sale system," which had been in place since 1953, was abolished and replaced with a contractual grain procurement system. This new approach reduced incentives for farmers who produced and sold more grain to the government and led to an overall drop in

Table 4.5 Output of Major Agrifood, 1978–2013 ('000 tons)

A: Output of Major Food Crops

	Grain	Rice	Wheat	Oil-Bearing Crops	Sugar Crops	Vegetables	Fruit
1978	304,765	136,930	53,840	5,218	23,819	NA	NA
1980	320,555	139,905	55,205	7,691	29,113	NA	NA
1985	379,108	168,569	85,805	15,784	60,468	NA	NA
1990	446,243	189,331	98,229	16,132	72,147	NA	18,744
1995	466,618	185,226	102,207	22,503	79,401	257,267	42,146
2000	462,175	187,908	99,636	29,548	76,353	NA	62,251
2001	452,637	177,580	93,873	28,649	86,551	484,224	66,580
2002	457,058	174,539	90,290	28,972	102,927	528,606	69,520
2003	430,695	160,656	86,488	28,110	96,416	540,323	145,174
2004	469,469	179,088	91,952	30,659	95,707	550,647	153,409
2005	484,022	180,588	97,445	30,771	94,519	564,515	161,201
2006	498,042	181,718	108,466	26,403	104,600	539,531	171,020
2007	501,603	186,034	109,298	25,687	121,882	564,520	181,363
2008	528,709	191,896	112,464	29,528	134,196	592,403	192,202
2009	530,821	195,103	115,115	31,543	122,766	618,238	203,955
2010	546,477	195,761	115,181	32,301	120,085	650,994	214,014
2011	571,208	201,001	117,401	33,068	125,165	679,297	227,682
2012	589,580	204,236	121,024	34,368	134,854	708,831	240,568
2013	601,938	203,612	121,926	35,170	137,461	NA	250,930

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Table 4.5 *continued*

B: Output of Major Animal Products

	Total Meat	Pork, Beef, Mutton	Pork	Poultry	Eggs	Milk	Aquatic Products
1978	8,563	8,563	NA	NA	NA	971	4,590
1980	12,054	12,054	11,341	NA	NA	1,367	4,497
1985	19,265	17,607	16,547	1,602	5,347	2,894	7,052
1994	28,570	25,135	22,811	3,229	7,946	4,751	12,370
1995	52,601	42,653	36,484	9,347	16,767	6,728	25,172
2000	60,139	47,432	39,660	11,911	21,820	9,191	37,062
2001	61,058	48,321	40,517	11,761	22,101	11,229	37,959
2002	62,343	49,284	41,231	11,971	22,657	14,004	39,549
2003	64,433	50,898	42,386	12,390	23,331	18,486	40,770
2004	66,087	52,343	43,410	12,578	23,706	23,684	42,466
2005	69,389	54,735	45,553	13,442	24,381	28,648	44,199
2006	70,890	55,910	46,505	13,631	24,240	33,025	45,836
2007	68,657	52,838	42,878	14,476	25,290	36,334	47,475
2008	72,787	56,140	46,205	15,337	27,022	37,815	48,956
2009	76,497	59,157	48,908	NA	27,425	36,777	51,164
2010	79,258	61,231	50,712	NA	27,627	37,480	53,730
2011	79,651	61,011	50,604	17,088	28,114	38,107	56,032
2012	83,872	64,059	53,427	NA	28,612	38,754	59,077
2013	85,350	65,744	54,930	17,984	28,761	36,495	61,720

NA = not available, PRC= People's Republic of China.

Source: SSB, various issues.

grain output (Tian 1990; Zhou 1997). Various modifications were subsequently made to the contractual system over the following years. By 1993, grain procurement through contracts was abandoned in many parts of the country. Also in 1993, the "unified grain sale system" was abolished.

From 1994 onward, urban residents purchased food grain in the market at market prices. Government grain procurement (for reserve purposes) was also done at market prices. Starting in 1997, guaranteed procurement of grain at state-set floor prices was introduced for major cereals (such as rice, wheat, and maize) to encourage farmers to stay in grain production and increase their income. In 1998, the grain harvest was at a record high of 512 mt. Grain was easily available in the market at a stable price (Zhou 2015).

With the rural reforms, while grain output increased, the output of all other food also increased. Comparing 2013 and 1978, the output of some food doubled, while most more than doubled (Table 4.5, Panel B). The increase in the output of sugar crops, vegetables, fruit, meat, poultry and eggs, milk, and aquatic products is impressive.

The increased food availability improved the per capita consumption of more and diverse food. The increased consumption of other food resulted in a decline in the consumption of grain in both rural and urban areas, a phenomenon that took place in urban areas first (Table 4.6). Direct consumption of grain per person has largely stabilized in urban areas but is still declining in rural areas. On the other hand, the intake of most other food, such as meat, eggs, and aquatic products, has been increasing in both rural and urban areas (Zhou 2015).

4.3 Key Determinants of Food Security

The PRC's food security practice as highlighted in the previous section raises a number of questions. Why did the food shortages become so acute that many people died of hunger during 1958–1962? Why did the food supply again become so short during 1966–1976? Indeed, why was the improvement in the food supply so negligible for over 2 decades with the per capita food availability in 1978 being still below that of 1952? Then, how could the food supply have become so abundant even though the per capita agricultural resources had been declining since the early 1980s? Answers to such questions can be valuable for both the PRC and other countries to learn from the PRC's past lessons and experiences in managing food security. Identified below are the key determinants that caused the PRC's food insecurity before the 1980s and contributed to improved food security since.

Table 4.6 Per Capita Food Consumption in Rural and Urban Areas, 1978–2012 (kg)

	Grain	Vegetables	Cooking Oil	Meat	Poultry	Eggs	Aquatic Products	Sugar	Alcoholic Drinks	Milk and Dairy Products
Rural										
1978	248	142	1.96	5.76	0.25	0.80	0.84	0.73	1.22	NA
1980	257	127	2.49	7.75	0.66	1.20	1.10	1.06	1.89	NA
1985	257	131	4.04	10.97	1.03	2.05	1.64	1.46	4.37	NA
1990	262	135	5.17	11.34	1.26	2.41	2.13	1.50	6.14	NA
1995	259	105	5.80	11.29	1.83	3.22	3.36	1.28	6.53	0.64
2000	250	107	5.45	14.41	2.81	4.77	3.92	1.28	7.02	1.06
2001	239	109	5.51	14.50	2.87	4.72	4.12	1.43	7.10	1.20
2002	237	111	5.77	14.87	2.91	4.66	4.36	1.64	7.49	1.19
2003	222	107	5.31	15.04	3.20	4.81	4.65	1.24	7.67	1.71
2004	218	107	4.31	14.76	3.13	4.59	4.49	1.11	7.84	1.98
2005	209	102	4.90	17.09	3.67	4.71	4.94	1.13	9.59	2.86
2006	206	101	5.84	17.03	3.51	5.00	5.01	1.09	9.97	3.15
2007	199	99	5.96	14.88	3.86	4.72	5.36	1.07	10.18	3.52
2008	199	100	6.25	13.94	4.36	5.43	5.25	1.11	9.67	3.43
2009	189	98	6.25	15.33	4.25	5.32	5.27	1.07	10.08	3.60
2010	181	93	6.31	15.80	4.17	5.12	5.15	1.03	9.74	3.55
2011	171	89	7.48	16.32	4.54	5.40	5.36	1.04	10.15	5.16
2012	164	85	7.80	16.40	4.50	5.90	5.40	1.20	10.00	NA

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Table 4.6 *continued*

	Grain	Vegetables	Cooking Oil	Meat	Poultry	Eggs	Aquatic Products	Sugar	Alcoholic Drinks	Milk and Dairy Products
Urban										
1982	145	159	5.78	18.67	2.26	5.88	7.67	2.80	4.48	NA
1985	135	144	5.76	19.32	3.24	6.84	7.08	2.52	7.80	NA
1990	131	139	6.40	21.74	3.42	7.25	7.69	2.14	9.25	4.6
1995	97	116	7.11	19.68	3.97	9.74	9.20	1.68	9.93	4.6
2000	82	115	8.16	20.06	5.44	11.21	11.74	1.70	10.01	11.55
2001	80	116	8.08	19.12	5.30	10.41	10.33	1.67	9.68	13.76
2002	78	117	8.52	23.28	9.24	10.56	13.20	NA	9.12	18.12
2003	80	118	9.20	23.74	9.20	11.19	13.35	NA	9.39	21.71
2004	78	122	9.29	22.85	6.37	10.35	12.48	NA	8.94	22.19
2005	77	119	9.25	23.86	8.97	10.40	12.55	NA	8.85	21.67
2006	76	118	9.38	23.78	8.34	10.41	12.95	NA	9.12	22.54
2007	78	118	9.63	22.14	9.66	10.33	14.20	NA	9.14	22.17
2008	NA	123	10.27	22.70	8.00	10.74	14.00	NA	NA	19.30
2009	81	120	9.67	24.20	10.47	10.57	14.30	NA	NA	19.27
2010	82	116	8.84	24.51	10.21	10.00	15.20	NA	7.00	18.10
2011	81	115	9.26	24.58	10.59	10.12	14.62	NA	6.76	NA
2012	79	112	9.10	24.90	10.80	10.50	15.20	NA	6.90	NA

kg = kilogram, NA = not available.

Note: Meat includes pork, beef, and mutton/lamb.

Source: SSB, various issues.

4.3.1 Factors Responsible for Food Insecurity

Collectivization

Collectivization is one of the major factors responsible for the PRC's food shortages for so long. From the preceding discussions, it is clear that under collectivized farming arrangements, individuals had no incentives to work hard when their rewards were not connected to their efforts. This reduced the food output level that was essential to ensure an adequate level of food supply. A number of researchers have also pointed out the extreme negative impact of collectivization on food output prior to the 1980s (e.g., Lin 1987). As soon as collectivization was abandoned, the PRC's food output increased impressively, as evidenced in Table 4.5.

Totalitarian System

By 1958, the PRC had become a highly planned economy through two major campaigns. One was the establishment of the people's commune. The other was the "reform" of urban private businesses into "socialist" businesses (i.e., to become state-owned or collectively owned; in many cases, there was confiscation or forced handover of assets to the government). Together with its ability to tightly control many other aspects of people's lives (e.g., education, art, media, science, private life, and morals of citizens) following a series of other campaigns since 1950, the government had become a totalitarian regime (Yang 2008).[7]

Through the highly planned economy, the totalitarian government monopolized all production resources, controlling the production, circulation, and distribution of all goods and services. Government resource monopolization and the strictly planned economy destroyed the incentives of individual producers, leading to severe shortages in the supply of virtually all essential goods and services and, of course, food (Yang 2008; Yang n.d.).

The totalitarian system was the fundamental reason why the Great Famine occurred during 1958–1962 (Yang 2008; Liu 2010). The firm control of the rural areas through the people's communes entailed many strange things such as inflating grain output by rural cadres and forcing farmers to produce iron and steel. The unified grain procurement system enabled the government, through the collaboration of rural cadres of the people's communes, to overprocure grain from farmers, leaving farmers insufficient food for their consumption. The public dining halls under

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[7] Other major campaigns between 1950 and 1957 include land reforms (1950–1952), suppression of counter-revolutionists (1950–1951), and the anti-rightists campaign in 1957.

the people's communes completely controlled farmers' access to food (Liu 2010).

Since the 1980s, there have been significant reforms in the PRC's society. These changes, however, have been largely concentrated in economic areas, which has enabled the markets to play a greater role and rendered producers with more incentives to produce. The political side of the totalitarian system remains little changed. It has continued to undermine the PRC's ability to achieve higher levels of food security. Its negative impacts on attaining a higher level of food security are many, as will be discussed in the rest of the chapter, with some major ones being the lack of media freedom, inability to constrain corruption, and various problems caused by the lack of transparency in government operations. The tight political control will continue to be a source of concern for the PRC to achieve a higher level of food security in the long run, as has also been pointed out by Becker (1996), "since the secrecy and dictatorship which made [the 1958–1962 Great Famine] possible still exist, it should serve as a terrible warning against what might happen again."

Lack of Error-Correcting Mechanisms

Because of the wide and strict control of all aspects of life under the totalitarian regime, it became hardly possible for anyone, either within or outside the party and/or bureaucratic system, to comment on or criticize any doings of the CPC government without ramification. As a result of the various and continuous political campaigns between 1950 and 1957, many people outside the party and/or bureaucratic system who tried to help the government by offering constructive suggestions were prosecuted or killed, while those who survived were too scared to express their views. Within the party and/or bureaucratic system, many also did not dare to express their views. The media had no freedom either to report true stories of what was going on in the country.

So, when food shortages became widespread and the famine emerged, transmission of accurate information upward to the government was limited. Due to the lack of a mechanism with which the government could be timely informed of the consequences of ill-conceived policies, many wrong policies could be continued (Yang 2008). For example, the practice of the public dining halls was proven to be disastrous. Yet the CPC government still insisted in a document issued on 3 November 1960 that people's communes should continue to run dining halls. It even emphasized that "the key to run dining halls well is to have politics into dining halls and to have rural cadres into kitchens" (CPC 1960). The fact is that by that time, the famine had

already become widespread, and millions of people had already died of starvation, for which the compulsory adoption of public dining halls is held largely responsible (Wen and Liu 2010).

The other example is that the high-level collectivization of agricultural production was detrimental to the PRC's food supply; yet dissolving the people's communes and reverting back to household-based operations was not easy. Before Mao died, it was absolutely impossible. Even after Mao's death, it was still met with resistance.

When there were no mechanisms that could help the government correct its own policy mistakes, often its ill-conceived policies were followed unnecessarily longer, causing serious damage to agricultural production and to the whole economy. Since the 1980s, especially after the advent of the Internet and its wide adoption, which has made exchanges easier, there have been improvements from the government's side in listening to opinions from the broad community, and in particular, from researchers. However, fundamental improvements are yet to emerge.

Government Officials Not Accountable to the People

In the PRC, government officials were appointed by their superiors but not really elected by the citizens. They had strong incentives to please their superiors but little incentive to serve the citizens under their jurisdiction. Because they were not held responsible to the citizens, the rewards to them and their promotion largely rested on how they kept their superiors happy. If their superiors did not want to hear negative news, they would not report negative news to them. Instead they reported, or fabricated, whatever their superiors wanted to hear. They could also carry out whatever their superiors asked them to do even though they knew those policies could lead to disasters.

During the times when food was seriously short, many officials also showed that they were selfish and had little integrity. They lacked basic human compassion, fairness, and justice. They used limited food resources for themselves and their immediate family members but at the cost of others' lives. During the Great Leap Forward and the Great Famine, many of them rendered little assistance to, instead inflicted more harshness on, the suffering farmers. Yet, after the famine, and in fact to date, very few have shown remorse for the miseries that they caused to many ordinary people. Many of them even got further promoted within the party and/or government system.

Lack of Economic Management Capabilities

Many senior officials working in the new government between 1950 and 1980 were military generals and strategists. They had limited

knowledge or expertise to manage a country's economy. At the lower level of the administration, many officers from the People's Liberation Army were appointed to manage although they lacked basic economic management skills. Since the early 1980s, there have been improvements; the country has gradually opened up to the rest of the world, and the subsequent international exchanges have helped the PRC introduce of economic management. However, mechanisms through which the formation and implementation of government policies can seek feedback from the broad community are yet to be developed and formalized.

4.3.2 Factors for Improved Food Security

Reverting to Household-Based Farming

Reverting to household-based farming in the early 1980s was fundamental to bringing about improvements in the PRC's food security and society at large. Family-based farming rapidly boosted food and other agricultural produce. The increased output enabled many people to have more food to eat and to have warmer clothes to wear, and also contributed to earning foreign exchange that was then used to import essential items for the development of other industries. Family-based farming will remain the most appropriate farming model for the PRC in today's environment, although how it may evolve in the future is to be seen.

Reintroducing a Market Mechanism into the Economy

Allowing the market to play an increasing role in the economy has been another important factor that has helped the PRC improve its food security. The PRC's experience has demonstrated that highly central planning is ineffective and inefficient. A market mechanism can work better in coordinating the allocation of resources than the centrally planned approach. The reintroduction and functioning of the market has encouraged a further increase in food output as well as brought about the supply of diverse food.

Reopening the Door of the Country

Another important contributing factor to the PRC's improved food security is the reopening of the country's doors to the international community after 3 decades of isolation. The benefits of the open-door policy have been multiple, such as access to more advanced production technologies and management know-how, opportunities for students to study at overseas universities, and attraction of foreign investments into the PRC. However, the greatest benefit of the open-door policy, as far

as food security is concerned, is the opportunity to engage in food trade with the rest of the world.

Food trade has enabled the PRC to secure food from more sources and secure diverse food to meet the growing food demand of more affluent consumers. This helps the PRC make better use of its comparative advantage to gain more benefits from trade as well as overcome domestic resource shortages. Table 4.3 shows that since 2000, the PRC's net grain imports have been increasing at a fast pace. The imports are equivalent to the expansion of the PRC's arable land, of which the PRC is short by a huge margin. Let us take soybeans as an example. Soybean imports account for the majority of the PRC's grain imports (over 80%). The net imports in 2013 were 63 mt. The yield of soybeans in the PRC in the early 2010s has been around 1.85 ton per ha. Hence, soybean imports alone saved the PRC over 34 million ha of arable land or, in other words, helped the PRC expand its arable land by over 34 million ha. Without trade, the PRC's food availability and diversity would not have been as comfortable as they are today.

Government Emphasis on Ensuring Food Supply

Since the 1980s, the government has paid increased attention to ensuring an adequate amount of food available to the huge population. Such emphasis is reflected in the development of various policies aimed at improving the food supply and the increasing amount of resources allocated to improving the food supply. Not all of these policy efforts can be regarded as successful. Some of them, perhaps, did not make proper use of comparative advantages, were harmful to the sustainable use of resources, or were counterproductive. One phenomenon related to the government's management of food supply is that on the one hand, when the supply becomes more comfortable, complacency prevails; on the other hand, when the supply is tight, even if it was perceived as such, anxiety dominates. The government can become overly worried even if a member of the public such as Lester Brown said something about the PRC's food supply. In 1995, when Brown's *Who Will Feed China* was published, this activated enormous panic within the government, followed by a reignited emphasis on increasing domestic food production. Nonetheless, government efforts have been instrumental, drawing attention from the broader society to improving the food supply in the country.

Policy Efforts for Improved Food Security

In addition to permitting farmers to revert to family-based farming and allowing markets to work in the economy, other policies have also been

developed since the early 1980s that have contributed to improving food security in different ways. These policies have focused on

- enhancing domestic food production;
- facilitating food market development and food processing;
- increasing support and subsidy to food production and marketing;
- establishing and maintaining grain reserve stocks;
- expanding existing and building new rural infrastructure such as roads, irrigation facilities, electricity networks, mobile phone coverage, and internet access;
- shifting from food subsidy to income subsidy for low-income consumers; and
- making use of the world food market.

Zhao and Qi (1988) and Editorial Board (2001) provided detailed records of grain policies between 1978 and 2000. More recent policies are available from government websites such as the State Council of the People's Republic of China, the Ministry of Commerce, the Ministry of Agriculture, and the National Development and Reform Commission. The CPC also has a collection of its policy documents available on the Internet.

Since the economic reforms in the early 1980s, the government's capability to handle the country's food supply has been increasing. It has also gradually started developing a longer-term vision for a more secure food supply for the country. This is reflected in the development of three major documents aimed at securing the food supply. In 2008, the government issued its first medium- and long-term national grain security plan (2008–2020) (Government of the People's Republic of China 2008). In 2013, a national plan for beef and lamb production (2013–2020) was developed (Government of the People's Republic of China 2013). The culmination of the government's efforts in boosting the country's food security to date is its attempt to develop a "Grains Act"—the first attempt in the PRC's history to ensure the provision of staple food to its citizens, especially low-income groups, through legislation.

The development of a grains act is a significant move in the right direction. The government made public the preliminary draft of the proposed Grains Act in February 2012 to solicit comments and suggestions (Legislative Affairs Office 2012). In November 2014, a revised version was published to seek further comments and suggestions (Legislative Affairs Office 2014). The draft act has set standards or targets for the PRC to follow in the management of its food economy. It has not yet been officially promulgated. When promulgated, how it would be implemented deserves attention.

We have identified the major factors that resulted in the food scarcity prior to the 1980s and food abundance since the 1980s. The most fundamental force that promoted or caused the changes, however, was the institutional changes that took place after Mao's death. Chapter 1 of this book points out that there are five primary institutions in any society—family, political (or governmental), economic, educational, and religious. These five institutions may affect the food security of a country in various ways, e.g., directly or indirectly, large or small, positively or negatively. It is noted, however, that changes to the institutions in the PRC have been minimal, except in the case of economic institutions. The abovementioned major factors responsible for the improved food supply are largely economically related. Hence, changes in economic institutions, most importantly the reinstallation of incentives to individual farmers and the reintroduction of markets, are primarily responsible for the improved status of food security in the PRC.

As a result of many changes in the economic institutions and thus more freedom in economic activities, the PRC's governmental institutions may no longer be regarded as totalitarian, although there have been no fundamental changes in the government or political institutions. Instead, it may have evolved into authoritarianism.[8] The lack of fundamental changes in the political institutions to make the government responsible to the people and to make government operations transparent has resulted in many serious problems. Some of these problems include widespread corruption, widening income inequality, and serious damage to natural resources. All such problems have been major impediments to the PRC achieving a higher level of food security. In the next section, we evaluate the PRC's current food security status and how these problems undermine its long-term food security.

4.4 Food Security Today: Status and Challenges

Food is plentiful in the PRC today. However, is food abundance equal to food security? This depends on how we define food security and against which criteria food security is evaluated. Based on the definition and the evaluation framework provided by Oshaug, Eide, and Eide (1994) as presented in Chapter 2, this section assesses the PRC's current food security status. It also addresses the challenges that the PRC is facing

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[8] In this chapter, the definitions of totalitarianism and authoritarianism are based on *Encyclopædia Britannica* (2015a, 2015b).

and the countermeasures it may need to deploy in its future quest for improved food security.

4.4.1 Current Status of Food Security

Food Supply and Nutritional Adequacy

At the national level, as noted earlier, the food supply is abundant. Table 4.5 shows that the total output of most food items has continuously increased in the past 3 decades. On a per capita basis, both food availability and consumption levels have improved. While the consumption of grain has declined, the consumption of many other food items, especially higher-valued food, has steadily increased (Table 4.6). The FAO statistics confirm that nutrition supply in the PRC has been more than adequate since the 1990s (Table 4.7).

Not only is the food supply adequate, the level of nutrition intake is also adequate. The latest nationwide survey of the status of nutrition intake was conducted in late 2002. According to the survey report, nutrition intake by residents of the PRC has notably improved and is largely adequate (Ministry of Health 2004). The intake of energy and protein is comparable to the dietary reference intake. In terms of fat intake, at the national level, the average proportion of energy supplied by fat is 29.8%, which is higher than the dietary reference intake.

The PRC also has sizable grain reserves. According to the FAO, a ratio of cereal stock to cereal utilization on an annual basis at 17%–18% would be the minimum necessary to safeguard a country's food security. The PRC does not publicize its reserve levels. Occasionally, government sources hint that the reserve level is above or well above the minimum level as prescribed by the FAO (*ChinaCom* 2002; Yinsha 2005; Sichuan Agricultural Information Network 2009). The PRC's current annual consumption of cereals (unprocessed) (2010–2012 average) is roughly 500 mt. Then, conservatively, the PRC's cereal reserve would be about 100 mt. In fact, there are reports that the reserve amount is too high (China Daily Blog 2013; Duan 2013).

Food Safety and Quality

While having an adequate amount of food to eat is no longer a problem for most citizens of the PRC, having safe and high-quality food has become a major issue. Some food available for consumption is unsafe. If an Internet search is done with the key words "the PRC's food safety," it will lead to many websites showing news or facts on unsafe food.

The widespread existence of unsafe and low-quality food in the PRC market is due to three major reasons: contamination during production, contamination during processing, and the overall deteriorating

Table 4.7 Nutrition Supply Adequacy, 1990–2014

	Dietary Energy Supply (DES) (kcal/capita/day)	Average Dietary Energy Requirement (ADER) (kcal/capita/day)	Average Dietary Energy Supply Adequacy (DES/ADER) (%)	Average Protein Supply (g/capita/day)	Average Fat Supply (g/capita/day)
1990–1992	2,475	2,333	106	65	55
1991–1993	2,488	2,336	106	67	57
1992–1994	2,544	2,343	109	70	60
1993–1995	2,622	2,351	112	73	63
1994–1996	2,673	2,361	113	76	65
1995–1997	2,712	2,372	114	78	67
1996–1998	2,737	2,382	115	79	68
1997–1999	2,760	2,391	115	80	71
1998–2000	2,786	2,401	116	82	73
1999–2001	2,800	2,411	116	83	75
2000–2002	2,822	2,421	117	84	76
2001–2003	2,829	2,431	116	84	78
2002–2004	2,843	2,440	117	85	79
2003–2005	2,858	2,448	117	86	81

continued on next page

Table 4.7 *continued*

	Dietary Energy Supply (DES) (kcal/capita/day)	Average Dietary Energy Requirement (ADER) (kcal/capita/day)	Average Dietary Energy Supply Adequacy (DES/ADER) (%)	Average Protein Supply (g/capita/day)	Average Fat Supply (g/capita/day)
2004–2006	2,874	2,453	117	87	83
2005–2007	2,894	2,457	118	88	85
2006–2008	2,925	2,459	119	89	87
2007–2009	2,961	2,460	120	91	89
2008–2010	3,003	2,460	122	93	92
2009–2011	3,036	2,459	123	94	93
2010–2012	3,064	2,457	125		
2011–2013	3,086	2,454	126		
2012–2014	3,102	2,450	127		

g = gram, kcal = kilocalories, PRC = People's Republic of China.
Source: Based on FAO (2014a).

environment. Food may already have been contaminated, consciously or unconsciously, during production. Some producers (i) overuse pesticides and other chemicals in food crop production, (ii) harvest and sell crops on which pesticides and other chemicals have been applied but the food is not safe yet for consumption, (iii) use prohibited pesticides and other chemicals in crop production (*Beijing Evening News* 2013; Jingji Banxiaoshi 2013), and (iv) use prohibited chemicals to feed animals to promote faster growth and/or to prevent disease. For example, feeding pigs with clenbuterol hydrochloride to develop more muscle (and less fat) tissue, feeding chickens with excessive carophyll red to produce eggs with red yolks, and feeding swamp eels with pills to enhance their growth (Qiao, Guo, and Klein 2012).

To make matters worse, during food processing and retailing, harmful ingredients or chemicals are sometimes added to improve marketability and profitability. For example, chemical whiteners have been used to produce steamed buns to make them look whiter and more attractive to buyers; detergent powder has been added to flour to produce flour sticks (*you tiao*) and make them look larger; meat has been injected with water to increase weight; the carcinogenic red dye Sudan I has been used to make food look attractive; dishes have been cooked with oils recycled from restaurant drains; and poisonous pesticides have been used in the production of ham (Zhou 2015).

The other reason for unsafe and low-quality food is the severe pollution to the environment in which food is produced. It is hard to find many places in the PRC today that have clean air, soil, and water. It is difficult to produce clean, safe, and high-quality food in such an environment.

The problem of unsafe and low-quality food has become worse since the early 1990s. The question is why such a problem has not been curtailed, avoided given that the problem has been in existence for over 20 years and that food safety is fundamentally important for human health. Two major factors are responsible for such a recurring problem. First, the penalties for producing, processing, and selling unsafe food are too low to discourage such unethical acts. Second, the government's surveillance system is corrupt and is not in a position to tackle such problems.

Cultural Acceptability

There are no major issues in the PRC as far as the cultural acceptability of food is concerned. People pay enormous attention to eating. They care about food appearance, presentation, and diversity. Cooking professionals and food processing industries have been innovative in inventing new food for their customers that is culturally acceptable.

In fact, the PRC is a society in which people eat almost anything, including offal of various animals. Many citizens are fond of eating wild animals and plants, especially if these animals and plants are rare. One major problem caused by this kind of inclination is the threat to biodiversity, especially the presence of some endangered species.

While the Han population dominates in the PRC (accounting for over 95% of the total population), there is also a sizable Muslim population (about 2% of the total population). Muslim people have dietary habits that require special catering, especially in the supply of beef and lamb, in addition to various other halal-certified food. The food supply to cater to such needs occupies an important place in the government's overall food supply plan due to associated political sensitivities in dealing with the Muslim population. In August 2013, the government publicized its 2013–2020 national plan for beef and lamb production. The importance of ensuring an adequate supply of beef and lamb to the Muslim population is emphasized in the very first sentence of the plan (Government of the People's Republic of China 2013). Occasionally, adulteration to halal food does occur (Khaliq 2013; World Bulletin 2013).

Environmental Sustainability

The PRC's recent fast economic growth has placed enormous strains on agricultural production resources in two major ways. One is the deviation of scarce resources (chiefly land and water) for nonagricultural uses; the other is the serious damage to the quality of agricultural production resources through pollution to air, water, and soil. Both have ramifications on future food production capabilities and thus long-term food security (Zhou 2010).

At the beginning of the PRC's economic takeoff in the 1980s, little attention was given to the management of natural resources for sustainable use. Thus, damage to the environment has occurred and accumulated over the past 30 years. Today, environmental degradation is serious and widespread. On a stroll around fields in the PRC's rural areas, especially in populous regions, many polluted water bodies or watercourses can be spotted. Looking at the water is distressing, considering that it is used to water crops and produce aquatic food. Given that a large amount of food is produced in a vastly degraded environment, it makes producing safe and quality food formidable.

There have been increased efforts, both from the governments (at different levels) and some small environment-conscious groups, to curtail the damage to the environment. Unfortunately, pollution to the environment continues today. Some firms continue to pollute watercourses, soil, and the air, illegally or sometimes even with

"protection" from local authorities (addicted to pursuing higher gross domestic product growth, many local governments tolerate or allow firms to pollute the environment). When firms are required to treat the pollutants discharged, instead of doing the right thing to treat and reduce pollution, many find ways to cheat to keep their costs low. For example, there have been reports that some firms dig wells and inject pollutants into deep soil, causing pollution to underground water (*Beijing News* 2013; Dai 2013). Such practices will cause enormous prolonged consequences to the land and water resources that will take centuries to fix, if possible at all. Other ways through which the environment is damaged include chemical residue from farming activities and emissions from the large and increasing number of motor vehicles.

The severely polluted environment has made producing quality food difficult. How the damaged environment will affect the quantity of food produced in the future is to be seen. It will take a long time to restore environmental stability and sustainability. It will continue to be an issue that will haunt the PRC society for a long time.

Social Stability

The adequacy of the food supply at the national level as presented earlier does not necessarily mean that all people in the PRC have adequate access to food. Although extreme nutrition deficiency due to lack of food access is rare, cases exist where households have difficulty in securing an adequate amount of food. Due to the ever-rising expenses of education, health care, and accommodation, some families have to reduce food consumption to meet other needs. According to the latest FAO estimation, currently, there are still about 134 million people in the PRC who are undernourished. This is 10% of the total population.

In today's PRC, it is still common for some parents to financially support their adult children who have no income due to unemployment or low salaries. The pressure resulting from rising nonfood expenditure on low-income households is large and increasing. Unfortunately, due to the high level of inflation, prices for everything, including those of food, have been rising quickly in the PRC in recent years. (Consumer price index [CPI] calculation in the PRC does not include house mortgage payments. House prices have gone up enormously. For example, in some parts of Beijing, the price in 2014 is 600% higher than that in 2004. Hence, the CPIs published by the official sources are low estimates.)

If family income increases faster than expenditure, then the increase in expenditure may not cause too many major financial difficulties.

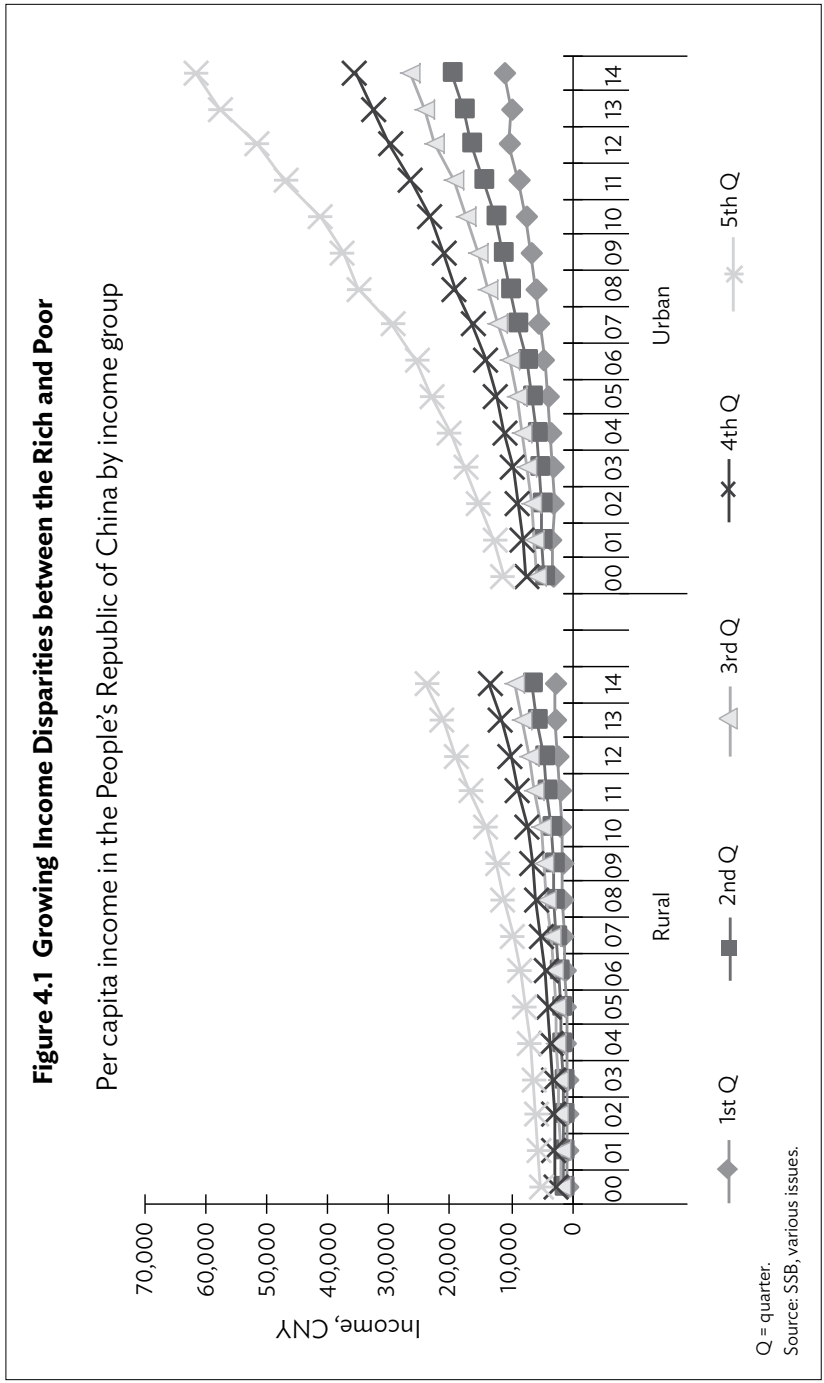
Figure 4.1 Growing Income Disparities between the Rich and Poor
Per capita income in the People's Republic of China by income group
Income, CNY
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14
Rural
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14
Urban
1st Q
2nd Q
3rd Q
4th Q
5th Q
Q = quarter.
Source: SSB, various issues.

However, in the PRC, wealth has become increasingly concentrated in the hands of a small portion of residents. The income gap between the rich and poor has been widening both within and between rural and urban areas (Figure 4.1).

In Figure 4.1, residents are placed into five quintiles according to their income, from low to high. The growing income inequality as shown is disappointing and disturbing, and has become a major cause of concern for social stability. For low-income residents, especially those in rural areas, their income is not enough to cover normal expenditure. Data show that the savings of rural residents falling into the bottom 20% (the first quintile) was negative from 2002 to 2011. Those falling in the second quintile fared only slightly better: in the 10-year period, they had two negative savings. However, their positive savings in other years were very minimal (SSB, various issues).

The above assessment of the current status of food security in the PRC suggests that at the national level, the people have had plenty of food to eat since the 1980s. This is an enormous achievement. With reference to the framework of Oshaug, Eide, and Eide (1994) (presented in Chapter 2), there are, however, aspects of food security that represent major challenges for the PRC. These include, concerns over food safety and quality due to the widespread and prolonged presence of unsafe and low-quality food, depletion and pollution of natural resources impacting the sustainability of long-term food production and supply, and growing income inequality undermining social stability and the poor's access to food. The major challenges and their possible countermeasures are addressed below.

4.4.2 Challenges and Countermeasures

Securing a Sustainable Food Supply

The availability of food is the most fundamental dimension of food security. Food supply in the distant future is unlikely to be a major issue for the PRC due to the foreseen population decline. For the present and the medium-term future, however, securing sufficient food for the huge population is still an enormous challenge. The PRC will have to use imports in the next several decades while trying very hard to produce as much as possible domestically so long as its comparative advantages permit.

The government is aware of the importance of supplying food to its citizens primarily with domestic resources. In its Outlines of Medium- and Long-Term National Grain Security Plan (2008–2020), the government emphasizes the need to achieve a very high level of self-sufficiency in wheat and rice (100%), and maize (95%) (Government of the People's Republic of China 2008).

A high level of self-sufficiency may be achievable only if the PRC can manage to effectively preserve its food production resources and to ensure an adequate level of investment to boost agricultural productivity. The PRC has invested impressively in agriculture in the past. However, preserving natural resources, both in quantity and quality, for food production is a formidable challenge. In the past 3 decades, resources have been continuously deviated from agriculture for the purpose of industrialization and urbanization. The future may see more agricultural resources (chiefly land and water) to be used for nonagricultural purposes due to the lower comparative advantage of agricultural production. Given limited natural resources, balancing the conflicting needs from agricultural and nonagricultural use represents a major challenge for the government.

Safeguarding the quality of resources is an important part of preserving the PRC's food production capacity. Otherwise, some of these resources may become unsuitable for producing food or may only produce food of low safety and quality standards. The PRC has to curtail and eventually stop polluting the environment. This requires firms not to discharge untreated pollutants, farmers to use agricultural chemicals appropriately and to farm sustainably, and citizens to reduce waste and dispose of waste responsibly.

Education is the key to encourage citizens to be more environment-conscious and friendly. Policing environmentally unfriendly acts by firm owners, factory workers, farmers, and the general public is not practical. When all citizens become conscious of protecting the environment, environment damage will be reduced. Severe penalties should be applied to those who deliberately damage the environment, resulting in serious consequences.

The PRC will continue to import food to meet any shortage of domestic supply. The imports will continue to increase into the medium future. How the PRC will secure the sources of imports is a major challenge. When the PRC trades food in the world market, there is the "the PRC effect," i.e., when the PRC net imports or exports food, prices in the world market might increase or decline by a large margin. To mitigate any large price escalation when the PRC net imports and imports a large quantity, an "agriculture going-out" strategy has been put into practice. This is a practical initiative on the PRC's part. However, to date, progress has been unimpressive and success low.

To improve the chances of success, some improvements to how the going-out strategy is executed are warranted. First, it is important to ensure that the outbound agricultural investment is private rather than through government-funded business activities. Private entrepreneurs have greater desire for success. Second, training programs should

be developed for and provided to entrepreneurs for their overseas ventures. These entrepreneurs must gain an adequate understanding of the business environment of host countries. They need to be instructed to follow local business rules and etiquette to conduct their business rather than those they use at home. Third, as a country, the PRC needs to develop a mentality that food produced by the going-out investments need not be directly exported to the PRC to boost its food supply, but rather they can be sold to anyone from any country so that the global pool of food increases. Investing overseas with an intention to sell the harvests back to the PRC is a recipe for failure. When the PRC invests overseas to produce more food, the global food supply will increase, and the PRC will benefit from such increases, although perhaps indirectly in many cases.

Eliminating Unsafe Food

Currently, the PRC's widespread and heavily polluted water, soil, and air have made it difficult to produce safe and high-quality food. Moreover, many producers, processors, and retailers deliberately contaminate food. The logical steps for the PRC to produce safe and high-quality food would be to first immediately stop or prevent deliberate food contamination and then rehabilitate the environment to ensure that resources available in the future are able to produce safe and quality food.

Unfortunately, forbidding the production and selling of adulterated food in the PRC's current social, political, and economic environment is impossible. It is not possible to eliminate unsafe food that is produced deliberately. After all, it is human beings who produce unsafe food. It is not possible for the current system to prevent or discourage some elements in the society from producing unsafe food. Further, consumers are too tolerant. In February each year, two government media agents, ChinaNet and People's Daily, conduct an Internet survey to solicit opinions of netizens (Internet users in the PRC are often referred to as netizens) on various aspects of their lives. The proportion of the respondents who are worried about the safety of food is as high as 96%. However, only 35% indicated they would do something, e.g., lodge a complaint, while 3% could not care less. The remaining 62% choose to tolerate it because they did not know where to lodge a complaint (Icxo Executive Companions 2012; Yu 2013). If so many people still buy food of dubious quality, low-quality food will be produced and sold in the market because the penalties for producing such food are so light.

It is a huge challenge for the authorities to be able to provide safe food for its citizens anytime soon. The country's quality and safety surveillance system is corrupt. The current institutional arrangements

indulge corruption. Without substantial reforms to the governmental institutions, corruption cannot be curtailed, and subsequently, it is impossible for the quality and safety surveillance system to perform its monitoring role as expected. It will take a long time, if ever, for those producers, processors, and retailers who deliberately pollute food to stop their unethical acts. There is little hope that these people will lift their ethical standards any time soon by exercising their conscience. Even if the above two problems could be rectified soon, treating the polluted soil and underground water will take a much longer time. Hence, the PRC may not be able to produce safe food for a long time.

Despite the difficulties, efforts still need to be made to reduce and ultimately eliminate adulterated food. Legal and economic means need to be applied that provide sufficient penalties to discourage the production of contaminated food and provide strong incentives to encourage the production of safe and quality food. As such, various safety and health regulations must be properly and strongly reinforced. Helping citizens re-establish basic social moral standards is also important.

Narrowing Income Inequality

Social stability is another important indicator of a country's food security status. Without social stability, a country's food security can be seriously undermined. Income equality is crucial to ensure social stability. However, in the PRC, the large and increasing income gap, as shown in Figure 4.1, has become a major cause of concern for social stability. In Figure 4.1, the income gap between the top 20% and bottom 20% of consumers is large. The gap is even larger if the income of the top 5% of the rich is compared with that of the bottom 5% of the poor. According to the China Family Panel Studies conducted by the Institute of Social Science Survey at Beijing University, total income received by the bottom 5% families accounted for 0.1% of the total income of all PRC families in 2012. The top 5% families received 23.4% of the total income of all families, i.e., the income of the top families is 234 times more than that of the bottom families (Du and Shi 2013).

The Gini coefficient is commonly used as a measure of inequality in income or wealth. In 2000, the government estimated the PRC's Gini coefficient to be 0.412, which is higher than the warning level of 0.4 set by the United Nations. By 2012, it had increased to 0.474. It is crucially important for the PRC to quickly rectify the alarming income disparity problem. Unfortunately, effectively increasing the income of rural and low-income people and reducing the income gap is unlikely in the near future. The government has made efforts to reform the income distribution system. However, some major interest groups that have a strong hold of power in, or have strong connections with the power of,

the government have always tried to block the reforms. If such blockages cannot be removed, income disparity will only become larger in the PRC (Qian 2013). Again, without substantial reforms of the current governmental institutions, reducing the PRC's income inequality to an acceptable level is not possible.

Reducing and Avoiding Food Waste

Reducing food waste helps improve a country's food availability. Food waste at the consumption stage is the food discarded that is still suitable for human consumption (FAO 2011). In the PRC, food waste is enormous. According to the PRC's Bureau of State Grains, food wasted each year at dining tables is worth about CNY200 billion, equivalent to the amount of enough to feed over 200 million people (Lei 2014). The estimate by another source is even higher: food wasted in the PRC at the consumption stage would be sufficient to feed 250–300 million people each year (Wang 2010). It is difficult to trace the origins of how these estimates were derived. It is highly probable that they are overstated. Nonetheless, the enormity of food waste can be easily witnessed across PRC in dining halls, restaurants, and other food outlets.

The amount of resources squandered due to food waste is aggravated as a result of rapid changes in the food consumption patterns in the PRC. In the past few decades, people have shifted from eating more food grains to consuming more high-protein food such as meat, dairy, and aquatic produce. More resources are needed to produce such protein-based food. The PRC's food production resources are scarce. Avoiding food waste is equivalent to having increased food production resources and food supply, thus enhancing the country's future food security.

Education is the key to significantly reduce food waste. Recent efforts by public media in the PRC to educate residents to avoid wasting food are welcome. Many younger people, especially those who were born after the 1980s, have little understanding about the miseries caused by food shortages in the past. Many of them do not know that in the not-too-distant past, there was a Great Famine in the PRC. They have little sense about the importance of saving food. These young people should be routinely educated that wasting food is a disgrace. While each and every person is entitled to having food, no one has the right to waste food.

Education will be less effective in curtailing food waste resulting from consumption based on public money and bribery. While the recent anticorruption campaign has deterred these kinds of consumption, reforms are needed to establish necessary institutional arrangements so that there is accountability in the use of public money, and corruption can be effectively prevented in the first instance. This way, food waste

on such occasions can be continuously reduced or avoided in the future even after the current anticorruption campaign ends.

Making Grain Reserve Management Transparent

Having an adequate amount of grain reserves is an important tool to manage a country's food security. The PRC has a reserve stock of at least 100 mt as noted earlier. This is comparable or even higher than the level suggested by the FAO (18% of annual consumption). However, the actual level of grain reserves has not been made public.

India, which also has a large population (1.31 billion in 2015), publicizes its reserve levels on a regular basis. India's reserve stock is also much smaller compared with the PRC's. The norm of India's reserve stock has been around 16–18 mt in recent years. Ironically, the PRC is often concerned about its grain security although its reserve is about 100 mt or even much higher.

Two reasons explain this paradox. First, some greedy and corrupt individuals who manage the grain reserves abuse the system for private gain. They take advantage of the public and government's concern over grain security and coerce the government into having more grain in the reserve so that there is greater room for them to manipulate the reserves for personal gains (*China Business News* 2008). The other reason is that no one is sure about the actual level of the reserve (Wang 2008; Zhang 2008). By having "more" in the reserve, it would be unlikely that all grain warehouses would have less grain than they should (due to manipulation by those greedy individuals); therefore, it would be safer.

Bringing transparency to grain reserve management in the PRC will be beneficial. It would help (i) prevent the reserve system from being abused for personal gain; (ii) reduce the reserve quantity, leading to huge financial savings; and (iii) manage food security by making better use of world markets. Transparency of the PRC's reserve management can also help producers and traders from both the PRC and the rest of the world adjust their production and business activities in response to changes in the PRC's reserve levels, hence reducing fluctuations caused by overspeculation. This would also help other countries manage their food security, a contribution to global food security.

Publicizing the level of grain reserves and bringing transparency to its grain reserve management requires changes in senior government officials' mentality toward the markets (both domestic and international). It also requires changes in the current institutional arrangements to reduce and eliminate the resistance to transparency from those individuals who hijack the public's concern about food security for private gains. In the recently proposed draft of the PRC's first Grains

Act, it was specified that the government would compile statistics on grain production, trade and consumption, and the demand–supply balance; monitoring and early warning; and information dissemination. It is unclear whether information on reserve levels will be regularly made available to the public.

Carrying Out Innovative Reforms to the Institutions

For the PRC to achieve its food security in accordance with the frameworks highlighted in Chapter 2, the country has to deal with the major challenges discussed above. To handle these challenges successfully, however, further innovative reforms are called for on various aspects of the current institutions.

Earlier discussions have indicated that the lack of accountability of the governments and officials to the people weakens the PRC's ability to improve its food security. This has also been a major cause for widespread corruption in the PRC, which has retarded efforts to achieving a higher level of food security. Changes would have to be made to ensure that governments and officials at various levels are accountable to the people under their jurisdiction; this in turn will help curtail corruption.

Ensuring that the policy-making process is transparent is a useful approach to make sure that governments and officials are accountable to the people. With transparency, the public will have the ability to stop officials from abusing their power. Media freedom is also essential to keep government officials under check. As such, reforms to the current government institutions are needed and are indeed the prerequisite for making necessary changes and improvements in many other aspects of society, such as economic, cultural, and social, for improved food security in the future.

Further improvements can also be made to the current economic institutions to improve food security. One important reform that needs to be carried out is the clarification of land-related property rights. As noted earlier, the PRC's grain output has been at a high level in the past. However, for the PRC to continue producing at a high level, two major obstacles exist. One is that the PRC's comparative advantage in producing grain is vanishing. The other is that the very small size of farms has restricted grain output.

While smart investments in agricultural infrastructure and research and development (R&D) can help improve the comparative advantage, increase in farm scale is needed to overcome the second obstacle. Research shows that farms with a larger grain production scale achieve higher yields and higher incomes (Zhan et al. 2012). If the farm scale is increased, farmers can produce more grain and earn higher incomes on the same amount of land. To increase farm sizes, the current land tenure

arrangement has to be changed to make land consolidation possible and easier. This requires courage on the part of the government to innovate ways to reform the current land tenure.

Equitable income distribution improves social stability, which in turn helps improve food security. Measures have to be undertaken to distribute income in a more equitable manner in the PRC. This requires breaking down the obstacles erected by some interest groups. It also requires society to promote the sense of justice and fairness. The financially better-off citizens should demand and support the government to implement fairer income distribution policies to improve social stability.

Cultural changes are also needed to reduce food waste and to eat healthily and responsibly. Showing off one's wealth through wasting food (e.g., consuming or ordering excessive food) should be made a public disgrace. Education needs be provided to the public to promote a healthy and balanced nutrition intake, with minimal or no food waste. The public should be encouraged to shift from commune dining to a system of dining based on individual servings to avoid excessive food being provided to the dining table. The public should also be educated to eat responsibly so that they are discouraged from eating rare or slow-growing animals or plants to help preserve threatened species for future food security.

4.5 Food Security Prospects by 2050

If the farm production scale can be expanded and investments in agricultural infrastructure and R&D are adequate, higher grain output can be expected even if the land area drops to a small extent in the future. With necessary imports from the world market, the PRC's future "grain security" should not be a major problem.

In 2013, the PRC produced 602 mt of grains (including soybeans). Net imports were about 73 mt (chiefly soybeans), accounting for about 12% of the total output. By the early or mid-2030s, the population will have peaked to around 1.45 billion. Assuming that by then the PRC can still produce 600 mt domestically and net import 100 mt, then per capita grain availability will still be comparable to the level in the early 2010s, close to 500 kg per capita. The proportion of imports out of total grain output will be around 17%. Considering that per capita direct grain consumption has been stabilized in urban areas and declining in rural areas, much of the grain is likely to be used for feed purposes and food processing. Thus, in normal circumstances, "feed security" is likely to assume more importance in the future. Should any major food shortages occur, grain used for feed and processing purposes can be

shifted to direct human consumption, causing no significant concerns to "grain" security.

Results of simulations on the PRC's food demand and supply in the global context by 2030 and 2050 also suggest that if any challenges of food supply (in terms of quantities) can be overcome before the mid-2030s, then, in the long run, food supply is unlikely to be a major issue for the PRC (see Chapter 10 for details). However, as pointed out earlier, food supply or food availability is only one dimension of food security. Comfortable food availability is not equivalent to the achievement of food security. In the future, the PRC still has a long way to go in improving food safety and quality, achieving fairer income distribution, and rehabilitating the damaged environment to truly achieve better food security.

4.6 Concluding Comments and Policy Implications

Since the 1980s, the PRC has remarkably improved the availability of food for its citizens. Before the 1980s, it suffered from chronic food shortages. Since 1980, the food supply has been plenty, and food varieties are diverse. A majority of consumers can now afford to buy food. This chapter has reviewed what led to such a drastic change in food security. We have shown that there was no magic behind the change, but a simple removal of the many strict controls exercised over what farmers could do on the land. Before the 1980s, farmers had little freedom to farm the land under the highly collectivized arrangements. When farmers were allowed, in the early 1980s, to revert to individual household-based farming that prevailed before 1955, the agricultural supply expanded rapidly.

After the removal of most controls over on-farm operations, other reforms to the PRC's economic institutions have been carried out and various policy measures introduced since the mid-1980s, which have also helped the agricultural output continue growing. These include the removal of controls over agricultural markets; increased investment in agricultural infrastructure and R&D, increased agricultural subsidies; and the implementation of protective floor prices for major cereal crops.

Currently, the PRC's food availability is comfortable. However, challenges in other aspects of food security persist. Unsafe and low-quality food is widespread, income inequality is expanding, and the already fragile environment is being subject to continued damage. Without overcoming these challenges, the PRC cannot achieve long-term food security. Overcoming such challenges calls for substantial reforms

to its current institutions. Reforms only to economic institutions might make it possible for the country to achieve significant improvements in its food availability. However, without substantial reforms to its current government institutions, achieving real food security in the country will be difficult.

Examining the PRC's food security practices since 1950 has generated several important lessons and experiences valuable for both the PRC and other countries to strive for improved food security for the future.

(i) Do not dictate to farmers on how they should run their farm operations. Do not impose unreasonable restrictions on them. Farmers are smart and they know how to farm the land.
(ii) A government should foster a conducive business environment in which farmers' production efforts can be adequately rewarded.
(iii) Government institutions should be ensured that will lead to transparent and efficient government operations and will also hold government officials accountable to the people under their jurisdiction.

In this chapter, it has been reaffirmed that the reversal back to household-based farming and the removal of the controls over farmers' on-land operations are the fundamental reasons for the food supply increasing rapidly since 1980. However, it must not be taken that household-based small-scale farming is and will continue to be the best model for agricultural production. This model suited the PRC's situation when its economy was still largely agrarian in the early 1980s. Today, the PRC's economy has advanced enormously and, subsequently, very small-scale farm operations are no longer the best model. The PRC has been slow in innovating policies to deal with this issue.

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5

Food Security Measures in Japan since World War II

Akihiko Hirasawa

5.1 Introduction

After the food shortages in the 1940s, Japan recovered fast and improved its food security. Since the mid-1970s, the country has achieved a high level of food security despite its limited agricultural resources. This chapter traces the evolution of Japan's food security since 1946 and identifies important policy measures undertaken by the government.

The term "food security" was introduced in Japan in the 1970s. Since then, the discourse on food security has focused on achieving a stable food supply at the national level (Koyama 2007; Ohga 2014). In the present, it is not the current level of food security but the risk of import disruption that is important for Japan. The high dependence of Japan's food supply on imports is of concern. Policy makers and stakeholders have underlined the need to sustain a significant level of domestic food production or the potential, given Japan's experiences in the past decades.

Immediately after the end of World War II in 1945, Japan faced its worst food crisis in its modern history. In 1973, it suffered from supply uncertainties caused by an export ban in the United States (US). The 2007–2008 price hikes in global food markets acted as another warning to Japan about the potential danger of an overreliance on imports for its food supply. Meanwhile, the disruption in the distribution system by the Great East Japan Earthquake and the subsequent accident at the Fukushima nuclear power plant in 2011 have resulted in concerns over the stability of regional and/or local food supplies.

Despite concerns, Japan has been successful in achieving a high level of food security. Along with economic development, the amount of food consumed by the Japanese has been adequate and its diversity has improved. Currently, the issue in food security management is no longer about struggling to obtain enough food to feed the people but

to take adequate preventive measures to ensure that a stable and high level of food security is sustained in the future. A review of food security measures developed in the Japanese context provides valuable lessons for not only the long-term food security of Japan but also that of other countries.

The next section provides background information and basic facts on Japan's food supply, which contextualize the subsequent discussions on the evolution of food security measures in Japan. Section 5.3 provides a detailed description of the worst food crisis in the mid 1940s and how it was handled. Section 5.4 elaborates on the major policy measures developed since the 1960s to handle crisis situations and to enhance Japan's food security. The measures adopted to manage Japan's food security at present and to handle any changing or unexpected circumstances are discussed in Section 5.5. Section 5.6 discusses changes in domestic circumstances and challenges in the future. The final section provides the conclusions and implications drawn from the preceding sections.

5.2 Statistical Overview

This section employs food balance sheets of the Government of Japan[1] from 1930 onward as the main source to analyze long-term trends. The statistical data concentrate on macroeconomic (total or average) aspects, reflecting notable resource constraints in Japan.

The fundamental or root cause of Japan's high dependence on imports is due to limited agricultural land resource endowment. As the economy developed, competitiveness of agriculture reduced. Economic development also resulted in a more diversified diet, leading to a higher demand for more land resources, thereby exacerbating the shortage of agricultural land. It was in such a context that the liberalization of agricultural imports in Japan resulted in a high dependence on imports.

5.2.1 Long-Term Trend of Calorie Supply

Calorie supply per capita is a good indicator to illustrate the long-term changes in food security. After the food shortages from the 1940s to the early 1950s, the expanding calorie supply and a diversified diet advanced rapidly, largely depending on imports.

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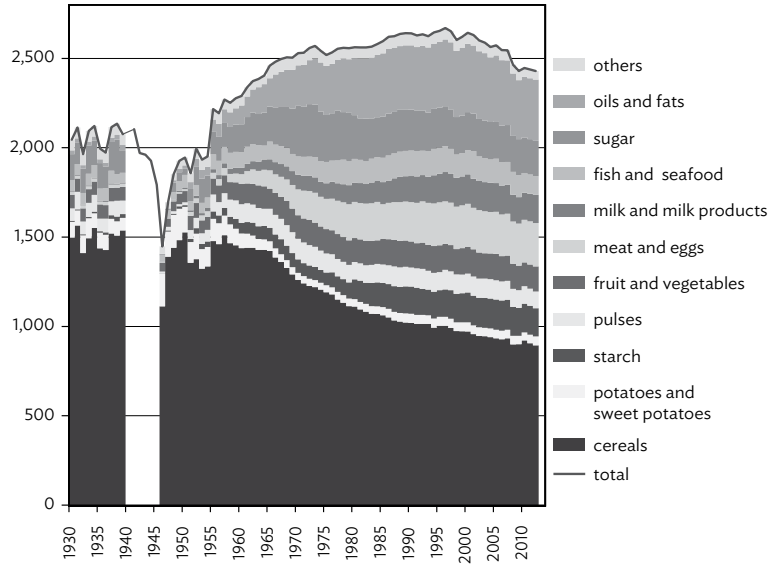
[1] Nobumitsu Hayashi kindly allowed the use of electronic data that he prepared. Since data are not available from 1941–1945, this study uses alternative sources from other publications.

Figure 5.1 Composition of Food Supply, 1930–2012 (kilocalories per capita per day)



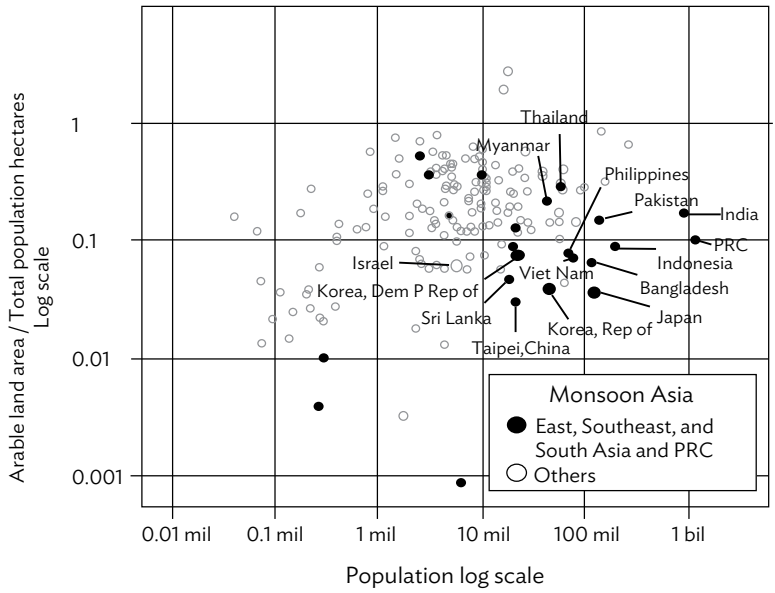
Sources: MAFF (2014a); MAF (1976) (data for 1930–1950 excluding the missing 1941–1945 are originally from Economic Stabilization Agency); data on total calories for 1941–1945 are from Matsuda (1951).

Throughout the 1930s, the calorie level was around 2,000 to 2,100 kilocalories (kcal) per capita per day (Figure 5.1). There was a steep downward trend during World War II (1941–1945), which bottomed out at 1,448 kcal per capita per day in 1946. It took about 10 years after the end of the war for the calorie intake to recover to the pre-war level. This was followed by a significant increase until 1973, then a slow steady increase, and finally a peak at 2,670 kcal per capita per day in 1996. Since then, there has been a clear downward trend due to population aging, among other factors. The latest value (2,429 kcal per capita per day in 2012) is almost as low as that in 1967.

5.2.2 Land Scarcity

Japan is part of monsoon Asia where land is scarce and heavily populated (Figure 5.2). Compared to many other economies, Japan has a low per capita arable land area. In fact, among economies with a population of more than 100 million, Japan has the smallest amount of arable land per capita. Japan is also mountainous, with limited flat land suitable for agriculture.

Figure 5.2 Population and Arable Land Area per Capita across Economies (157 countries, 1994–1998 average)



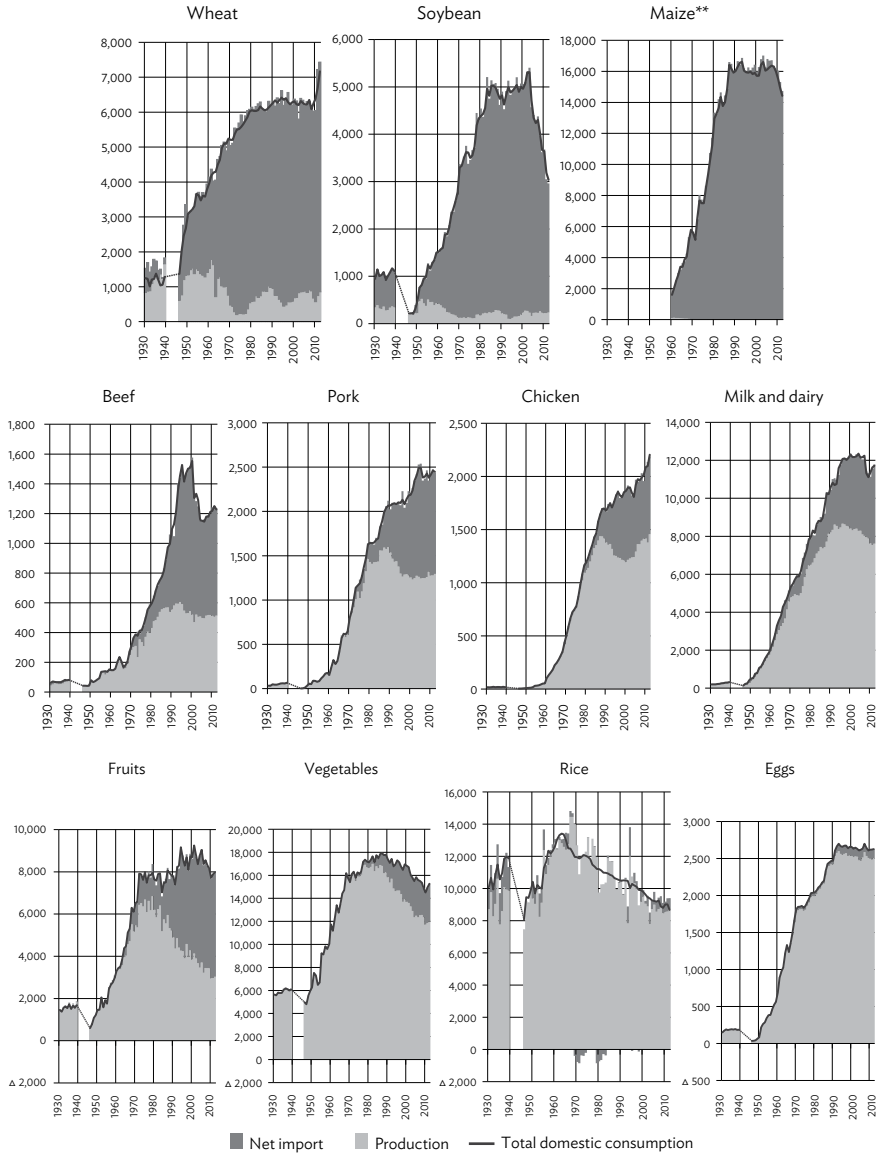
PRC = People's Republic of China.
Source: Hirasawa (2013).

Food importation is the consequence of land scarcity. Taking 1985 as an example, the "land equivalence" of agricultural imports was 18.9 million hectares (ha) (Kaneda 2001). At the same time, the actual utilized agricultural area was 5.82 million ha. Therefore, to substitute the agricultural imports with domestic production, Japan would need 3.24 times more farmland. Since the early 1960s, farmland has decreased continuously, facing demands from other sectors. This is to say, importation on a major scale is inevitable to maintain the desired living standards, especially with regard to food energy consumption and a diversified diet including animal protein.

5.2.3 Evolution of Import Dependence

From the late 1940s to the 1980s, there was a major expansion in the imports of grains and oilseeds such as wheat, maize, and soybeans (Figure 5.3). Since then, Japan's reliance on imports has been extremely high for depending on imports of maize and soybeans as the main sources

Figure 5.3 Development of Imports, Production, and Consumption since 1930* (1,000 tons)



* Data for 1940–1945 are not available.

** Data on maize prior to 1960 are not available.

Sources: MAF (1976); MAFF (2014a).

of feed, the animal agriculture sector also grew rapidly during this period. Figure 5.3 shows that domestic production of animal products peaked in the 1980s and 1990s. Since then, domestic output of animal products (with the exception of eggs) has remained stable despite a significant rise in demand. In other words, domestic livestock industries were unable to take the advantage of demand growth. Instead, imports of animal products have expanded since the 1970s. Imported animal products now occupy 30%–60% of Japan's market share. Imports of fruit and vegetables have also expanded since the 1970s and 1980s, while domestic production has declined. The exceptional food items that are significantly less dependent upon imports are rice and eggs.

Limited food production resources have made it imperative for Japan to import. Its liberalized food import policies also facilitated large quantities of imports. Japan started to gradually liberalize its imports of agricultural products in the 1960s (Hirasawa 2013). The liberalization of food imports is largely due to international trade negotiations, mainly in the General Agreement on Tariffs and Trade and with the US.[2] Today, Japan's restrictions on food imports are low and declining due to various new bilateral, regional, and global free trade negotiations. In the case of maize imported for animal feed purposes, there has been a total exemption of import tariffs since 1927 (MAF 1970).

Self-sufficiency ratios (SSRs) (domestic production/domestic supply for consumption) are often used to indicate the dependence on imports. Japan's food SSRs dropped drastically in the long term (Figure 5.4). As of 2012, SSRs were 28% for cereals and 39% for net calorie supply. Currently, almost half of the cereals (mainly maize) is used for animal feed.

Starting in 2000, the SSR based on the value of production since 1960 has been made available through the food balance sheets of the Ministry of Agriculture, Forestry and Fisheries (MAFF). It is an effective indicator, accounting for economic activities such as animal agriculture, which depends on imported feed and high value added by farmers. However, the value of production SSR is unsuitable as an indicator of food security because it reflects a high domestic price instead of the physical amount of food. Thus, the ratio is much higher than the net calorie SSR.

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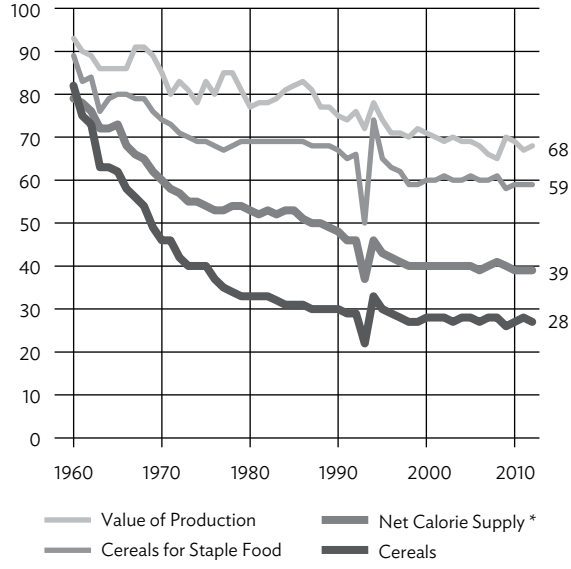
2 Article 2 of the Treaty of Mutual Cooperation and Security between Japan and the US concluded in 1960. It promoted trade liberalization of agricultural products and was called the "economic clause." Japan's trade surplus with the US was also an important factor that led to Japan's trade liberalization from the late 1970s. Japan's business community has mostly insisted on the liberalization of agricultural imports since the mid-1980s. In contrast, public opinion polls have constantly shown that a large majority of people are anxious to maintain and expand domestic agricultural production.

Figure 5.4 Food Self-Sufficiency Ratio since 1960



* Calories of animal products attributable to imported feed is deducted from the net calorie supply.
Source: MAFF (2014a).

The remaining domestic production is sustained by protection and support measures undertaken by the government. According to Organisation for Economic Co-operation and Development data, Japan's producer support estimate (PSE) was 55.6% in 2013 and belongs to a higher class among member countries, after Norway and Switzerland and on par with the Republic of Korea and Iceland. However, this declined from 65.1% in 1986 as a result of trade liberalization.[3]

5.3 Food Crisis: Aftermath of World War II

The food crisis in 1946 was the worst event for food security in Japan's recent history, with the country facing a long period of food shortages

[3] PSE (producer support estimates) constitutes market price support and transfers from the government. Percentage PSE = 100 * PSE / (value of agricultural production at the farm gate + transfers from the government). Organisation for Economic Co-operation and Development. Producer and Consumer Support Estimates Database. http://www.oecd.org/tad/agricultural-policies/producerandconsumersupportestimatesdatabase.htm

during and immediately after the war. As described subsequently, Japan managed to narrowly escape a major catastrophe.

5.3.1 The Institutional Environment

The prominent elements of the institutional environment were economic control after the war and allied occupation.

Prior to the end of the war, there had been a food control system as part of economic control. The main components were the mandated delivery of rice (and other crops) from farmers to the government, a ration system, and price control. The system was formed gradually from the 1930s and completed with the Foodstuff Control Act of 1942. Supply shortages caused by the severe drought of 1939 in the Republic of Korea and the western regions of Japan promoted the move to bring in direct control by the government (Tama 2013b). Most other goods were also controlled.

A delivery quota was allotted to each hamlet (i.e., a subgroup in a village) (Tama 2013b; Tanabe 1948). Farmers' organizations under the control of the government, the Agricultural Association (*Nogyokai),* collected crops. Retail and wholesale industries transformed into semigovernment ration organizations (*Shokuryo Eidan)*. The ration rate per person was differentiated by age, labor intensity, and sex, according to the biological needs of each group. There was a dual price system where producer prices and consumer prices were determined independently to some extent, to cover the production costs of farms as well as to ensure affordability of food for consumers (Tanabe 1948). This was intended to enable an adequate rice supply and to control wage inflation (Tama 2013b). However, producer prices had been depressed during the war (Tanabe 1948).

Such a control system was necessary because the food situation was serious even before the crisis. In addition, the ration amount per person had already been cut by 10% 3 months before the war ended (Table 5.1). The level of rice rationing, at 297 grams per day per adult (both sexes), was equivalent to only 974 kcal per capita per day (calculated by the author using data from Tanabe 1948). This is below the basal metabolism (i.e., energy necessary when at total rest) of an adult male in 2015 (Table 5.2), even after taking into consideration that the body weight of a 20-year-old male increased by 16.8% between 1950 and 2012 (MHW 1978; MHLW 2014a). The necessary level for an adult male was 2,400 kcal per capita per day (Tanabe 1948). Many black markets came into being at the end of the war, offering additional sources of food. Despite this, the food control system enabled a relatively equal distribution of food.

Table 5.1 Ration Standard of Rice (for Adults 26 to 60 Years of Age) (grams/capita/day)

On and After	Ration Amount
April 1941	330
May 1945	297
November 1946	380
November 1948	405

Note: Milled rice equivalent including substitute food.
Source: Food Agency (1951).

Table 5.2 Basal Metabolism of Adult, 2015

Sex	Age	Basal Metabolism (kcal/capita/day)	kcal/kg	Reference Weight (kg)
Male	18–29	1,520	24.0	63.2
	30–49	1,530	22.3	68.5
Female	18–29	1,110	22.1	50.0
	30–49	1,150	21.7	53.1

kcal = kilocalorie, kg = kilogram.
Source: MHLW (2014b).

Following the end of the war, the Allied powers occupied Japan from August 1945 to April 1952. They, primarily the US military, ruled Japan indirectly through the Government of Japan. During the occupation, food policy and/or control was one of the main concerns for both the general headquarters (GHQ), Supreme Commander for the Allied Powers; and the Government of Japan. Both were concerned about securing the food supply at the national, regional, and household levels to avoid large-scale hunger and social disorder.

5.3.2 Key Factors Responsible for the Food Crisis

The three key factors responsible for the food crisis were the disruption of imports, crop failure in 1945, and the malfunction of the "rice delivery system." The former two factors depressed the total food supply in terms of physical restrictions. The third factor threatened the distribution of food (and viability of the ration system) as a result of farmers' behavior, which was negatively affected by inflation. To a small extent, the ongoing repatriation of servicemen and women and civilians added tension on the demand side.

Table 5.3 Supply and Demand of Rice in the 1940s (1,000 tons, unmilled equivalent)

Rice Year[a]	Production	Net Import[b]	Consumption[c]	Consumption Per Capita (kg)	Population (million)
1940	10,345	1,533	11,714	161	72.8
1941	9,131	2,115	10,759	146	73.7
1942	8,263	2,247	11,066	149	74.5
1943	10,016	990	11,160	154	72.6
1944	9,433	653	10,692	148	72.4
1945	8,784	201	8,898	122	72.8
1946	5,872	16	6,121	83	74.0
1947	9,208	3	9,151	118	77.7
1948	8,798	44	8,883	112	79.2
1949	9,966	94	9,853	122	81.1

kg = kilogram.
[a] Rice year: November of previous year to October of the current year.
[b] calculated by subtracting export from import.
[c] consumption includes stock changes.
Source: Food Agency (1960).

First, imports were severely limited. In the past, Japan had been dependent on imports from other Asian economies for around 20% of its rice supply (Table 5.3).[4] There had also been significant imports of wheat, pulses, fish, and sugar (Table 5.4). However, importation was disrupted during the war. After the war ended, imports required permission from the GHQ and the availability of foreign exchange, both of which were difficult to obtain at that time.

A memorandum of 9 October 1945 stated that any import to Japan would be permitted only if the case met three conditions. First, the goods should be essential to maintain a minimum level of living for the nation. Second, it should be demonstrated that it was impossible to secure adequate quantities of the goods without imports even with the maximum utilization of domestic ones. Third, payment conditions should be met (ISR 1969a).

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[4] To secure imports, Japan promoted rice production in Korea (today the Republic of Korea and the People's Democratic Republic of Korea) and Taipei,China through research and infrastructure construction, especially after a supply shortage and the Rice Riot of 1918 in Japan (Honma and Hayami 2009). Yet this move caused a rice surplus in Japan and led to the control of the price and distribution in the 1930s (Tama 2013a). Japan also imported soybeans and grain from China (today the People's Republic of China). In the early 1940s, Japan also imported a significant amount of rice from Southeast Asian countries (OFA 1948).

Table 5.4 Sources of Food Supply before World War II (5-year average) (1,000 tons)

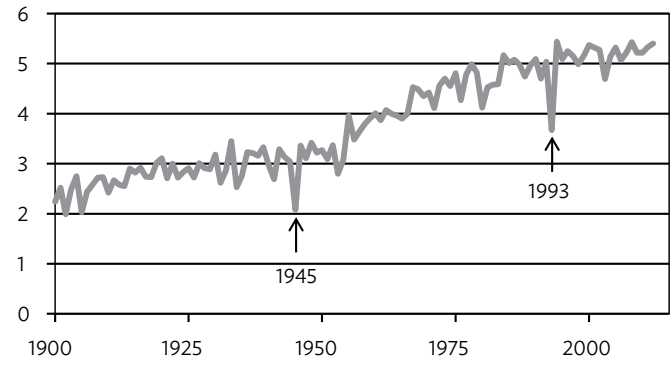
	Domestic Production			Imports		
	1911–1915	1921–1925	1931–1935	1911–1915	1921–1925	1931–1935
Cereals	10,509	11,765	12,630	647	1,753	2,578
Rice	7,376	8,535	9,134	526	1,212	1,931
Wheat	663	743	1,095	103	519	598
Barley	1,896	1,820	1,911	4	6	4
Potatoes	4,581	4,709	4,561	10	58	70
Pulses	702	830	649	345	641	840
Vegetables	5,315	5,455	6,529	–	–	–
Fruit	651	772	1,133	0	3	11
Meats and eggs	75	117	152	–	16	13
Milk and products	52	110	229	9	28	10
Fish and seafood	1,566	2,236	3,818	132	287	970
Sugar	121	87	121	332	711	904
Oils and fats	71	62	95	1	0	0

Source: MAF (1976).

Food imports were made difficult. For the 1948 rice year (November 1947 to October 1948), the Far Eastern Commission, overseeing the Allied Council for Japan, stated that food imports to Japan should be limited to the minimum level to prevent hunger, disease epidemics, and social unrest, which could threaten the security of the occupation forces.

Second, there was a major rice crop failure. In 1945, the yield of rice was 2.08 ton/ha, which was only about two-thirds of the normal level and the lowest in the previous 40 years (Figure 5.5). At the end of August 1945, it was expected that Japan would produce a total of 8.4 million tons of rice (Table 5.5). Later, this projection was reduced due to adverse weather conditions. On 17–18 September 1945, a typhoon hit the western regions. Then, in early October, strong winds and floods caused serious damage in the Pacific coast area (Oda 2012). After the two consecutive disasters, the Ministry of Agriculture and Forestry (MAF) reduced the rice production estimate to 7.1 million tons and then to 6.5 million tons (Table 5.5). The actual harvest was even lower at 5.9 million tons.

Figure 5.5 Yield of Rice (tons/ha)



ha = hectare.
Source: MAFF (2013).

Table 5.5 Estimation of Rice Production and Deficit, 1945 (million tons)

Point of Time	Production	Change	Deficit
Assumed requirement (including imports)	9.88		
At the end of August	8.40[a]		–1.48
After typhoon in mid-September	7.08[a]	–1.32	–2.80[a]
After wind and flood damage in early October	6.51[a]	–0.57	–3.37
Actual harvest	5.87[b]	–0.64	–4.01

Calculated from data in [a] Oda (2012); [b] Food Agency (1960).

There were criticisms over the accuracy of the production amounts (Oda 2012). The output level reported by local officials depended upon the cooperation from rural communities (Oda 2012). While rural communities tended to underreport their output levels so that more could be kept for their own consumption, the tendency to underreport became even stronger when they faced a major threat of food shortages. There were also intentional underestimations among local authorities, according to ISR (1969b). This made it even tougher to plan emergency measures.

Third, the "rice delivery system" did not function well. In the 1946 rice year (November 1945 to October 1946), rice delivery was significantly slow, and the final result was the lowest ever. Even with

Table 5.6 Delivery of Rice (1,000 tons)

Year[a]	Production	Quota of Delivery	Delivery	Deficit of Delivery[b]	Planned Remaining at Farm	Actual Remaining at Farm[b]	Quota Rate (%)	Progress of Delivery (%)
	(A)	(B)	(C)	B–C	A–B	A–C	B/A	C/B
1941	8,245	4,335	4,330	5	3,910	3,915	54.4%	96.5%
1942	9,999	6,153	5,996	157	3,847	4,004	61.5%	97.4%
1943	9,422	5,859	5,952	–93	3,564	3,470	62.5%	101.7%
1944	8,784	5,588	5,594	–7	3,196	3,190	63.5%	100.1%
1945	5,872	3,786	2,934	852	2,086	2,938	64.5%	77.5%
1946	9,208	3,906	4,058	–152	5,302	5,150	42.4%	104.4%
1947	8,798	4,355	4,364	–9	4,443	4,434	49.5%	100.2%
1948	9,966	4,311	4,583	–272	5,655	5,383	41.8%	106.3%
1949	9,383	4,215	4,342	–126	5,168	5,041	45.1%	103.0%
1950	9,651	4,089	4,101	–12	5,562	5,550	42.4%	100.7%
1951	9,042	3,671	3,796	–125	5,371	5,246	40.6%	103.6%
1952	9,923	3,820	4,211	–390	6,102	5,712	38.5%	110.4%
1953	8,239	2,115	3,001	–886	6,124	5,238	27.5%	116.1%
1954	9,114	2,646	3,393	v747	6,468	5,721	37.2%	101.2%

Notes:
[a] Year is the calendar year of production. The rice produced is counted in the next (n+1) rice year.
[b] Calculated by the author.
Source: ISR (1969b).

various policy measures, the final result was only 77.5%, which was less than the level of the usual year (nearly 100%) (Table 5.6).

The delivery plan for the 1946 rice year was ambitious. In spite of a major drop in production, the quota rate (quota of delivery/production) was raised slightly to 64.5% due to shortages in the supply to rations and the underreporting of production. To make the delivery plan smooth, the government introduced measures such as raising the producer price by 50%, revising the delivery allotment, allowing the delivery of substitute food instead of rice with no limit, and extra rationing of agricultural inputs to farmers, which was conditional on the actual delivery of rice (Oda 2012; ISR 1970.).

Given the shortage of rice, farmers hesitated in delivering their harvest for a number of reasons, including the remaining rice to be left in the hands of farmers would be much smaller than in previous years (Tanabe 1948), especially in the case of small-scale farmers (Nomura 1950), and delivery during the war had been so burdensome that farmers had lost stock in hand (Matsuda 1951). Meanwhile, the authority of government control had diminished significantly since the defeat in the war (MAF 1972).

At the same time, the black market price of rice was much higher than the government price (Oda 2012; Tanabe 1948); and production input costs relying on the black market well surpassed the government producer price (Tanabe 1948). Besides, decontrol of the economy was expected. In fact, some goods including fresh food were decontrolled in November 1945, although many of them were controlled again by the spring of 1946 (ISR 1969a).

In addition to the above three major factors, hyperinflation also contributed to the crisis. As there were severe shortages of almost all kinds of goods, inflation was high (Table 5.7). Black market prices skyrocketed. In Tokyo, the black market consumer price was 35 times as high as the official price from October 1945 to April 1946. Even 1 year later, the rate was still equal to or higher than 10 times (Matsuda 1951). Food prices followed a similar trend (Table 5.8). This promoted illegal sale of food at the farm level, resulting in less food handed over by farmers through the quota delivery.

The high black market prices were a huge burden for consumers, especially low-income ones. As rations decreased, people needed to purchase food on the black market, but prices were too high. Engel's coefficient (expenditure for food/consumer expenditure) was as high as 73% during the second half of 1946, including around 11% on rationed food and 52% on nonrationed food (proxy for food from black markets) (Matsuda 1951). Rice became a superior good. Even as late as 1950, expenditure for rice was still higher among high-income households

Table 5.7 Evolution of Consumer Price Index in Tokyo

Year	CPI
1934–1936	1.000
1944	2.098
1945	3.084
1946	18.93
1947	50.99
1948	149.6
1949	243.4
1950	239.1
1951	255.5
1952	266.1
1953	286.2
1954	301.8

CPI = consumer price index.

Note: Average value of 1934–36 (base period) = 1.000

Source: Sakurai (1989).

Table 5.8 Ratio of Black Market Prices to Official Prices of Staple Food, June

Year	Rice (Domestically Grown)	Barley (Rolled)	Wheat Flour
1946	23.6	16.4	15.5
1947	9.5	11.3	10.7
1948	4.0	2.4	2.2
1949	2.0	1.4	1.3
1950	2.1	–	–
1951	2.1	–	–
1952	1.6	–	–
1953	1.9	–	–
1954	1.8	–	–

Note: The figures until 1949 stand for the average of all cities included in the consumer price survey. Figures since 1950 stand for Tokyo only.

Source: ISR (1969b).

(ISR 1969b). On the contrary, the pre-war level of Engel's coefficient (average of 1935–1941) was around 40%.

The total amount of rice sold on the black market after the war is not known. Estimates of the amount varied widely among observers at that time from 300 kilotons to 1,500 kilotons per year. According to an estimate, it was 930 kilotons for the 1945 crop and 675 kilotons for the 1946 crop (ISR 1969b).

5.3.3 Countermeasures

The main countermeasures against the food crisis were rice delivery by force and imports. While both were essential, each single measure was not enough to deal with the situation. As described below, early warning by the government set grounds for the negotiations on the imports.

Immediately after the 1945 typhoon that hit just before the rice harvest, MAF estimated that it was necessary to import 3 million tons of food to compensate for the losses and other deficits. This would ensure a ration of 1,080 kcal per capita per day per adult (calculated from Tanabe 1948; ISR 1970). As early as 18 September, the day after the typhoon, the government decided to submit a request to the GHQ to approve and support imports (Oda 2012). From that day, it took almost 9 months to get significant imports.

On 29 September, the government formally submitted a request for the import of food including 3 million tons of grain (ISR 1970; Oda 2012). At first, the GHQ refused the request because it did not have enough information. Then, the GHQ gradually came to a compromise as the situation worsened.

The GHQ conducted a survey on the situation and published a report on 13 November 1945 accepting that more than 3 million tons of food imports were necessary to ensure 1,800 kcal per capita per day (including nonrationed food). Without the imports, it would be 1,300 kcal per capita per day and even less in urban areas (Oda 2012).

From late December 1945, the Economic and Scientific Section of the GHQ sent staff to Asian countries seeking food imports for Japan. It took a few months to reveal that there was not such a surplus because of bad crops and other factors in other parts of Asia (Oda 2012).

Therefore, the GHQ changed its stance in January and February 1946 and urgently requested the Government of the US to export food to Japan (Oda 2012). The response was negative, and the negotiations took an additional several months because of food shortages across the world, including Europe at that time.

As of mid-December 1945, the progress of rice delivery was only 15.6%, which was less than half of the previous year (32.7%) (Oda 2012). The underreporting of production and the withholding of rice led to an uneven distribution of food between rural and urban regions. Severe shortages occurred in the urban and northern regions, where the crop situation was the worst hit in 1945 because of the cold weather (Tanabe 1948). The first delay in rations in Tokyo took place in September (Nomura 1950). At the end of December, Tokyo had stocks enough for only 3 days of rations, although the necessary level for effective operation was 15 days (Oda 2012). Besides, as evacuees returned, the capital's population swelled from 3.17 million in July 1945 to 4.43 million in October 1946 (Nomura 1950).

General Douglas MacArthur, who led the GHQ, expected that rations would discontinue in May 1946 without imports. He cautioned that if rations were stopped, severe hunger and malnutrition, mainly among the poor, would be inevitable, and epidemic diseases and social unrest would spread. Therefore, providing food for Japan would be cheaper than deploying additional troops to control any undesirable situations (Oda 2012).

In February 1946, MAF implemented emergency food policy measures in the form of an emergency imperial ordinance, which was later accepted by the Imperial Diet in August of that year. While the negotiation for food imports became prolonged, the authorities had to do something domestically. It was also a kind of demonstration to ensure that the imports did occur. The main measure was the compulsory delivery of rice. "Compulsory" meant expropriation. In the cases of a significant withholding of rice, officers searched individual farms and collected the rice, sometimes with the assistance of the US military police. Newspapers, political parties, and the GHQ backed the measure eventually. Such a crackdown was expected to make other farmers deliver rice voluntarily. The delivery period, which usually ended by March (Tanabe 1948; Nomura 1950), was extended to June (Matsuda 1951). Compulsory delivery was conducted mainly in March and April (Oda 2012). The final result (77.5%) showed a 25.5 percentage points or a 1 million ton increase from the figure in late February (52% in contrast to the usual rate of 85%–95%) (ISR 1970, 1969b; Tanabe 1948).[5]

In the spring of 1946, delays in rations became continuous and widespread. The food situation in urban areas got worse in April and

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[5] Additionally, 0.3 million tons became available during the 1946 rice year from handovers from the military and imports from China before the end of the war.

Table 5.9 Significant Delay in Rations, 1946 (days)

Location	City	Apr	May	Jun	Oct
North	Sapporo	NA	45.5	50.5	58.4
	Aomori	NA	25.0	32.0	NA
East	Tokyo	6.9	14.3	20.2	15.4
	Yokohama	7.0	10.4	14.7	5.2
	Kofu	NA	5.0	16.8	NA
West	Kyoto	NA	NA	11.3	13.6
	Osaka	NA	2.4	9.5	24.2

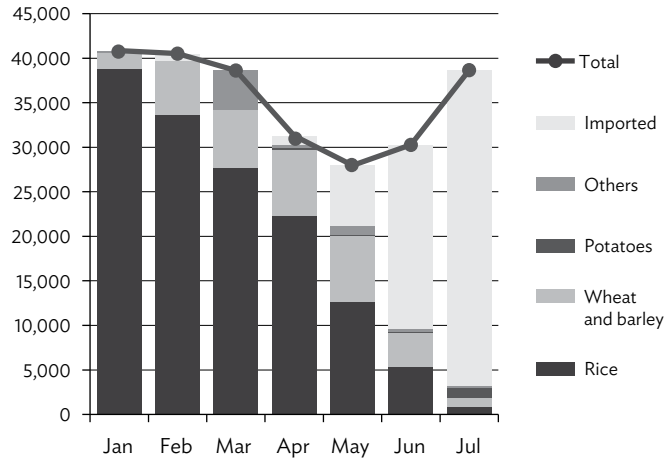
NA = not available.
Source: ISR (1970).

May. The actual ration amount was reported to be around 80% of the requisite in Tokyo and a few other cities. Demonstrations for food took place in many areas, surrounding ration stations and local government offices. About 250,000 people reportedly participated in the "Food May Day" demonstration in Tokyo on 19 May (Oda 2012). In northern cities such as Sapporo and Aomori, the ration delay in June surpassed 1 month and reached 50 and 32 days, respectively (Table 5.9).

During these months, MAF transferred rice owned by the government from production areas to consumption areas. This measure meant that the remaining stocks in production areas, excluding food for local needs until July or August, were transferred on the condition that there would be compensation in kind sourced from imports in the near future (Matsuda 1951). The GHQ called the measure "deficit transfer." The implementation of the measure was one of the most difficult challenges for MAF because it had never been tried out, and local administrative organizations tended to defend their food in the crisis. At the end, 61.8 kilotons (48% of the planned amount) of rice were transferred by mid-May. The rice supported the consuming areas during the worst period of May and June (ISR 1970; MAF 1972). Even though the absolute amount was small, it was crucial for urban areas during those months (ISR 1970).

From March 1946, the amount of food from domestic sources available for rations in Tokyo shrank rapidly and to a negligible level by July (Figure 5.6). In the second-largest city, Osaka, the total ration amount decreased by 40% from the previous month in June. In Tokyo, as of May 1946, the energy intake dropped to 1,352 kcal per capita per day, of which the ration was 775 kcal (ISR 1970). The situation was on the brink of a catastrophe. However, the catastrophe was avoided, as

Figure 5.6 Actual Amount of Rations in Tokyo, 1946 (tons)



Source: ISR (1970).

Table 5.10 Share of Imported Food in the Rations among the Six Largest Cities, July 1946 (tons)

		Import	
	Total Amount	Amount	Share
Tokyo	38,646	35,437	91.7%
Yokohama	5,930	5,226	88.1%
Nagoya	6,370	0	0.0%
Kyoto	8,101	6,341	78.3%
Osaka	11,691	5,779	49.4%
Kobe	4,775	2,501	52.4%
Total	75,512	55,283	73.2%

Source: ISR (1970).

more food was imported starting in May. By July, the rations among five out of Japan's six largest cities heavily relied on imports (Table 5.10). At the national level, imported food rations were concentrated from July to September (ISR 1970), after which the domestic early crop of rice and sweet potatoes came.

Table 5.11 Import of Food Crops (1,000 tons)

Year*	Wheat	Wheat Flour	Barley	Rice	Maize	Others	Total
1946	355	91	NA	16	88	163	713
1947	835	165	191	3	413	302	1,909
1948	637	251	168	42	49	788	1,936
1949	1,792	70	383	88	193	207	2,734

NA = not available.

* Rice year: from November of previous year to October of the current year.

Source: Food Agency (1951).

The imports and early crops of 1946 were the real relief and essential for avoiding a catastrophe in the off-crop season (ISR 1970), but these were far from adequate. The total amount of imports in the 1946 rice year (November 1945 to October 1946) was 0.7 million tons, which was less than one-fourth of the original request and a little over one-third of the revised request (Table 5.11). On another front, the utilization of early crops implied consumption in advance and meant a decline in the supply for the next rice year (MAF 1972). Hence, people survived, but hunger continued unabated. In 1946, the caloric intake dropped to 1,361 kcal per capita per day (Table 5.12).[6] The situation was worse in urban areas. Given the shortfall and delay in ration supplies, people had to purchase supplemental food from the black market to survive. The delay in the rations in the 1947 rice year was 15.4 days, which was actually an increase from the previous 1946 rice year (12.6 days). In both years, the delay ended up in the cancelation of the remaining supply to consumers through rations (Sakurai 1989).

In the period of food shortages, hundreds of thousands of people died from diseases such as tuberculosis predisposed by malnutrition. Deaths from tuberculosis were over 100,000 in both 1942 and 1947–1950. There is evidence that more people died during 1943–1946, although exact data are not available (Dower 2004). In October 1945, survey results from the Ministry of Health and Welfare reported that mortality from tuberculosis and other infectious diseases caused by malnutrition and a decrease in resistance to illness was increasing drastically (Tanabe 1948).

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[6] This is less than the value from the food balance sheet shown in Section 5.2.

Table 5.12 Food Consumption (per capita per day)

	Quantity (g)		Calorie (kcal)			
	Staple Grains		Staple Grains			
		Rice		Rice	Others	Total
1930	428	364	1,465	1,248	635	2,100
1934–36 average	422	361	1,443	1,237	639	2,082
1939	440	380	1,505	1,303	623	2,128
1946	287	224	991	770	370	1,361
1947	382	289	1,317	995	383	1,700
1948	405	282	1,398	972	446	1,844
1949	415	291	1,429	1,000	493	1,922
1950	435	298	1,497	1,023	460	1,957

g = gram, kcal = kilocalorie.
Source: Food Agency (1952).

Because of food shortages, urban people often visited rural areas to purchase food outside the ration system from farmers. They heavily relied on barter trade. The activity significantly lowered productivity of other industries in the country during the worst period (ISR 1970).

Initially, Japan lacked foreign exchange to import food. The US provided food as emergency aid in kind under the Government and Relief in Occupied Area program, the purpose of which was to prevent starvation, disease, and social unrest. The share of food in the program was around 90% in 1945–46, 70% in 1947, and 50% in 1948. The share of aid in food imports dropped to slightly over 20% in 1951. In the same year, the aid ended (ISR 1969a).

5.3.4 Recovery from Shortages

The recovery from hunger relied on an immediate increase in production and a gradual expansion of imports. Rice production in 1946 increased by over 3 million tons. Imports increased from 0.7 million tons in 1946 to 1.9 million tons in 1947 and 2.7 million tons in 1949. The recovery of rice production was due to better weather and the replenishment of inputs and labor. Several policy reforms also encouraged farmers to produce and deliver more.

To make statistical data more reliable, mainly to improve the accuracy in delivery allotment, the national government took over

the statistical surveys of agricultural production from the local governments, which tended to be influenced by local interests (Oda 2012).

The government gradually raised the official producer price to narrow the gap with the blackmarket price. High inflation continued until the introduction of austerity measures in 1949, following a request from the GHQ. Deflation pressure also contributed to the phasing out of the price gap.

In 1949 the supply–demand imbalance of food eased significantly. Controls over potatoes production and marketing (including potato and sweet potato) were removed because many consumers reduced their purchase of rationed potatoes (ISR 1969b; Sakurai 1989). Coarse cereals were decontrolled in 1951. Also in 1951, the food ration organization was privatized, which meant the transition into an indirect control system (Sakurai 1989).

In 1951, the Minister of Finance proposed to decontrol rice in the context of the austerity policy. The intention was to raise the domestic price to the level of the import price and thereby erase the subsidy for imported rice. But the GHQ turned down the initiative. In 1956, the Economic Planning Agency's *Economic White Paper* stated that the Japanese economy could "no longer be termed postwar," which reflected the significant recovery of the economy and became a famous quote.

5.3.5 Lessons Learned

Lessons from Japan's efforts in avoiding a major human catastrophe due to serious food shortages are as follows. The compulsory delivery to some extent mitigated the seriousness of food shortages in 1945–1946 caused by the delay and shortfall in imports. Food imports were crucial for avoiding a catastrophe in the summer of 1946 until early autumn when the 1946 early crops became available. The Government of Japan was able to implement and maintain the ration system chiefly through two measures: compulsory delivery and imports.

Other measures were also helpful. Early warnings, estimates of shortages, and requests for imports by the government provided the basis for negotiation with the GHQ and the negotiation by the GHQ with the Government of the US. The food control system (i.e., the ration system, the delivery system, and price control) ensured relatively equal distribution of food across rural and urban areas and across rich and poor people. With some autonomy, the executive branch of the Government of Japan was able to implement various emergency measures in a timely manner. There were also adequate institutional

arrangements that enabled immediate information gathering. It is important that the various responses to the situation were quick.

The lack of accuracy in the statistics of rice production was a major obstacle in handling the food shortage emergency situations. It is also noted, however, the GHQ, the Government of the US, and Japan's political parties did not respond to the food crisis promptly enough.

5.4 Dependence on Imports and the International Supply Crisis in 1973

By the early 1970s, Japan had become heavily dependent on food imports, chiefly from the US. In 1973, a major international food supply crisis emerged. The US imposed a broad export ban on soybeans and suggested possible export controls on other crops. Such measures would seriously affect Japan's domestic food supply. Japan woke up to the risk from heavy dependence on imports, especially from a few countries such as the US. The expression "food security" came into use from this experience.

5.4.1 "Selective Expansion" by the Agricultural Basic Act of 1961

With its defeat in the war, Japan lost its colonies, which had been a source of food. On the other hand, the US already had surplus production in 1948 (Kishi 1996), while Europe and some other regions in the world recovered from food shortages in the aftermath of World War II. Japan rapidly expanded imports of agricultural products such as wheat, soybeans, and maize. Imports under US aid schemes (US–Japan agreement, based on the Mutual Security Act and Public Law 480) in the mid-1950s triggered the trend of a "cheap" agricultural policy, in which the emphasis on boosting domestic production of major crops weakened (Tama 2013a). A formal framework of agricultural policy confirmed this trend. Specifically, the "selective expansion of agricultural production" was one of the key concepts in the Agricultural Basic Act (Act No. 127 of 1961). The purpose of the act was to enhance the productivity of agriculture and to ensure that the income level of farmers was on par with that of other industries. Selective expansion was atop the list of measures toward this end. It consisted of boosting the production of commodities with growing needs, diverting the production of commodities with reduced needs, and rationalizing the production of commodities in competition with foreign products. In actual terms, this

meant the promotion of animal products, vegetables, and fruit, on the one hand, and high import dependence for staple food and feed crops, on the other hand. In short, it was a shift from land-extensive farming to relatively land-saving farming. A prominent exception in land-extensive farming was rice, which was maintained and expected to be rationalized through scaling up of farms (i.e., lowering production cost) instead of imports.[7] Selective expansion formed the composition of Japan's agricultural sector, which continues to the present.

Selective expansion is compatible with the international supply–demand situation and international policy trends at that time. Interestingly, the Food and Agriculture Organization (FAO) had launched a similar concept in its 1953 conference.[8] The term "selective expansion of production" appeared in its 1953 conference as a main topic of agenda item III, World situation, trends and policies in respect of food and agriculture - B. Policies in regard to food and agriculture (FAO 1953). The conference report states "the present situation requires a change of emphasis in policy for the immediate future in at least two important directions. First, the former emphasis on general expansion of food production, vital in the postwar crisis, must give way to a more selective approach. Production must be increased in the areas of greatest need, and in the commodities for which expanded consumption is needed and for which effective demand can be developed" (FAO 1953: item 23).

Resolution No. 6 of the conference regarding this issue was "Selective Expansion of Agricultural Production," which had exactly the same name with the concept stated in Japan's Agricultural Basic Act. The resolution asked the FAO Director-General to invite member

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7 The actual expansion of farm size was slow, and instead the producer price of rice was raised. With the price support for surplus rice, the actual function of the Food Control System changed into support for rice farmers (Honma and Hayami 2009). The official rice price had a political role as compensation for agricultural trade liberalization (Tama 2013a). The distribution and price of rice was gradually deregulated, and the Foodstuff Control Act of 1942 was eliminated in 1995.

8 Isoshi Kajii, who belongs to the generation that witnessed the development of the Agricultural Basic Act, pointed to the similarity between the Japanese concept and the "selective and effective expansion" at the FAO conference in Honma (2003). The report of the conference also confirmed that both concepts actually share the same name, "selective expansion of agricultural production" (Hirasawa 2014). Moreover, Japan had joined the FAO in 1951 and attended the conference in 1953. The Japanese delegation consisted of eight people, including two from the Ministry of Agriculture and Forestry and an ex-officer of MAF (FAO 1953). Japan also attended the next conference in 1955 but as a council member. The head of the delegation was a former administrative vice minister of the Ministry of Agriculture and Commerce. The 1955 Conference reviewed the progress of selective expansion policies among member countries since the previous conference (FAO 1955).

governments to submit reports on the development of policies for a "selective expansion of production and consumption" (FAO 1953 item 61). This was "aimed at reducing the danger of new surpluses arising" and "it was pointed out that any further expansion should be selective" (FAO 1955: item 16). Between this session and the next session in 1955, regional consultations were held in the Far East and other two regions, with the objective of "exploring the extent to which a complementary development of national agricultures in these regions might be possible, with a consequent expansion of trade." (FAO 1955: item 20) By the time of the conference in 1953, "surpluses of many agricultural commodities had emerged in some areas, notably North America" (FAO 1955: item 12).

The US had a surplus of major crops. Japan did not have enough farmland for food and feed production. To suppress labor costs as well as to ensure enough supply, imports from the US were welcome in Japan. However, the sectors that expanded by selective expansion were damaged by trade liberalization since the 1970s as mentioned earlier. The high dependence on imports from the US for cereals and soybeans was soon revealed to be problematic.

5.4.2 Supply Crisis due to the United States Export Ban in 1973

In June 1973, the US banned soybean exports as a part of an anti-inflation policy without prior notification or consultation with Japan. The "soybean shock" lasted 3 months. In the end, Japan managed to purchase enough soybeans. The event, however, undermined the credibility of the US as a stable supplier.

In 1972–1973, the Soviet Union suddenly increased its imports of agricultural commodities, especially wheat, on a huge scale (Table 5.13). Imports to other countries such as Japan increased rapidly, too. The world trade in wheat and maize grew by around 50% in 2 years, while exports from the US expanded by about two and one-half times during the same period. The US was a principal exporting country of the commodities, and US policy had promoted the expansion to deal with domestic surplus.

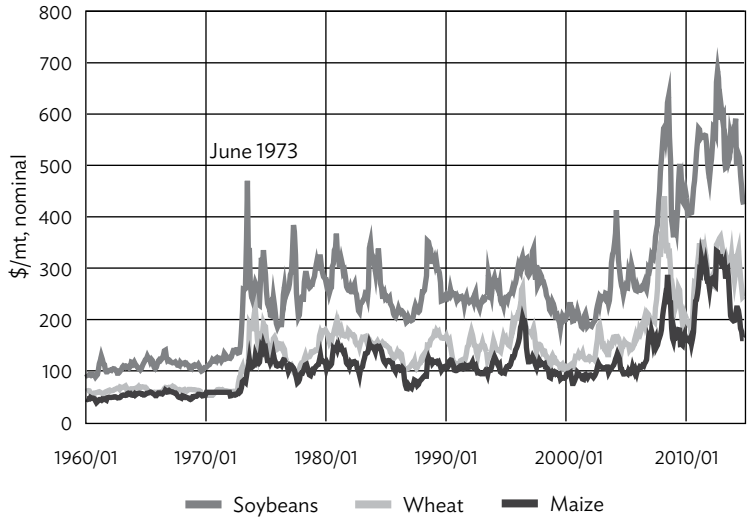
The strong demand for food imports coupled with poor harvests and fish catch in some countries (including Peruvian anchovy) caused price hikes of agricultural commodities in the US and international markets (Figure 5.7). The export price of US soybeans jumped from $148 per ton in November 1972 to $470 per ton in June 1973. And at the same time, the US was confronting inflation. On 29 March 1973, the US imposed price ceilings on beef, pork, and lamb (Destler 1978). The price ceilings on outputs and the price hikes of feed crops squeezed livestock farmers.

Table 5.13 Exports from the United States and Imports to Japan and the Soviet Union of Maize, Soybeans, and Wheat (million tons)

		Year	Maize	Soybeans	Wheat
Soviet Union	Imports	1971	0.9	0	2.3
		1972	4.1	0.3	8.1
		1973	5.4	0.7	15.2
United States	Exports	1971	12.9	11.5	16.2
		1972	22.4	12.0	21.3
		1973	33.2	13.2	37.4
Japan	Imports	1973	7.8	3.6	5.4
	From the United States		6.5	3.2	3.6
	Share of the United States		84.2%	88.3%	67.1%

Sources: FAO (2015a); Ministry of Finance (2015).

Figure 5.7 Development of Crop Prices ($/ton)



mt = million tons.
Source: World Bank (2015).

In an address on 13 June 1973, US President Richard Nixon announced an immediate 60-day freeze on prices of goods purchased by consumers. However, the prices of unprocessed agricultural products at the farm level were exempt from the freeze because such a measure would worsen the tight supply of crops, even though the greatest part of the price increase was due to food. Already 16 million ha of farmland had been opened up to production earlier in the year, but it would take until the harvest in autumn to see the effect. Nixon said that the US would introduce export controls on food products to suppress the domestic prices but declared that it would keep existing export commitments and consult with trading partner countries.

> *One of the major reasons for the rise in food prices at home is that there is now an unprecedented demand abroad for the products of America's farms.* Over the long run, increased food exports will be a vital factor in raising farm income, in improving our balance of payments, in *supporting America's position of leadership in the world*. In the short term, however, when we have shortages and sharply rising prices of food here at home, I have made this basic decision: in allocating the products of America's farms between markets abroad and those in the United States, *we must put the American consumer first*.
>
> Therefore, I have decided that *a new system for export controls on food products is needed*—a system designed to hold the price of animal feedstuffs and other grains in the American market to levels that will make it possible to produce meat and eggs and milk at prices you can afford.
>
> I shall ask the Congress, on an urgent basis, to give me the new and more flexible authority needed to impose such a system. In exercising such authority, this will be my policy: *we will keep the export commitments we have made as a nation. We shall also consult with other countries to seek their cooperation* in resolving the worldwide problem of rising food prices. But we will not let foreign sales price meat and eggs off the American table (Nixon 1973: emphasis added).

The Nixon administration asked exporters to notify existing export orders and new ones thereafter. Exports would be controlled "if necessary to restrain exports sufficiently to bring domestic prices of feed down to levels consistent with the present prices of meats and other animal products" (White House 1973). According to the results of

the survey on the notifications, the amount of soybeans scheduled to be exported from 15 July to 30 August in the year was 1.8 million tons. This was double the amount that was believed to be the domestic surplus available for export (Oki 2008; Destler 1978).

On 27 June, the US imposed an immediate embargo on soybean and cottonseed exports to cut food prices. On 2 July, the Secretary of Commerce said the department would announce the quantities available for export until the next harvest of soybeans. Furthermore, the US would also control maize exports "if there is any big increase in export demand for corn" (*Chicago Tribune* 1973; AP 1973).

On 2 July, the US replaced the embargo with a system of validated licenses. Under the system, the amounts of existing export contracts would be cut by 50% for soybeans and by 40% for soybean oilcake and meal. Further control after autumn would depend on the size of harvest of the year (GATT 1973a). There was no special treatment for Japan.

The soybean embargo and the possible embargo on maize had been unexpected and were frightening for Japan, which depended on the US for most of its supply of soybeans, maize, and wheat (Table 5.14). Domestic production of these had dropped to a negligible level since the introduction of selective expansion mentioned earlier. The Japanese government and industries were optimistic at first and expected some special treatment because Japan was the largest and most stable customer of US crops, and the US had promised it would remain a reliable source for food purchase when urging Japan to import more from the US. However, the atmosphere changed with the plan to cut the existing contracts by half without consultation and in contradiction to Nixon's address. The official act by the US shocked Japanese society. Concerns emerged on further cuts in imports, which could lead to food shortages (Yamada 2012; Oki 2008).

Soybeans are an important food in the Japanese diet. They are used not only for cooking oil and animal feed in the form of soymeal, but also traditional staples such as soy sauce, tofu, miso (fermented paste), and natto (fermented soybean). So the embargo on top of the price hike was hard on Japanese society, given that an overwhelming share of soybeans consumed was from imports (Table 5.14).

It is noted that in spite of these events, Destler (1978) insisted that US officials had to make decisions on export control based on data of which they were skeptical and that "export controls appear totally unnecessary. Once the embargo was imposed, it became clear that much of the apparent export demand was speculative" (Destler 1978: 629), as many contracts did not apply for an export license.

It took nearly 2 months to phase out export control. On 12 July, the US announced that it would license 100% of the existing export

Table 5.14 Supply and Consumption of Soybeans in Japan, 1973 (1,000 tons)

	Soybeans	Products
Domestic Production	118	
Import	3,635	
Domestic Consumption	3,620	
Processed	2,948	
Soybean Oil	2,739	483
Miso	193	783
Soy Source	16	1,411
Tofu	NA	1,085
Food	627	

Sources: MAF (1976) and MAFF (2013).

contracts for soybeans destined for Japan and grown for tofu and high-grade miso . Then on 1 August, the US announced that all soybeans under contract before the embargo would be licensed (JAAPG 1973). According to the announcement on 7 September, export licenses were to be issued to any contract on 8 September and thereafter during September. Also, all restrictions on exports were to be terminated as of 1 October (GATT 1973b). As a result, Japan could secure enough soybeans from the US.

In 1980, the US imposed a cereals embargo on exports to the Soviet Union after the latter sent troops to Afghanistan. An article in *Time* (1980: 6) said, "grain becomes a weapon." Although this embargo was not effective because the international supply situation was loose and the Soviet Union could purchase enough food from other countries to feed its people, Japan became more cautious about import dependence.

6.4.3 Reactions from Japan

The crisis was short-lived but had a long-term impact on Japan. There was a consensus that something had to be done to reduce the risk caused by the high dependence on imports for food and feed from the US (RACI 1974). Practicable choices were limited because Japan did not have enough land resources for self-sufficiency. In addition, there was no other exporting country comparable to the US in terms of the scale and stability, given that world exports were concentrated in the US and that Japan as well as the Soviet Union were, by far, the biggest importing countries.

Japan introduced new measures for soybeans, cereals, and other feed crops. Key elements among the measures were stabilizing the domestic market, attempting to secure imports from the US and other countries, enhancing information availability and analysis to be better prepared, diversifying exporting countries through agricultural development, and increasing domestic production and stockpiling.

Emergency measures included selling government cereal stocks, temporary support for the feed-price stabilization program, and an act against cornering of the market and speculative stocking of products. Measures with mid- and long-term perspectives were also introduced as discussed below.

MAF expanded the existing feed price stabilization program by establishing an additional special fund to deal with extreme price hikes. Industries operated the existing funds, while a government corporation operated the new additional fund. The new fund was financed by the government and the feed industry on a 50–50 basis.

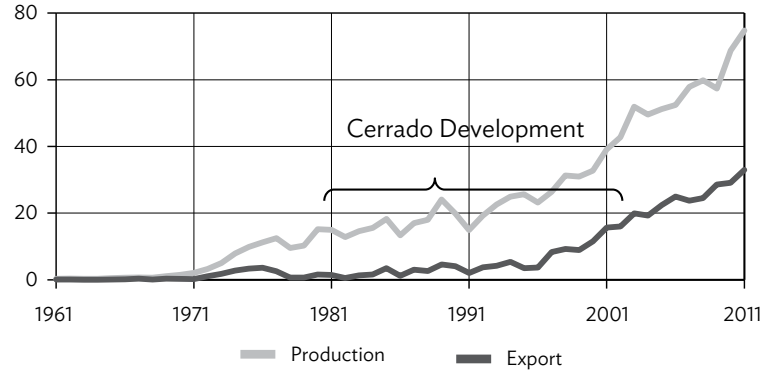
In August 1975, Japan and the US agreed on the import of feed cereals (8 million tons) and wheat and soybeans (8 million tons for each) for the coming 3 years (JAAPG 1975). The government promoted the use of long-term import contracts in the private sector (JAAPG 1974). Furthermore, trading companies and the trading federation of the Japanese agricultural cooperatives group (Zen-noh) started direct investment to the US in the late 1970s.

To understand structural changes in the supply–demand of food in the world in the future, MAF developed a world food supply–demand model. MAF also sent investigation teams to North America, Central and South America, Europe, Southeast Asia, and Oceania.

The world food supply–demand model was a partial equilibrium model covering 10 commodities and 25 regions with the capability of forecasting from year to year. MAF published the forecasts for 1980 and 1985 (MAF 1975). The architect of the model, Keiji Ohga, continued for decades improving the model in the FAO and the International Food Policy Research Institute as well as in Japan. This model has made a significant contribution to international public goods. The late IMPACT model of the International Food Policy Research Institute is based on his model. The AGLINK–COSMO model has also integrated elements of Ohga's model (MAFF 2009).

Japan also expanded international cooperation for agricultural development. The Japan International Cooperation Agency was established in 1974 for the purpose of developing imports and diversifying exporting countries. By far, the largest program was the development of Brazil's Cerrado region (1979–2001). During the program, the productivity and thus production and export of soybeans

Figure 5.8 Trends of Soybeans in Brazil: Production and Export



Source: FAO (2015b).

increased significantly (Figure 5.8). Although it did not contribute directly to Japan's procurement in a significant manner, it enabled Brazil to evolve into the second top-exporting country of soybeans comparable to the US.

The domestic production of wheat and feed crops was expanded to some extent, but it had no chance to reach the level of the pre-war period (MAF 1975; JAAPG 1975). Numerical targets of higher self-sufficiency were set but not met. MAF increased and encouraged the stockpiling of feed grain and soybeans by both the government and the private sector (JAAPG 1974).

5.4.4 Lessons Learned

An apparent lesson is the risk arising from high import dependence. As Oki (2008) pointed out, complaints among domestic consumers in food-exporting countries can surpass trade and diplomatic interests, as observed often over these years. On the other hand, large imports were inevitable to maintain living standards because Japan did not have enough farmland.

The size of the importing country also matters. It is not easy for a large importer like Japan to find alternative sources in concentrated international markets even in ordinary times. So Japan sought other measures on the external side, while keeping domestic production and boosting its stockpile.

As it turned out, Japan found two additional measures in the midst of these constraints: foreign agricultural development and a world forecast model. Following the Cerrado development program, Brazil changed the trade pattern of soybeans in the world significantly and now serves as one of the main suppliers to the People's Republic of China (PRC). This evolution eased the supply–demand situation in the world and thereby contributed to stable imports to Japan. World forecast models now enable Japan and some other Asian countries to deal with forthcoming situations in advance and in a better way, such as through international cooperation.

5.5 Current Measures for Food Security

Since 1999, an explicit food security policy for being prepared even during ordinary times has been developed under the new Basic Act and Basic Plans. As such, it has a preparatory and preventive nature and has increasingly evolved into a comprehensive policy.

5.5.1 Basic Act of 1999

In 1999, the current Food, Agriculture and Rural Areas Basic Act (Act No. 106 of 16 July 1999) replaced the Agricultural Basic Act of 1961. In the formation process of the new Basic Act, food security was one of the major concerns, given the international price hike in 1996 and the expectation of a huge expansion in imports by the PRC and other emerging countries in the future. The "Who will feed the PRC" issue caused wide concerns internationally at that time. The fragility of domestic agriculture and adaptation to trade liberalization were also major problems.

As a result, the new Basic Act called for an increase in domestic agricultural production (Article 2 (2)) for securing a stable food supply and introduced a target rate of the food self-sufficiency ratio (Article 15). At the same time, imports and reserves are also considered important sources (Article 2 (2)).

The target rate of food self-sufficiency ratios has been set in the Basic Plan for Food, Agriculture and Rural Areas established every 5 years in principle. This was the first time that such a target was set by law. The levels of the targets were ambitious when actual agricultural production was reducing continuously.

> Article 2 (Securing of Stable Food Supply):
> (1) Given that food is indispensable for maintaining human life and important as a basis for a healthy and fulfilling life,

high-quality food must be stably supplied into the future at a reasonable price.

(2) Given that the world's food supply and demand balance and food trade involve unstable factors, a stable supply of food to citizens must be ensured by increasing domestic agricultural production as a base and appropriately combining it with imports and stockpiling.

...

(4) Supply of the minimum food necessary for citizens must be secured in such a manner that no serious hindrance will be caused to the stability of citizens' lives or to the smooth operation of the national economy even where the domestic food supply and demand balance becomes or is likely to become extremely tight for a reasonable period of time due to a contingent cause such as poor harvests or interrupted imports.

Article 15:

(2) The Basic Plan is to provide for the following matters:
  (i) the basic policy for measures for food, agriculture, and rural areas;
  (ii) the target rate of food self-sufficiency;
  (iii) measures to be comprehensively and systematically implemented by the government with regard to food, agriculture, and rural areas; and
  (iv) in addition to what is set forth in the above three items, matters necessary for comprehensively and systematically promoting measures for food, agriculture and rural areas.

As policies for securing a stable food supply, the act includes food safety and quality (Article 16 (1)), development of the food industry (Article 17), securing stable imports (Article 18(1)), developing healthy dietary guidelines and disseminating knowledge and information regarding food consumption (Article 18(2)), emergency measures for food security (Article 19), and international cooperation for agricultural development (Article 20). Among these, Articles 18, 19, and 20 are relevant to current food security measures.

Article 18 (Measures concerning Imports and Exports of Agricultural Products):

(1) The State is to take necessary measures for securing the stable importing of agricultural products for demand that cannot be met by domestic production, and where importing agricultural

> products causes or is likely to cause a serious hindrance to the production of competitive agricultural products and there is an urgent necessity, it is to adjust the tariff rate, restrict the importing or implement other necessary measures.

> Article 19 (Food Security in Emergencies):
> In the case prescribed in Article 2, paragraph (4), if the State finds it to be necessary for securing the minimum food necessary for citizens, it is to increase the production of food, restrict distribution or implement other necessary measures.

> Article 20 (Promotion of International Cooperation):
> In order to contribute to ensuring the stability of the world's food supply and demand balance into the future, the State is to endeavor to promote technical and financial cooperation for the development of agriculture and rural areas in developing regions, food aid to these regions, and other international cooperation.

Besides, the act also has a prescription for maintaining resources for agricultural production in the context of sustainable development (Article 4) among general provisions.

> Article 4 (Sustainable Development of Agriculture):
> Given the importance of the function of supplying food and other agricultural products and the Multiple Functions performed by agriculture, the sustainable development of agriculture must be ensured by securing necessary agricultural land, agricultural water, and other agricultural resources as well as the agricultural workforce ...[9]

5.5.2 Development of Measures

Under the new Basic Act, the current food security policy has developed on the basis of a series of basic plans that are drawn up every 5 years.

The Basic Plan of 2000 (MAFF 2000), which was the first basic plan, set the following five policy areas to orchestrate measures on ensuring a stable food supply.

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[9] Source of the translation of the Basic Act: http://www.japaneselawtranslation.go.jp/law/detail/?id=2339&vm=04&re=01 (Translation date 23 May 2013).

(i) Food consumption: sanitary and quality control, labels, and healthy diet
(ii) Food industry: enhancing business foundation, cooperation with domestic agriculture, rationalization of distribution, and lowering environmental load
(iii) International trade: ensuring stable import, promoting exports, stockpiling
(iv) Food security in emergency: necessary measures in emergency and developing a manual
(v) International cooperation: technical and financial cooperation and food aid

As part of the measures for food security in an emergency situation, the Food Security Manual for Emergency Situations (renamed Guidelines for Food Security in Emergency Situations in 2012) was introduced in 2002 (MAFF 2002). The manual is composed of practices to be conducted in ordinary times, classification of emergency situations, arrangement of organizations to deal with the situations, and measures for each level of emergency. Most measures were similar to the ones used in the food control system during the 1940s and 1950s. There are three levels of emergency corresponding to the extent of severity (Figure 5.9). Level 0 includes the anticipation of a major crop failure domestically or in the foreign production region. Level 1 includes export restrictions in the main exporting countries like the case in 1973. Level 2 corresponds to a major decrease in the imports of cereals and soybeans. The measures for this level are seemingly equivalent to wartime ones, such as production control (conversion and use of nonarable land), rationing, price caps, and allocation of oil. The measures are based on existing laws including the Act for Stabilization of Supply-Demand

Figure 5.9 Composition of Measures in the Food Security Manual

Level 0	Level 1	Level 2
▪ Supply-related information ▪ Utilizing stock and ensuring import ▪ Minimizing loss ▪ Monitoring prices	▪ Additional planting ▪ Correction of regional imbalance and excessive stockpiling ▪ Standard price	▪ Production conversion (energy efficient crops, fallow areas) ▪ Land use change (wilderness, rangeland) ▪ Rationing ▪ Price cap ▪ Fuel-oil allocation

Source: Based on MAFF (2002).

and Prices of Staple Food (Act No. 113, 1994) that succeeded the Food Control Act of 1942; the Price Control Ordinance of 1946; and the acts established in 1973 to deal with the soybean supply crisis, inflation, and oil shock.

The Basic Plan of 2005 (MAFF 2005) stressed the facilitation of stable imports. It included information gathering and exchange, free trade agreements and economic partnership agreements, eliminating trade barriers such as export control and export tariffs, as well as stockpiling of cereals and others.

In reaction to international price hikes of commodities since late 2006, the development of the food security policy geared up. MAFF started constant monitoring of key production countries and regions in 2007 and set up a permanent division devoted to food security in 2008. In addition, private companies such as Marubeni, Sumitomo, and Mitsui invest directly in Brazil, Argentina, and Australia. They usually tend to keep away from farmland purchases or crop production but have increasingly expanded food trading in these countries and helped them to export to diverse destinations with a focus on Asia.

The Basic Plan of 2010 (MAFF 2010) introduced a wide-ranging policy for "establishing a comprehensive food security." The main additional measures undertaken were

- creating an enduring supply of agricultural inputs such as fertilizers and genetic resources;
- appropriately and efficiently stockpiling rice and wheat;
- enhancing sanitary and phytosanitary measures;
- creating measures against disruption of commercial distribution;
- enhancing mid- and long-term forecasts of international supply–demand;
- monitoring and regulating markets (in the world) in cooperation with other countries to prevent significant inappropriate price formation in futures markets;
- encouraging interational aid;
- actualizing international rice stocks among East and Southeast Asian countries;
- helping overseas agricultural investment by the private sector; and
- promoting principles for responsible (international) agricultural investment.

Following the success of the Cerrado development in Brazil, Japan began an agricultural development program of the savanna area in Mozambique based on tripartite cooperation including Brazil. With the soil and climate in the region resembling those in Brazil, this savanna

area in Mozambique has a huge potential for agricultural production, while there are economic and socioeconomic challenges.

An additional guideline for local and short-term emergency was adopted in 2012, after learning lessons from the Great East Japan Earthquake and the accident at the Fukushima nuclear power plant in 2011.

The New Basic Plan of 2015 (MAFF 2015) introduced some new key elements as follows:

- "Food self-sufficiency capacity," which represents the potential capacity of domestic production in the case of emergency, employing existing resources such as land, technicians, and labor, rather than current actual production, which is reflected in the self-sufficiency ratio.
- Developing a forecast system of food supply–demand in the long term (2050) based on a new impact evaluation of climate change.
- Developing technologies toward expansion of domestic feedstuff production and toward exploitation of unused domestic resources as raw materials for fertilizers.
- Facilitating activities to secure functions of the food supply chain, including development of a business contingency plan for the food industry, coordination between business and local governments, and food storage at the household level.

For the food self-sufficiency capacity, an indicator—i.e., available calorie supplies per capita per day by domestic production of agriculture, forestry, and fisheries based on a certain scenario of conversion in agricultural production—was developed. The trend of the indicator was consistently downward, even though the SSR level has been stable since the late 1990s. The government publishes the latest values of the indicator based on four different scenarios every year (Table 5.15).

5.5.3 Observations

Import-dependent countries have to deal with uncertainties such as market disruptions caused by major players like the US, even if they do not intend to restrict trade. Obviously, most current measures by the Government of Japan can deal with not only a severe shortage of supply but also more frequent and less severe cases of disruption. Hence the scope of the food security policy in Japan is broader to ensure a high standard of "the stability of citizens' lives or to the smooth operation of the national economy" (Basic Act of 1999 Article 2(4)). Given the

Table 5.15 Indicators of Food Self-Sufficiency Capacity for Fiscal Year 2013 (per capita/day)

Indicators	
Pattern A: concentration on rice, wheat, and soybeans (with consideration of nutritional balance)	1,495 kcal
Pattern B: concentration on rice, wheat, and soybeans (without consideration of nutritional balance)	1,855 kcal
Pattern C: concentration on potatoes (with consideration of nutritional balance)	2,462 kcal
Pattern D: concentration on potatoes (without consideration of nutritional balance)	2,754 kcal
Reference levels	
Energy supply (actual one)	2,424 kcal
Estimated energy need	2,147 kcal

kcal = kilocalorie.
Source: MAFF (2015).

preparatory and preventive nature of the measures, it is difficult to point out which measure is more effective. Besides government policy measures, business activities by the private sector, especially trading companies, also contribute to stable imports.

5.6 Changing Situations and Prospects

As far as food security is concerned, Japan is faced with challenges that are both macro and micro in nature. The former necessitates a major rearrangement in production in the future as discussed below. The latter refers to the widening disparity of purchasing power among households and individuals.

5.6.1 Changing Resource Endowment

In the current scenario, agricultural land resource endowment in Japan will change because of the changing population. The trend in land resources is another factor.

According to projections by the National Institute of Population and Social Security Research, based on their main scenario, the Japanese population will decrease by around one-third by 2060 and around 60% by 2100 compared with 2010 (Table 5.16). Even in the most moderate case, the population will decrease by half by the end of the 21st century.

Table 5.16 Predicted Population in Japan (base year 2010 = 100%)

Year	Mortality	Birth Rate		
		Low	Middle	High
2060	High	61.4%	66.6%	72.8%
	Middle	62.5%	67.7%	73.9%
	Low	63.5%	68.8%	75.0%
2100	High	28.9%	38.0%	49.8%
	Middle	29.6%	38.7%	50.6%
	Low	30.4%	39.5%	51.5%

Note: Projections represent different scenarios regarding birth rate and mortality. Projections for 2100 are ancillary.

Source: NIPSSR (2012).

Even if the numbers for 2100 are ancillary and some countermeasures can be employed, there is a good chance of a major shrinkage in the long term.[10]

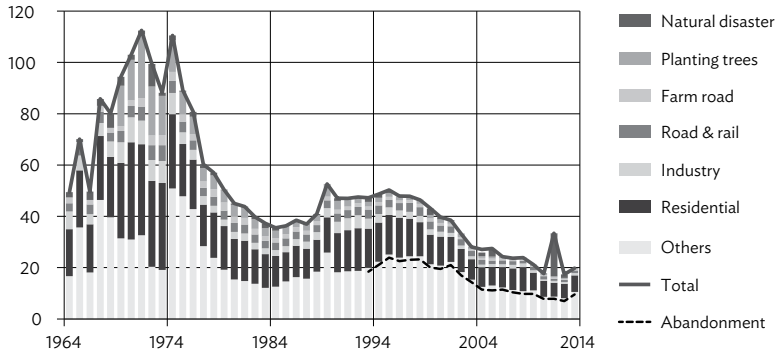
A lower population translates into more land per capita. This means that the land resource constraints can be eased and that agriculture can become more competitive, provided agricultural land is maintained and used appropriately.

The conversion and abandonment of arable land slowed significantly as the demand from nonagricultural sectors shrank (Figure 5.10). The arable land area has decreased from a peak of 6.08 million ha in 1961 to 4.54 million ha in 2012. Yet the decline slowed as economic growth slowed and land prices decreased. The size of abandoned land was 0.4 million ha in 2010. In terms of flow, annual conversion, and additional abandonment of arable land peaked in the 1970s (0.11 million ha per year). It has decreased since the mid-1990s to the current level of less than 0.02 million ha per year.

Even though Japan does not have enough farmland to satisfy domestic consumption, at the same time, under the rice crop diversion program, there is a surplus of more than one-third paddy fields. The paddy fields and diverted area among them account for 54% and 19% of the total agricultural land (Figure 5.11), respectively. The breakdown

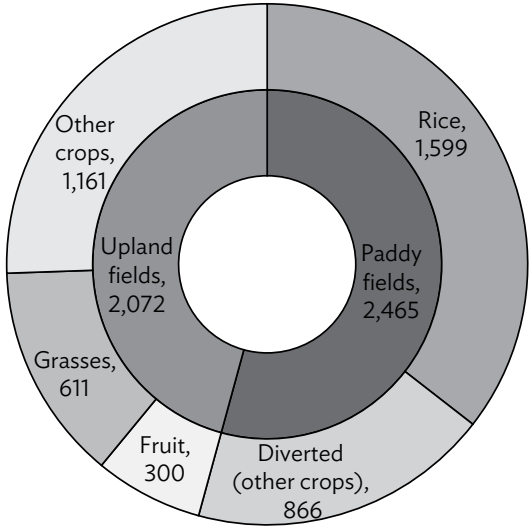
[10] According to the long-term vision of Japan's population policy, which was approved in a cabinet meeting on 27 December 2014, even in the best case scenario, presuming that the total fertility rate will increase from 1.43 in 2013 to 1.8 by 2030 and 2.07 by 2040, respectively, the population will decrease by around 20% by 2060 and around 30% by 2110.

Figure 5.10 Conversion and Additional Abandonment of Arable Land (1,000 ha)



ha = hectare.
Source: MAFF (2014b).

Figure 5.11 Composition of Farmland Area, 2013 (1,000 ha)



ha = hectare.
Sources: MHLW. Survey on Income Redistribution (various dates).

of arable land shows that the rice planting area had already shrunk by half from the peak of 3.30 million ha in 1960 to 1.58 million ha in 2012. This decline almost matches the decline in arable land area.

The promotion of converting to alternative crops was not successful, given the concentration of government protection and support to rice, while downplaying other crops.[11] Such a policy framework is compatible with the "selective expansion" from the former Agricultural Basic Act of 1961.

A decreasing population means less demand for rice as well as other agricultural commodities in the future, leading to a surplus of agricultural land. Given the scale of the potential surplus, unless Japan exports a significant amount, these lands can only be absorbed into the animal feed and/or oilseed sector, which mainly depends on imports. As mentioned earlier, the land equivalence of agricultural imports was more than three times larger than actual agricultural land in the mid-1980s.

The major obstacles to the transition in agricultural production are shrinking production, aging farmers, and trade liberalization.

Japan will see a rapid decrease in the number of farmers. This will lead to both a scaling up of surviving farms and land abandonment. In the situation of fewer farmers and more abundant agricultural land, marginal lands could be used for grazing, which could potentially reduce the production cost of livestock.

However, additional trade liberalization agreements such as the Trans-Pacific Partnership could lead to a significant decrease in domestic agricultural production and further dependence on imports, leaving agricultural land abandoned. The impact is likely to be more severe than in the past when growth in demand absorbed expansion of imports.

In short, maintaining farmland and adapting agricultural land use to the demographic changes, especially on the demand side, in the midst of trade liberalization, is a challenge for Japan. Extensive agriculture with low costs, such as grazing, could be part of the solution.

5.6.2 Widening Economic Disparities

At present, there are symptoms indicating that food insecurity at the household and individual levels among the low-income groups could rise.

For example, the disparity in income levels has increased in the past 3 decades. The Gini coefficient trend has been upward since the

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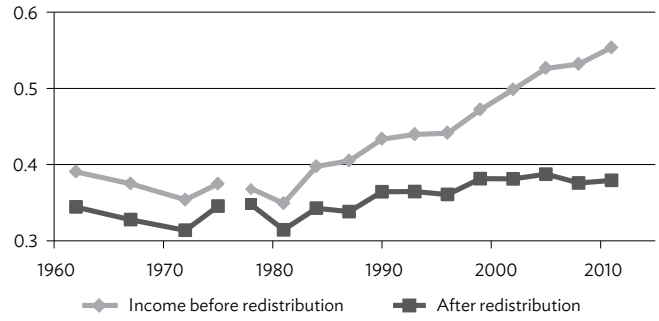
[11] Existing measures to facilitate the high dependence on imports, as well as ratchet rules of trade liberalization, substantially undermined the flexibility in the policy choice of Japan to protect and/or promote domestic production of crops other than rice.

Figure 5.12 Trend of Gini Coefficients



Sources: MHLW (various dates).

Table 5.17 Development of the Relative Poverty Ratio[a] in Japan (%)

	1985	1988	1991	1994	1997	2000	2003	2006	2009	2012
All	12.0	13.2	13.5	13.7	14.6	15.3	14.9	15.7	16.0	16.1
Children[b]	10.9	12.9	12.8	12.1	13.4	14.5	13.7	14.2	15.7	16.3
Households[c] with child	10.3	11.9	11.7	11.2	12.2	13.1	12.5	12.2	14.6	15.1
Households[c] with child and only one adult	54.5	51.4	50.1	53.2	63.1	58.2	58.7	54.3	50.8	54.6

[a] Relative poverty represents income level less than half of the median of disposable income adjusted by the number of family members adopting definition by OECD.

[b] Children are less than 18 years old. Adults are 18 years old or above.

[c] Economic active households—i.e., head of the household—is older than 17 and younger than 65.

Source: MHLW (2014c).

1980s (Figure 5.12). The relative poverty ratio is on an upward trend and reached 16.1% in 2012 (Table 5.17). Households receiving public assistance bottomed out in 1996 and increased from 1.4% to 3.2% in 2012, which is as high as in the mid-1970s. There is a concentration of poverty among single-parent families. Reportedly, there are children for whom school lunch is the main source of food.[12]

[12] Statement by Aya Abe from the National Institute of Population and Social Security Research. Nikkei Business Online (2014).

In 2012 (and 2007), the National Institute of Population and Social Security Research conducted household surveys on social security. The surveys asked whether households had experienced economic inability of purchasing food needed for the family during the past year. In 2012, there were such experiences "often," "sometimes," and "rarely" among 1.6%, 4.5%, and 8.5% of the respondents, respectively (NIPSSR 2014).

After World War II, Japan had been a relatively equal society economically. Factors contributing to this equality include the loss of capital in wartime, hyperinflation in the aftermath of the war, land reform, the "capital levy" in 1946–1947 (Shavell 1948), stable jobs, the popularization of advanced education and income redistribution with progressive taxation, a social security system, and reallocation of tax money to low-income regions. However, since the late 1980s, job stability, salary levels, and the income redistribution system have gradually degraded. So far, there is no sign of change in the trend. Therefore, the likelihood of greater food insecurity at the low-income household and individual levels is a concern that should not be ignored.

5.7 Concluding Remarks

This chapter traced major events threatening national food security in Japan since 1946 and illustrated the development of policy measures to ensure food security, which were mainly introduced as counter and/or preventive measures against crises and threats. Conclusions and more general lessons are as follows.

5.7.1 Conclusions

The single-most important measure to ensure an adequate food supply was importation on a large scale, although it was perceived as double-edged. Agricultural land resources and the food supply had been constraints for Japan for a long time. In the aftermath of World War II, Japan eventually found an affluent and relatively stable source of imports: the United States. Importing was also a cost-effective way of sourcing. During the Cold War and with surpluses in the US, Japan could expand imports steadily and enjoy a diversified diet. At the same time, however, this led to a risk related to the high dependence on imports. Fortunately, the supply–demand situation of international markets has not been tight for the most part since the 1950s. Yet the future was uncertain, and supply instability sometimes emerged. Therefore, Japan has tried to maintain steady domestic production as well as secure stable imports. So far, Japan has been able to secure

the domestic food supply, although the result in the long term is yet to be seen.

When national food shortages significantly affect calorie intake, control measures covering the whole food system are essential. Japan remains prepared for measures in such an emergency, and it has introduced preventive measures focusing on a stable supply at the national level.

With a high economic development level, the public will expect a high level of stability in the food supply. Recent measures adopted by the government have been designed to best cater for such expectations. These measures are able to handle frequent and small-scale disruptions in the food supply, both domestically and internationally, to ensure stable supply with the desired quantity and quality.

To deal with land resource constraints and low competitiveness in agricultural production, Japan has used intervention, regulations, and support measures to accommodate concerns over food security. To formulate and carry out such measures effectively, well-functioning of political and economic institutions are quite important.

The ongoing shrinkage in the population makes it possible for Japan to improve the deficit of domestic food production significantly (and also the competitiveness to some extent) in the future by maintaining farmland. It seems to be the first opportunity for Japan in centuries.

The selective expansion policy of the former Agricultural Basic Act, which formed the current composition of Japanese agriculture, was a product of the shortfall of land resources in Japan and surplus production in the US. Now the situation has changed. The new situation of potentially more land resources per capita in Japan due to the decline in the population, needs an alternative paradigm. Japan should consider how to make the best of this opportunity.

5.7.2 General Lessons

In ordinary times, economic development or, in other words, income level is the key factor for improving food security. In the case of emergencies, the market does not necessarily work well enough for securing the food supply. The risk is demonstrated by the two crises in the past decades, i.e., the food crisis in the aftermath of World War II and the US export ban in 1973.

On international imports, two issues are pointed out. First, peace is a requirement for the smooth functioning of the international market and transport. Second, international shortages of food caused by shortages in exporting countries and/or a sudden boost of imports in third countries sometimes arise. In such cases, an exporting country might be obliged to

introduce export allotments that could be inadequate for each importing country. The extent of the dependence on imports, the concentration of imports, the absolute size of imports, and the capability to increase domestic production affect the impact of the import disruption and the ability to find alternative sources.

Domestically, there can also be disruptions to distribution, where government regulations or controls are needed. Especially in the case of severe shortages, strong government intervention to ensure equitable allotment is justified.

Even with emergency measures, the consequences of disruptions to the food supply can be severe for the welfare of the nation. Furthermore, nowadays, the public expect high standards of the stability and quality of food. Therefore, preventing emergencies would be better than confronting them. For example, expanding the production and export capacity through international cooperation can be beneficial for both the recipient and assisting countries. Besides, being prepared can make an emergency controllable. In short, preventive and preparatory measures translate into resilience. Being conscious of the exposure to risks in ordinary times helps to understand what action to take and enables swift reaction in an emergency.

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6

Food Security in the Republic of Korea and the Democratic People's Republic of Korea: Why the Difference?

Joo-Ho Song and Tae-Jin Kwon

6.1 Introduction

By the 2010s, the Republic of Korea had achieved a high level of food security, but today, the Democratic People's Republic of Korea still does not have an adequate amount of food to feed its people. This chapter examines the food security status in these two countries over the past decades and identifies forces that have resulted in the huge difference in their levels of food security.

The Republic of Korea and the Democratic People's Republic of Korea used to be the same country: Korea. In 1945, Korea gained its independence from Japanese colonial rule. Soon, the Korean peninsula was divided into two countries, the Republic of Korea and the Democratic People's Republic of Korea. The 38th parallel separated the two countries with the Democratic People's Republic of Korea to its north and the Republic of Korea to its south. The United States (US) Armed Forces were stationed in the Republic of Korea, while the Soviet Armed Forces in the Democratic People's Republic of Korea. The Republic of Korea chose to be based on a market economy as a democratic country; the Democratic People's Republic of Korea was based on a centrally planned economy as a socialist state.

In 1950, the Korean War occurred and continued for 3 years. On 27 July 1953, the two countries signed an armistice to make a new border on the Military Demarcation Line. The massively fortified strip (the Korean Demilitarized Zone) bisects the peninsula and is one of the world's most dangerous potential flash points. As a result,

people in the two countries have lived different lives under different regimes.

At the time of independence from Japan, the northern part of the Korean peninsula was an industrial zone, and the southern part was largely an agricultural zone. The northern part also had more land with less population, and thus was in a better position than the southern part in terms of food provision. The Democratic People's Republic of Korea was more economically developed, and its per capita income was higher than the Republic of Korea until the mid-1970s.

Since the mid-1960s, the Republic of Korea has achieved rapid economic development and has evolved from a country receiving foreign aid to one that gives aid. In the meantime, the Democratic People's Republic of Korea has become dependent on foreign aid. Although the Republic of Korea does not produce enough food to feed its people due to the limited amount of arable land, its deficit has been replenished through imports. Few people in the Republic of Korea worry about their meals. Poor people seldom suffer from starvation due to various social safety net programs. However, a large segment of people from the Democratic People's Republic of Korea, including children, suffer from chronic food shortages. Many starved to death in the mid-1990s. Today, even with foreign aid, the Democratic People's Republic of Korea has difficulty feeding its people adequately.

This chapter examines the food security practices of the two countries and elaborates on the reasons for the differences between them. Sections 6.2 and 6.3 survey the food security status in each of the two countries. Section 6.4 explores the causes that resulted in the different food security status in these two countries. Finally, Section 6.5 gives concluding remarks and implications.

6.2 Food Security in the Republic of Korea

6.2.1 Dynamics in Food Demand and Supply

Overview

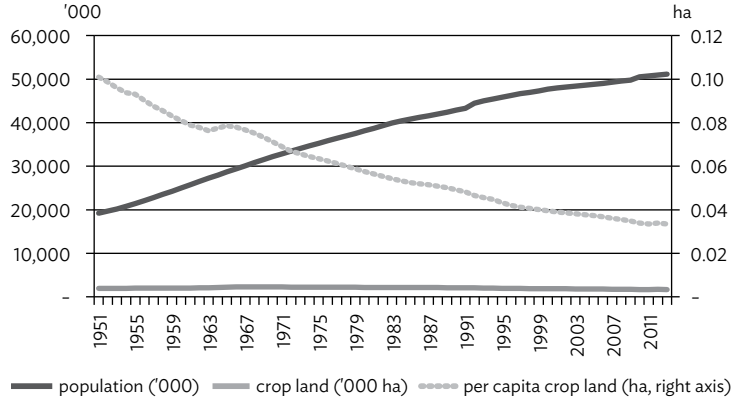
At the time of its establishment in 1948, the Republic of Korea could not produce enough food to feed its people. Deficient fertilizer and pesticide application, poor quality of seeds, and inadequate irrigation systems all contributed to low yields. The country had to rely partly on foreign sources to feed its people. The country was poor, with a per capita gross domestic product (GDP) of less than $100 per annum. It did not have enough money to import food. The food shortages had to be met to a great extent by food aid from donor countries. This situation lasted until

the late 1960s. In 1969, when the Republic of Korea could afford imports, there was a shift from dependence on food aid to commercial imports. The extensive use of imports and aid, however, affected the domestic production pattern of crops. Many farmers abandoned production of some traditional crops such as wheat and cotton. This further intensified the dependency on foreign supply of such crops.

The population increased from 20.78 million in 1954 to 51.14 million in 2013, an increase of almost 150%. In the meantime, the arable land area, both in total and per capita, shrank. In 1954, the total cultivated land was 1.95 million hectares (ha). It increased to 2.31 million ha in 1968 due to increased efforts to reclaim more land to produce more food. Starting from the late 1960s, the size of the total cultivated land reduced continuously as a result of rapid urbanization and industrialization. By 2013, it dropped to 1.71 million ha. Combined with the high population growth, arable land decreased from 0.094 ha per capita in 1954 to 0.033 ha per capita in 2013 (Figure 6.1).

Domestic production alone could not meet food demand, and the dependency on food imports has continued and increased since the early 1970s. Following the increase in consumer income, demand for meat and processed food also increased. Such demand induced further changes to the domestic food production mix. Domestically, food production increasingly concentrated on staple food, chiefly rice. Efforts

Figure 6.1 Trends of Population, Cultivated Area, and Per Capita Cultivated Area, Republic of Korea, 1954–2003



ha = hectare.
Source: MAFRA (2015).

to produce feed grain declined with shortages being met by imports. By the early 2010s, although a significant portion of rice supply was still from domestic sources, the overall self-sufficiency ratio (SSR) for grain (including feed grain) became low, at 25% in 2013.

Post-War Food Shortages and Reliance on Food Aid

The Korean War (1950–1953) worsened the food shortage problem due to the loss of grain stocks, interruption to farm production, and damage to fields and other infrastructure. The influx of refugees from the Democratic People's Republic of Korea after the war increased the population and thus food demand. The price of rice, the staple food, rose sharply, increasing 334% from 1954 to 1957. To cope with the severe food shortages and to stabilize rice prices, the government revived the compulsory rice collection system from farmers, which had been enforced during World War II by the Japanese colonial government. The collected rice was distributed to government employees, poor people, and military personnel. The procurement price for rice was below the market price until 1960. This neither made the farmers happy nor contributed to boosting food production.

After 1945, the country received a large amount of foreign aid, mostly from the US, to lessen economic turmoil and spur economic development. From 1945 to 1954, various relief programs provided $1.225 billion as aid. Of this, $473 million was for agricultural products (Chang 1988). In 1955, the US passed the Agricultural Trade Development and Assistance Act of 1954, commonly known as Public Law 480 or PL480. This law allowed the US to use surplus agricultural products as food aid to many developing countries. In 1955, the Republic of Korea entered into an agreement with the US to receive about 500,000 tons of rice, barley, and wheat every year as food aid under PL480 to resolve food shortages. The quantity of food aid provided each year accounted for 5%–23% of domestic food production during 1956–1963 (MOA 1978).

US food aid helped solve the chronic food shortages in the 1950s and 1960s. However, the quantity of food aid often exceeded the appropriate level. In 1958, 968,000 tons of food were provided, which was 47.3% higher than the projected deficit (MOA 1978). Since the food aid was sold at prices lower than the market prices, the prices for domestically produced food were depressed. Farmers were discouraged from producing more food. Some less competitive crops such as wheat and cotton and minor crops vanished in the Republic of Korea. During 1955–1967, most of the PL480 aid was in the form of grants.

In 1968, a long-term loan arrangement was made for imports under PL480. Imports under PL480 were terminated in 1981. The US provided

$2,994 million of agricultural products as food aid during 1945–1981, which accounted for 49.6% of the total US economic aid to the country (MAF 2003).

Management of Staple Food Demand and Supply

Rice is the staple food in the Republic of Korea. Rice is not just food but has cultural significance, as reflected in the celebration of good rice harvests in farmers' music (*Nongak*). Rice accounts for a significant portion of the total food consumption. Hence, if the demand–supply of rice were adequately managed, it would help maintain the overall food demand–supply enormously. The government has focused its policy efforts on rice demand and supply.

The government developed two food production expansion five-year plans (1953–1957 and 1958–1962) to increase food production with a focus on rice production expansion.[1] The most important measures were expanding cultivated land through land reclamation, increasing the supply of fertilizers, developing high-yield varieties, and applying appropriate pesticides and herbicides. Before 1963, the increase in total food production was modest, increasing slightly from 4.413 million tons in 1954 to 4.819 million tons in 1963. In the early 1960s, a shift in food production took place from producing many crops to a focus on rice. The government set a target to be self-sufficient in rice. This strategic shift led to concentrated policy efforts and increased expenditures on rice production. Heavy investment on land reclamation, farming mechanization, and irrigation systems for rice production were made during the 1960s–1990s, partly with foreign loans.

On the demand side, the government encouraged people to eat rice mixed with barley and coarse grain to reduce the demand for rice. In schools, teachers were asked to check whether students' lunch boxes had mixed grain (rice and other grain). The government also monitored restaurants to ensure that they were using mixed grain. In the meantime, imported wheat was processed into wheat flour, which was sold at a low price to encourage consumers to substitute it for rice. Such measures helped the country mitigate the rigid consumer demand for rice during the years of tight supply. In more recent times, as income has grown, people have taken to consuming more meat and vegetables. This has helped reduce the intake of rice. Over the past decades, the per capita average consumption of rice has gradually declined from a peak of 136.0 kilograms (kg) in 1970 to 67.2 kg in 2013.

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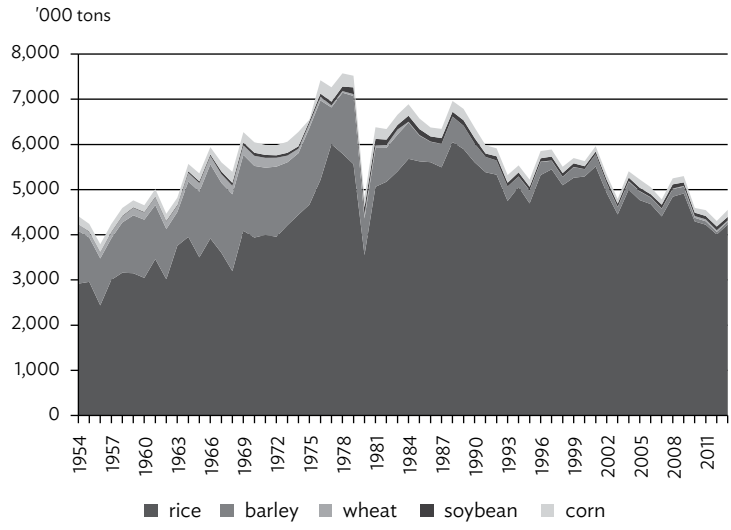
[1] Such plans were later incorporated into the nationwide five-year economic development plan started in 1962.

As a result of diligent efforts to boost rice output since the 1960s, the Republic of Korea's rice output started increasing and impressively so (Figure 6.2). In 1978, the country finally attained its rice self-sufficiency target. (The sudden plummet in rice output in 1980 was a result of cold weather, which reduced rice production by 36% compared with the previous year.) It is noted, however, the production of other grain crops has shrunk continuously (Figure 6.2), with the deficit being met through imports. Combined with the lower per capita consumption, the high level of supply of rice from domestic production, through focused efforts, has enabled the country to be in a reasonably comfortable situation in terms of the staple food supply, despite the increase in total population.

Attainment of a Diverse and High Level of Food Intake

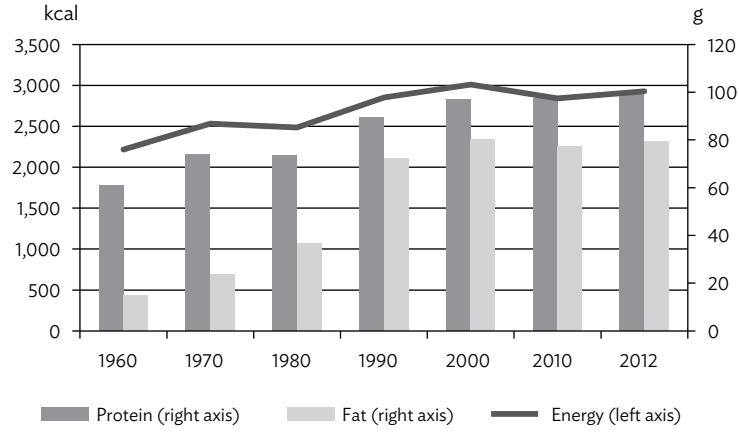
Over the past decades, the food supply in the Republic of Korea has continued to improve, and the achievement in increasing residents' food intake has been impressive. In terms of energy supply (kilocalories [kcal] per capita per day), it was 2,218 kcal in 1960, below the 2,450 kcal

Figure 6.2 Production Trend for Major Crops, Republic of Korea, 1954–2013



Source: MAFRA (2015).

Figure 6.3 Nutrition and Food Supply per Capita per Day, Republic of Korea



g = gram, kcal = kilocalorie.
Source: KREI (2013a).

average dietary energy requirement (ADER). It has increased since then, reaching 2,500 kcal per capita per day and exceeding the ADER by the early 1970s. Starting from the early 1980s, it further increased and has remained at a level well above the ADER (Figure 6.3). Both protein and fat supply have also increased. They used to be low in 1960, being 60.8 grams per capita per day and 14.8 grams per capita per day respectively, below the daily intake requirements. In 2013, protein supply increased to 99.2 grams, while fat supply increased to 96.9 grams, above the daily requirement level (KREI 2013a).

Not only is the food intake level adequate, the food intake composition has also become more diversified. Table 6.1 shows that in 1960, cereals were the major item consumed. The consumption of nonvegetable food was minimal. By the early 2010s, while the consumption of cereal dropped by a big margin, the consumption of all other major food, including animal food such as meat and milk, increased rapidly. The nutrition intake from animal food experienced a major boost by the early 2010s (Table 6.1).

Incidence of Low-Level Food Self-Sufficiency

Despite the high level of food supply achievements, the Republic of Korea's food supply relies on imports due to its limited agricultural

Table 6.1 Per Capita Food Supply, Republic of Korea, 1960–2012 (kilogram/year)

	1960	1970	1980	1990	2000	2010	2012
Grain	199	216	185	175	166.8	145	146
Rice	124	134	133	121	98	81	79
Wheat	19	19	29	30	36	33	32
Barley	49	60	14	2	2	1	1
Pulses	6.6	9	9.7	10.3	10.7	10.4	10.9
Vegetables	42	66	121	133	166	132	139
Fruit	6.6	12	16.2	29	40.7	44.2	46.2
Meat	4.8	8.4	13.9	23.6	37.5	43.5	45.9
Eggs	2.1	3.8	5.8	7.9	8.6	9.9	10.4
Milk	0.2	3	10.8	31.8	49.3	57	54.9
Fish and shellfish	13.7	23.1	22.5	30.5	30.7	36.6	39
Seaweed	1.2	2.6	4.5	5.7	6.1	14.7	15.9
Oils and fats	0.3	1.5	5	14.3	15.9	13.9	14.7

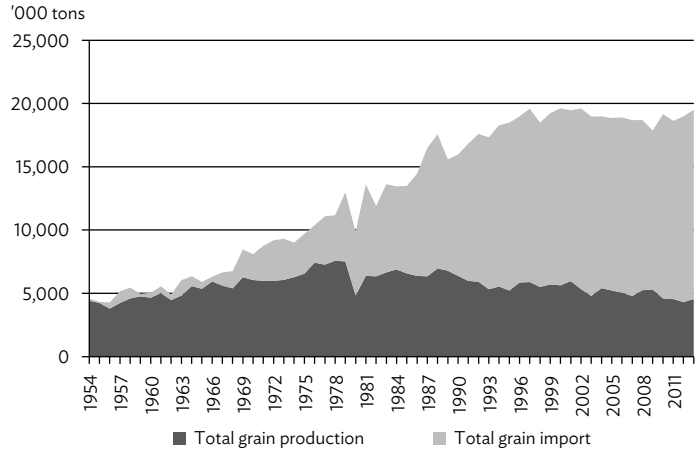
Source: KREI (2013a).

resource endowments. The population density was 501 persons per square kilometer in 2013, which is the third highest after Bangladesh and Taipei,China among economies with a population of more than 10 million. The area of hilly land accounts for 65% of national land, implying less land is suitable for cultivation and that the per capita arable land is small. Added to the already low availability of arable land, each year, 20,000 ha are converted for nonagricultural use. Consequently, the country is not able to produce enough food to meet demand and has to import a significant amount of food.

In recent years, food imports have been increasing. Following the government's signing of free trade agreements with many countries, imports are increasing faster and their quantity getting larger, leading to a lower food SSR. Figure 6.4 shows the trend of how total grain demand was met by domestically produced grain and imported grain. In 2013, out of the 19.2 million tons of grain demanded, domestically produced grain was 4.5 million tons only. Imports amounted to 14.7 million tons, with about 10 million tons being maize largely for feed purposes.

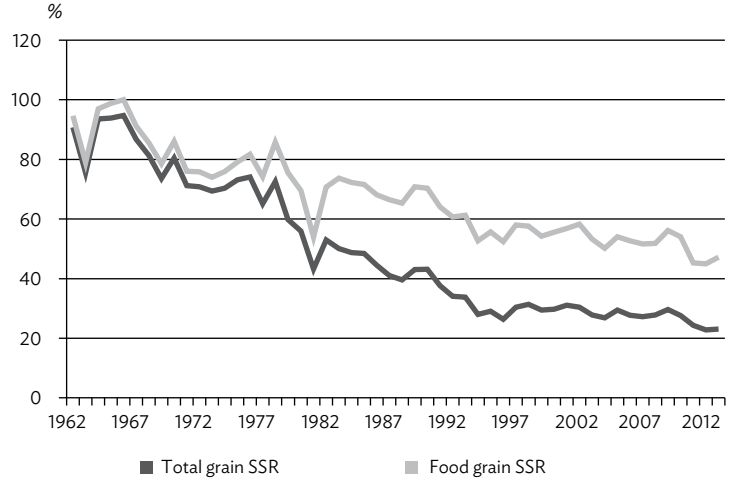
Figure 6.5 demonstrates that grain self-sufficiency has dropped significantly. Food grain self-sufficiency was 94.9% in 1961, dropping to 47.2% in 2013. In the case of all grain (i.e., including feed grain), self-sufficiency dropped from 91.1% in 1961 to 23.1% in 2013. During

Figure 6.4 Trends of Domestic Production and Grain Imports, Republic of Korea, 1954–2013



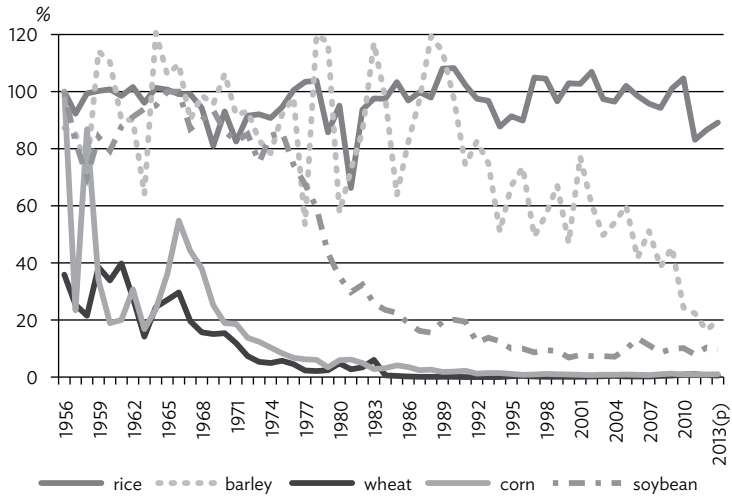
Source: MAFRA (2015).

Figure 6.5 Decline in Food Self-Sufficiency Ratios, Republic of Korea



SSR = self-sufficiency ratio.
Source: MAFRA (2015).

Figure 6.6 Grain Self-Sufficiency, Republic of Korea (by year for each item)



Source: MAFRA (2015).

this time, the increase in demand for feed grain was enormous, from 171,000 tons in 1960 to 10,040,000 tons in 2013. This is because rising protein intake has contributed to the increase in the heads of livestock raised in the Republic of Korea including cattle, pigs, and chickens.

At the crop level, all grain crops except paddy rice experienced a major decline in self-sufficiency (Figure 6.6). Maize had a high SSR in the 1950s (it was used as food at that time). Its SSR started declining rapidly since the 1970s when it started being used as feed. The SSR for wheat dropped in a pattern similar to that of maize. By the 2010s, their self-sufficiency dropped below 1%. The SSR for soybeans and barley started to drop rapidly at a later time, but by the 2010s, it also reached a low level, being about 20% for barley and 10% for soybeans in 2013. The only crop for which the Republic of Korea has managed to maintain a high rate of self-sufficiency is rice, the nation's staple food. The low and declining level of grain self-sufficiency is a source of concern to the government and the public. How the recent signing of free trade agreements (FTAs) with various countries will affect the SSR is yet to be observed. It is most likely that the Republic of Korea will defend its maintenance of a high level of self-sufficiency for rice.

6.2.2 Evaluation of Food Security

In the Republic of Korea, food security is viewed or assessed differently from practices elsewhere. Historically, the people often did not have enough food to eat. Having food to eat is therefore important and is reflected in the greetings of daily life. When people met in the morning, the common greeting was "Have you had your breakfast?" Since many people often did not have enough food to eat, asking such a question indicates, "I am concerned about your well-being." Nowadays, having food for breakfast is no longer a concern for most people in the country. Nonetheless, greeting people this way still continues, reflecting people's deep-rooted fear of a lack of food to eat.

This mentality is reflected in the broader society in that many people see food security as "grain self-sufficiency." People would regard food security as higher if the grain self-sufficiency rate is higher. The current low grain self-sufficiency, below 25%, is not surprisingly a big concern.

Table 6.2 shows the results of a survey of the general public about the importance of food self-sufficiency. In the three surveys conducted in 2003, 2006, and 2009, a large and increasing proportion of respondents believed it is necessary for the Republic of Korea to raise food self-sufficiency to improve its food security.

Clearly, "food security" is more than just "a high level of food self-sufficiency." A broader and more comprehensive approach has to be used when assessing food security. In this chapter, the food security evaluation framework as suggested by the Food and Agriculture Organization (FAO) (2014a) is used (see Chapter 2 for details). This framework requires evaluating food security from four dimensions: availability, accessibility, utilization, and stability.

Table 6.2 Public Opinion on Food Self-Sufficiency Ratios, Republic of Korea (%)

	2003	2006	2009
Need to increase SSR	66.5	68.5	74.1
Maintain current SSR	23.6	25.1	21.6
Do not need to increase SSR	4.6	4.0	3.9
Do not know	5.4	2.5	0.4
Total	100.0	100.0	100.0

SSR = self-sufficiency ratio.
Source: KREI (2013b).

Food Availability

Food availability can be evaluated by examining the average dietary energy supply adequacy, the average value of food production, the share of dietary energy supply from cereals, the average protein supply, and the average supply of proteins of animal origin.

Figure 6.7 shows that calorie intake per capita has improved rapidly since the early 1960s. By the mid-1960s, it had reached the ADER. It has remained at a level that is above the ADER, with increasing energy from nonvegetal food. Fat intake used to be below the reference daily intake (RDI) in the 1960s but has steadily increased ever since. By the mid-1990s, it reached the RDI and has been higher since then. Protein intake was also low in the 1960s, but its increase was faster than fat intake. By the mid-1970s, it had reached the RDI and stayed at that level until the late 1990s when it marginally surpassed the RDI.

Hence, despite the fact that the Republic of Korea is short of food production resources, it has managed to make sufficient amounts of food available to its citizens to fulfill their nutritional requirements. At the national level, food availability is more than adequate.

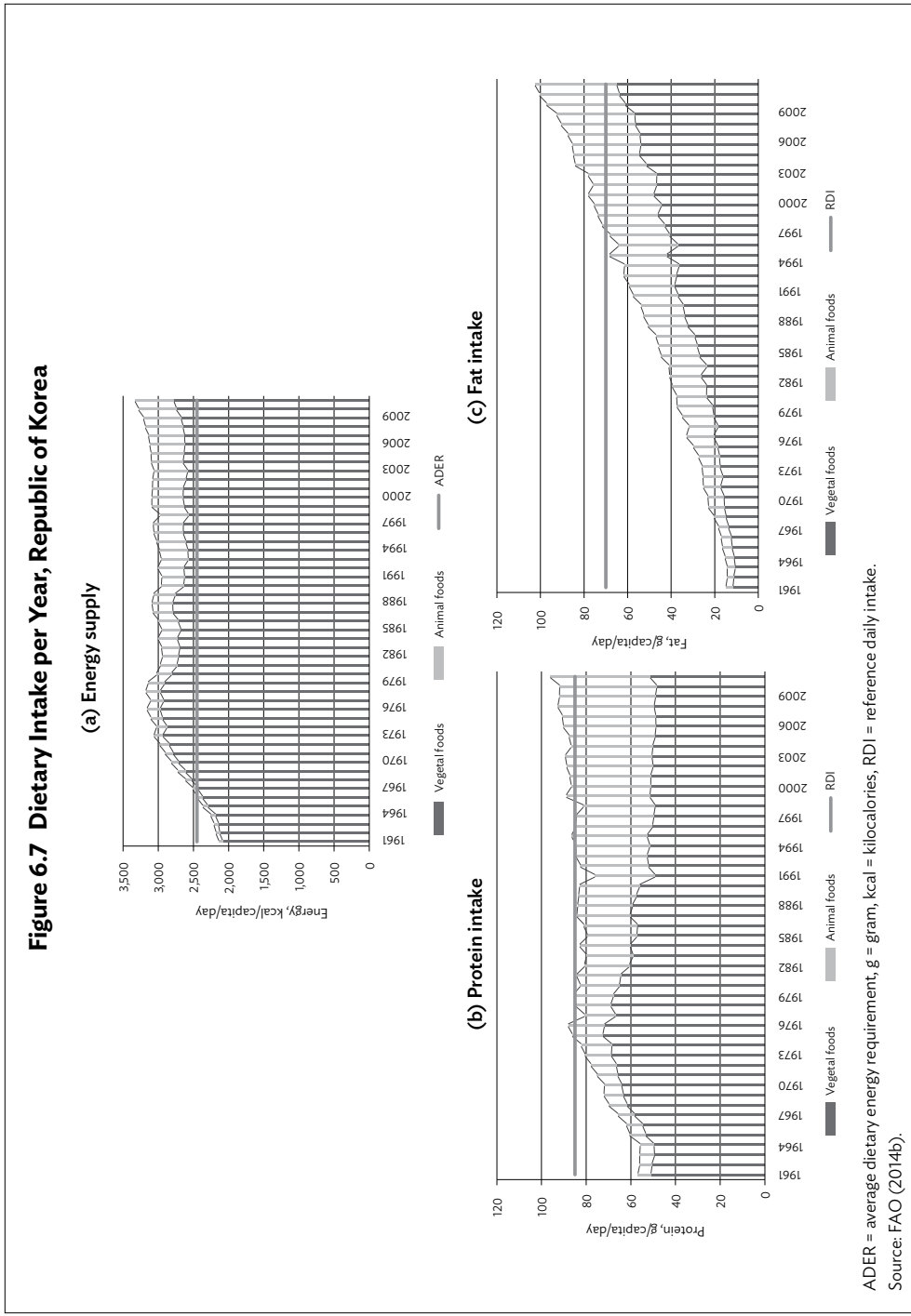
Food Accessibility

Food accessibility can be measured by the percentage of paved roads over total roads, road density, GDP per capita (in purchasing power equivalent), domestic food price level index, prevalence of undernourishment, and other food deficit–related indicators. The country has done well in all these aspects. The GDP per capita exceeded $20,000 in 2006. Transport infrastructure is well established. The malnutrition-suffering population is below 5%, and there are almost no cases of undernourished children under age 5 years. The domestic food price levels cause little concern to the public.

Food Utilization

Food utilization can be assessed by indicators such as access to improved water sources, access to improved sanitation facilities, and the percentage of children under age 5 years who are underweight. According to FAO (2014a), the percentage of the population with access to improved food sources in the Republic of Korea has improved from 89.6% in 1991 to 97.8% in 2012, and the percentage of the population with access to sanitation facilities has been 100% since 1990. The percentage of children under age 5 years who are underweight is below 1%. In general, food safety is a high standard. Food safety incidents do occur sometimes. However, there have been efforts to develop various strategies to further improve food safety and quality.

Figure 6.7 Dietary Intake per Year, Republic of Korea



ADER = average dietary energy requirement, g = gram, kcal = kilocalories, RDI = reference daily intake.
Source: FAO (2014b).

Food Stability

Indicators for evaluating food stability include the cereal import dependency ratio, value of food imports over total merchandise exports, domestic food price volatility, and per capita food supply variability. The Republic of Korea has accumulated a large trade surplus and has enough foreign currencies for food imports. The value of imported agricultural products is only 3% of the total exports. The per capita food supply variability also shows an improving trend in general. However, the cereal import dependency ratio is high and was over 75% in 2009–2011, and domestic food prices remain volatile.

The potential impact of further opening up of the market on domestic food production causes concern. Recently, the country has been working toward the conclusion of bilateral or regional FTAs with many countries. Since 2004 when the first FTA was signed with Chile, the Republic of Korea has concluded FTAs with 15 countries or regions including the US, the European Union, the Association of Southeast Asian Nations (ASEAN), Turkey, Peru, the European Free Trade Association, India, Australia, Canada, New Zealand, the People's Republic of China (PRC), Colombia, and Viet Nam. Negotiations are ongoing for a trilateral FTA between the Republic of Korea, the PRC, and Japan, for the Regional Comprehensive Economic Partnership. In addition, bilateral FTAs with Indonesia, Ecuador, and Central American countries are in progress. The Republic of Korea also expressed interest in joining the Trans-Pacific Partnership (TPP) agreement. While the conclusion of various FTAs will increase the Republic of Korea's access to more markets for its industrial goods, they will also increase the access of foreign agricultural products to its food markets. The country's agriculture is not globally competitive. The further opening up of domestic food markets to foreign competition may further undermine the survival of existing farmers. The potentially further reduced domestic food output has thus become a cause of concern among the public in the sense that when the global food supply is short and imports are difficult (due to export restrictions), the country's food security could be significantly threatened.

Sources of the Republic of Korea's food imports are also heavily concentrated; over 80% of its major grain imports are from three countries only (Table 6.3). In the case of rice and soybeans, around 95% are from three sources only. Between 1996–2004 and 2005–2013, differences in concentration ratios of food imports were small. Maize registered a decline of 13 percentage points, from 93% to 80%, while soybeans had a relatively modest decline from 99% to 95%. Overconcentration of import sources deserves attention, and more

Table 6.3 Concentration Ratios of Foreign Suppliers for Rice, Wheat, Maize, and Soybeans, Republic of Korea (%)

	1996–2004			2005–2013		
	C1	C2	C3	C1	C2	C3
Rice	67.0	83.4	93.1	55.4	85.1	95.5
Wheat	43.1	71.4	80.0	37.0	66.7	79.7
Soybeans	85.9	96.6	99.3	45.2	80.1	94.6
Maize	49.4	86.5	93.0	57.7	70.9	80.3

C1 = share of first most important supplier; C2 = cumulative share of first and second most important suppliers; C3 = sum of first, second, and third most important suppliers' share.

Source: UN Comtrade (2015).

diversified sources can be useful to mitigate food export abnormalities of one or two major exporting countries.

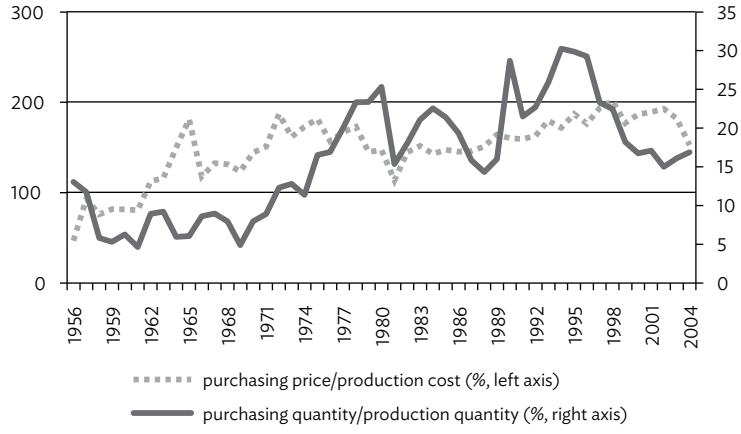
The above evaluation suggests that as far as the four dimensions of food security—availability, accessibility, utilization, and stability—are concerned, the Republic of Korea has a high level of food security. However, due to its heavy dependence on imports to ensure the availability of food, the stability of imports is a potential concern, and further efforts to secure more stable food imports are warranted.

6.2.3 Policies Used in the Pursuit of Food Security

Compulsory Rice Collecting Policies

Policies that affect farmers' income play an important role in food production. In the 1950s, especially after the Korean War, hyperinflation prevailed, and private grain markets did not function well to help curtail the inflation. Thus, the government controlled the rice market by reintroducing a rice compulsory collecting system and distributed the rice to government officials, poor people, and military personnel. The rice was collected at prices lower than market prices and even lower than production costs (Figure 6.8) to keep food prices low for consumers. This policy did not help increase grain production. The compulsory collecting system was abolished in 1956 and changed to a government procurement system that purchased rice from farmers who wanted to sell rice at a predetermined price. However, because the purchase price was lower than the production cost, not many farmers sold their rice to the government. The ratio of government purchasing quantity over total production quantity remained very low at around 5% until 1960.

Figure 6.8 Price of Purchased Rice, Production Cost, and Volume, Republic of Korea (by year)



Source: MAFRA (2015).

Price Support

In the early 1960s, there were sharp drops in grain self-sufficiency, especially wheat and maize. To ensure a certain level of self-sufficiency was on the government's policy agenda. In the mid-1960s, price support for grain production was introduced. The grain procurement price was raised substantially, as reflected in the ratio of purchasing price against production cost (Figure 6.8). A rise in total grain production followed (Figure 6.4). This resulted in large and increasing government expenditure for supporting grain production. From the late 1960s, the government decided to enforce price support for rice and barley only to ensure a high level of self-sufficiency for staple food.

Higher purchasing prices coupled with higher purchasing volumes by the government boosted farmers' incomes. As a result the total grain output exhibited a continual increasing trend until 1980 when extreme cold weather struck (Figure 6.4). Overall, despite the costs associated with this price support policy, it enabled the Republic of Korea to maintain a reasonably high level of rice self-sufficiency, important socially and politically.

There have been diverse opinions about the large and increasing amount of rice purchased by the government since the 1990s. Some

people argued that the price support through government purchasing resulted in an excessive supply of rice. Because of the excessive supply, some were worried that it might be necessary for the country to enforce a fallow program in the future, an opinion based on the experiences of the US, the European Union, and Japan. Some proposed it would be better to employ a direct payment program to support farmers rather than through excessive government intervention in the market. However, many people in the country do not like the idea of a direct payment program on the following two major grounds: (i) it goes against the traditional ethics of "work to have food to eat," and (ii) it is hard to implement a direct payment program due to the lack of accurate and detailed information on farmland use.

Nonetheless, changes have to be made after the World Trade Organization (WTO) came into force. In 2005, the Republic of Korea made changes to the price arrangements for the government purchase program or the public stockholding program.

Public Stockholding Program

Prices of agricultural products can change significantly because of relatively inelastic supply and demand. Many governments maintain public stockholdings or buffer stocks in their quest for better food security. As noted earlier, the Republic of Korea also resorted to this approach to enhance its food security. It started a stockholding program in the 1950s. The volume of purchased rice gradually increased, and after 1975, the government has maintained the purchased volume over 16% of total rice produced (Figure 6.8).

After the completion of the Uruguay Round, the WTO regime started in 1995. Agricultural policies of all WTO member countries needed to be conducted in accordance with the WTO rules. According to the Uruguay Round Agreement on Agriculture (URAA), public stockholding for food security purposes is exempted from reduction commitments if food purchases by the government shall be made at current market prices and sales from food security stocks shall be made at no less than the current domestic market price for the product and quality in question. However, if the stocks of foodstuff for food security purposes are acquired and released at administered prices, then the difference between the acquisition price and the external reference price shall be accounted for in the Aggregate Measurement of Support (AMS) (URAA, Annex 2, paragraph 3 and footnote 5).

The public stockholding program of the Republic of Korea was operated with administered acquisition prices, which were usually

higher than market prices. According to the new rules, it should be operated within the AMS limit. The AMS limit of the Republic of Korea was W2,182.6 billion in 1995 and was gradually reduced to W1,490.0 billion in 2004. The country used most AMS limits for rice; 97% of the AMS limits were used in 2004, of which 92% were used for rice price support; 3% for barley; and the rest for maize, rapeseeds, and soybeans (Song and Bae 2009).

In 2005, the Republic of Korea switched from administered prices to market prices for rice purchased for the public stockholding program.[2] Payments are made to rice growers through a direct payment program to compensate them for their loss of price support.

Tariff Protection

The high cost for producing agricultural products in the Republic of Korea means low global competitiveness. Therefore, the government has tried to inhibit imports by keeping tariffs high. The average bounded tariff for agricultural products was high in 2012 at 56.1% (WTO, ITC, and UNCTAD 2012). The prices of most agricultural products are higher than the global prices. The producer support estimate was 52.5% in 2013, in fourth place following Norway, Japan, and Switzerland among Organisation for Economic Co-operation and Development (OECD) members. The ratio of market price support in the producer support estimate is high as well, at 93% (OECD 2014). If the government had lowered the level of protection for agriculture, the self-sufficiency would have been much lower.

Because rice is the most important staple food, the government continued to keep the border protection for rice. After the Uruguay Round negotiation was settled in 1994, all WTO members were no longer required to maintain any trade restrictive measures except ordinary custom duties for the trade of all agricultural products. However, exceptional measures were allowed for the Republic of Korea to delay

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[2] In the Doha Development Agenda negotiations in WTO, public stockholding for the purpose of food security is a hot issue. India and some developing countries insist that public stockholding programs for food security with an administered price should be allowed, regardless of the AMS limit. It is regarded as a price support but intends to enhance the food security of small farmers and poor consumers in developing countries. India and its allies insist that most developed countries actually used this system for a long time and that it is not fair to restrict the introduction of this system to developing countries in WTO. Currently, an interim solution has been agreed to not appeal this system to the dispute settlement body until a permanent solution can be agreed in the Doha Development Agenda.

introducing tariffs on rice for 10 years (1995–2004). In 2004, tariffs on rice were delayed for another 10 years. The trade-off that the Republic of Korea had to make to have this delay was to increase the tariff rate quota for rice from 1% of domestic consumption in 1995 (51,307 tons) to 8% of domestic consumption in 2014 (408,700 tons). No import of rice was allowed beyond the tariff rate quota volume. This measure protected the rice industry without exposure to global competition. As a result, although imports of other agricultural products sharply increased and domestic production was reduced since the launch of WTO, rice production was protected and could keep the self-sufficiency ratio at a level higher than 90%.

In all FTAs concluded between the Republic of Korea and other countries, rice was excluded from tariff concessions. In 2015, the Republic of Korea finally moved to tariffication for rice imports with a tariff rate of 513%. Rice is now confronted with foreign competition.

Establishment of Organizations for Better Food Security

The Republic of Korea has established various organizations to enhance food security. The Rural Development Administration (RDA), established in 1961, boosted agricultural productivity by improving crop varieties, promoting machinery use in agriculture, and providing agricultural technology guidance and advice to farmers. The high-yield rice variety, *Tongil*, developed in the 1970s, remarkably increased rice yields, which led to the achievement of the Republic of Korea's rice self-sufficiency in 1978 (the *Tongil* variety is not grown anymore because the quality and taste was inferior to traditional varieties, and the policy objective was changed from an emphasis on quantity to quality after attaining self-sufficiency in rice). Due to continuous efforts of the RDA, yields of major crops have shown rapid progress during the last 50 years (Table 6.4).

Table 6.4 Trend of Yields of Major Crops, Republic of Korea, 1965–2013 (kg/ha)

	1965 (A)	2013 (B)	B/A, %
Rice	2,890	5,080	175.8
Barley	1,760	2,440	138.6
Soybeans	570	1,930	338.6
Corn	810	5,060	624.7

kg/ha = kilogram per hectare.
Source: MAFRA (2015).

The RDA also contributed to promoting the wider use of farm machinery and chemical fertilizers. In 1970, farmers possessed 3,581 tractors, but this number increased to 639,517 in 2013. The amount of chemical fertilizers applied was 563,000 tons in 1970, increasing to 1,104,000 tons in 1990. Concerns for environmental pollution resulting from agricultural chemical use have been mounting. Thus, the government stopped subsidies for fertilizers and pesticides in 2005. This may have been partially responsible for the reduced use of fertilizers in recent years, which, for example, was 459,000 tons in 2013. The RDA also established agricultural technology centers in each of the counties to be in charge of disseminating new varieties and farmer training programs, which contributed to improving farmers' productivity.

The Agricultural Product Quality Management Service was established in 1998 by expanding and restructuring the Agricultural Product Inspection Service established in 1949. It is in charge of the certification of agricultural product quality, safety control of harmful substances including agricultural chemicals, and quality assurance. It has contributed to enhancing consumers' trust in the safety and quality of agricultural products produced in the Republic of Korea. The Ministry of Food and Drug Safety is in charge of monitoring food safety including recalling harmful food, promoting healthy living, and managing food safety-related regulations.

6.2.4 Sustaining a High Level of Food Security: Challenges and Actions

The Republic of Korea's achievements of a high level of food security in the past few decades have been impressive. For the country to maintain a high level of food security in the future, there are many challenges to overcome. Two major ones are (i) maintaining a food SSR that is socially and politically acceptable, and (ii) coping with global food supply instability.

Limited resources available have resulted in low and declining self-sufficiency. While a low SSR is not necessarily detrimental to food security, it does concern the public who have suffered bitterly in the past from insecure food provisions. This in turn is a concern for politicians. The potential for the country to produce more food domestically is not optimistic. According to the Korea Rural Economic Institute (2014), the total arable land is expected to shrink from 1,719,000 ha in 2013 to 1,597,000 ha in 2023—a decrease of 7.1%. The area sown to rice is expected to decrease from 833,000 ha in 2013, to 764,000 ha in 2023 and rice production from 4,230,000 tons in 2013 to 3,960,000 tons in

2023. Beef and pork production are also expected to decrease, from 257,000 tons and 857,000 tons in 2013 to 239,000 tons and 834,000 tons in 2023, respectively. The decline in livestock output is chiefly due to concerns over potential outbreaks of livestock diseases and pollution to the environment if livestock production is further intensified.

Low and declining self-sufficiency in food production means there is the need for increased food imports. For example, the Korea Rural Economic Institute (2014) forecasted that beef imports would increase from 255,000 tons in 2013 to 333,000 tons in 2023. Pork imports would increase from 185,000 tons to 259,000 tons during the same period. As noted earlier from the survey results, the large proportion of food imports makes the public uneasy due to a potentially unstable global food market.

The stability of the future global food market is hard to foresee. OECD–FAO suggested that global demand for food will increase following growing world population, but the food supply will also increase in proportion to meet the increased demand. In the case of rice, the item that the people are most concerned about, its production and consumption will both increase until 2023, and stockholding will be stable (OECD–FAO 2014). However, there are also pessimistic views about future food supply. There are claims that the future food supply will be challenging due to the need for environment protection, lack of water resources, expansion of biofuels, and potential climate change (Godfray et al. 2010; Rosin, Stock, and Campbell 2012). The United Nations (2011) also showed that the increase in global grain production has slowed from an annual growth of 2.6% between 1960 and 1970 to just 1.2% between 1990 and 2007, lower than the population growth rate. It is not certain that future food production will be adequate for the growing global population. Unfortunately, as a small player, the Republic of Korea can exert little influence over the global food market.

In the future, there are three major external factors that can have important impacts on food demand and supply in the Republic of Korea and thus its food security: (i) changes in food imports following further opening up of the market as a result of more FTAs, (ii) impact of climate change on food production, and (iii) possible arbitrary trade restrictions by food exporting countries.

First, increased opening up of food markets to foreign products has always been a threat to agriculture due to its low competitiveness in the global market. The Republic of Korea has concluded FTAs with 15 countries as of 2015 and is in the process of negotiating more. All FTAs will grant foreign products greater and easier access to the market as remaining protection is gradually phased out. The impact of FTAs on agriculture will be increasingly felt over the medium and longer term.

For example, in the case of meat, all tariffs will be abolished within a maximum of 15 years when an FTA comes into effect. Rice has been excluded from tariff concessions in all FTAs so far.[3] However, it could become a target of tariff concessions if the TPP is settled among 12 participating countries and the Republic of Korea joins the TPP later. If so, more rice will be imported, and rice production is most likely to decline further.

Second, there have been concerns that climate change could reduce food production. If this happens, the global food supply will become tighter. This would certainly not be in the Republic of Korea's favor, a country that depends heavily on food imports. Climate change can also negatively impact domestic food production. Kim et al. (2013) analyzed possible impacts of climate change on the Republic of Korea's rice production. According to their analysis, compared with the baseline scenario (2,970,000 tons), rice production will decrease by 7.9%–13.0% in 2050 if the worst scenario emerged. In the baseline scenario, rice imports in 2050 would be 1,087,000 tons. Climate change, however, could result in increased imports ranging from 1,598,000 tons to 1,779,000tons.

Third, there remains a high possibility of trade restrictions by food exporting countries in the future, representing another major threat to food security. Any sudden export restrictions could seriously jeopardize the supply of food to the Republic of Korea. According to FAO surveys, 33 countries had restrictions on the export of at least one agricultural product between 2007 and March 2011 (Sharma 2011). OECD (2012) also surveyed the export restrictions of rice exporting countries during 2007–2011. In 2008, at least eight countries including the PRC, India, Indonesia, and Viet Nam restricted the export of rice using export taxes, export bans, or export allotments. Currently, there are no globally accepted rules to prohibit such export restrictions, and food export restrictions can happen anytime. Regulating export restrictions to ensure stable global food trade is essential. The Doha Development Agenda negotiations have discussed disciplining of export restrictions, but no tangible results have been achieved so far.

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[3] The Republic of Korea finally placed tariffs on rice, beginning 1 January 2015. However, it has not made any tariff reduction commitment in FTAs with respect to rice. Strictly speaking, rice has been excluded from tariff reduction/elimination commitments (similar to tariff concessions). An FTA is a WTO-plus commitment. For example, the Republic of Korea's beef tariff rate is 40% in WTO (as with all WTO members), but it was 32% in 2015 to the US because in that, the beef tariff rate will be eliminated in 15 years from 2013. Tariff concessions here refer to further tariff reduction commitments in FTAs.

To handle such challenges, the Republic of Korea has taken actions in a number of areas to pursue a sustained high level of food security into the future. Several major ones are as follows.

Global cooperation. Global cooperation can be the most effective approach for import-dependent countries to ensure food security. The Republic of Korea joined an international emergency rice reserve initiative in 2012. ASEAN countries started the initiative, the ASEAN Emergency Rice Reserve in 1979. Rice is the most important staple food for ASEAN countries. In 2012, the reserve was expanded to include three neighboring countries (the PRC, Japan, and the Republic of Korea), and is now referred to as the ASEAN Plus Three Emergency Rice Reserve. Its main purpose is to provide food assistance to members in cases of temporary natural disasters or man-made calamities. Currently, the total reserve is 787,000 tons (of which the PRC's share is 300,000 tons, the Republic of Korea's 250,000 tons, and Japan's 150,000 tons). The Asian Development Bank (2012) evaluated the effectiveness of the current arrangement and suggested that the size of the reserve needs to be increased up to 1.2 million tons as a realistic target for it to be effective in case of an emergency. The Republic of Korea is expected to continue its effort to promote this international cooperation.

Use of the direct payment program. The direct payment program for stabilizing farmers' incomes contributes to enhancing the stability of food production on a long-term basis. Earlier, direct payments in the Republic of Korea focused mainly on rice. Since 2014, it has been extended to other field crops. The direct payment program was employed to compensate farmers for their income loss due to increased opening up of the market. It is designed to operate in conformity with the WTO rules in that direct payment is paid decoupled with prices.

Reducing and avoiding food waste. The Republic of Korea has made efforts to reduce food waste and losses. People like to put a lot of food on their dining table although they cannot eat all of the food. The food waste is close to 5 million tons every year, and the cost for treating the waste is approximately W808 billion (approximately $735 million) (MOE 2013). Reducing food waste helps improve the food supply position. The resources saved by reducing waste can be diverted for investments to improve various aspects of food security, e.g., nutrition education. A volume-based food waste collecting fee system was introduced in 2013. This represents a step forward in discouraging food waste. More efforts are needed to stop wasting food.

Minimum food self-sufficiency targets. The government has established food self-sufficiency targets as one measure to enhance food security. There have been diverse opinions about whether self-sufficiency targets are necessary in a free trade regime. Some

economists argue that establishing self-sufficiency targets is not necessary because they are inefficient, and there are no ideal means to enforce the targets to be achieved (Choi et al. 2006). However, the dominant view seems to be that establishing self-sufficiency targets can be used as a guideline for policy design even though not a mandatory goal and such targets are needed for occasions of serious global food crises due to a heavy dependence on imports (Choi et al. 2006; Choi, Woo, and Whang 2010).

The Republic of Korea first established the self-sufficiency targets for food grain and calorie in 2006. The Basic Act on Agriculture and Rural Community enacted in 1999 regulates that "the government shall establish and maintain the target for the level of food self-sufficiency, and make an effort for ensuring a reasonable volume of food stock". The act was amended in 2001 to "include targets for reasonable food self-sufficiency in establishing the framework for developing agriculture and rural community." In 2006, the total grain and calorie self-sufficiency targets were set as 25% and 47%, respectively, for 2015 (Table 6.5). In view of the global food price crisis during 2007–2008, these targets were lifted in 2011 to be 30% and 52%, respectively, for 2015. In the same time, the targets for 2020 were also set, 32% for total grain and 55% for calories. In the 2011 revision, a new target for food grain was set, 57% for 2015 and 60% for 2020 (MAFRA 2013).

An SSR of around 30% in total grain is very low. Even if it is achieved, the role it can play in case of prolonged serious global food shortage may be still quite limited. On the other hand, the cost to pursue it may be very high. However, taking into account the importance of food and the food shortages in the past, such self-sufficiency targets may still be hugely valuable in that they can act as an important psychological safety net among the public. In return, the government may win over their support for trade reforms in many other areas that could render greater benefits to the Republic of Korea.

Table 6.5 Food Self-Sufficiency Targets, Republic of Korea (%)

	2010 Performance	2015 Target		2020 Target
		Previous	New	
Total Grain SSR	27.6	25.0	30.0	32
Food Grain SSR	54.0	–	57	60
Calorie SSR	49.3	47	52	55

SSR = self-sufficiency ratio.
Source: MAFRA (2013).

6.3 Food Security in the Democratic People's Republic of Korea

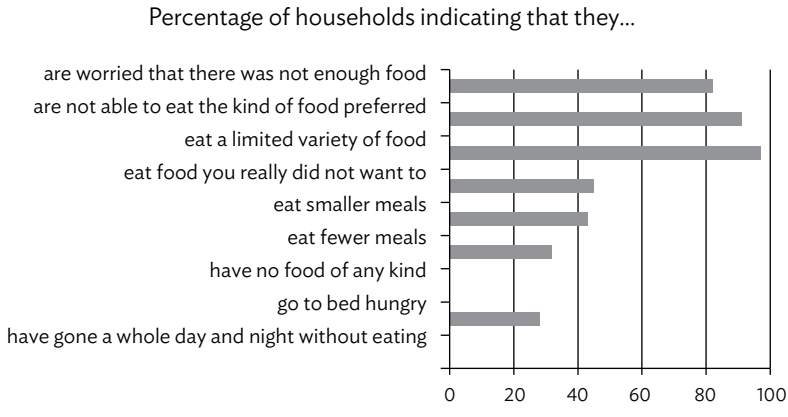
6.3.1 Food Supply: An Overview

The Democratic People's Republic of Korea has continually suffered from chronic food shortages since the separation of the Korean peninsula. Prior to the 1990s, it could obtain some assistance from various socialist states for being an ally to them. The collapse of many socialist states starting from the late 1980s has made it difficult for the country to obtain aid for its food supply. As one of the few socialist states refusing to carry out substantial reforms, its overall economy also suffered from lack of growth. Slow economic growth coupled with self-isolation has often resulted in an inadequate food supply to its residents, causing widespread undernourishment and even death from starvation. Unfortunately, reliable data about the food supply is scarce. We make use of the available data and information to gauge the extent of food security or insecurity in the Democratic People's Republic of Korea.

According to the FAO, the Democratic People's Republic of Korea is one of the 38 countries that need food support from other countries (FAO 2014c). Among these countries, 29 are in Africa; 5 countries, including the Democratic People's Republic of Korea are in Asia; and 4 are in South America. The Assessment Capacities Project, operated by Save the Children International, Action contre la Faim, and the Norwegian Refugee Council, suggests that 16.0 million out of 24.6 million people in the Democratic People's Republic of Korea experience a chronic unstable food supply (ACAPS 2015). The United Nations Office for the Coordination of Humanitarian Affairs believes 1.8 million, or 7% of the population, require immediate food support (UN 2015). The World Food Programme (WFP) believes 30% of people suffer from serious food shortages, and 45% of them are on the border (FAO/WFP 2013). People who live in mountain areas are even more disadvantaged in the food supply system and often suffer more from food shortages (Kwon et al. 2004; Kwon 2010).

The household-level food security survey conducted by FAO/WFP in September 2013 revealed the widespread inadequacy of food availability. Some indicators of food insecurity are shown in Figure 6.9. Over 90% of households indicated that they have a limited variety of food to consume, while over 80% are worried that there is not enough food. The proportion of households that eat smaller meals and fewer meals lies between 30% and 50%.

Figure 6.9 Food Insecurity Survey at the Household Level, Democratic People's Republic of Korea



Source: FAO/WFP (2013).

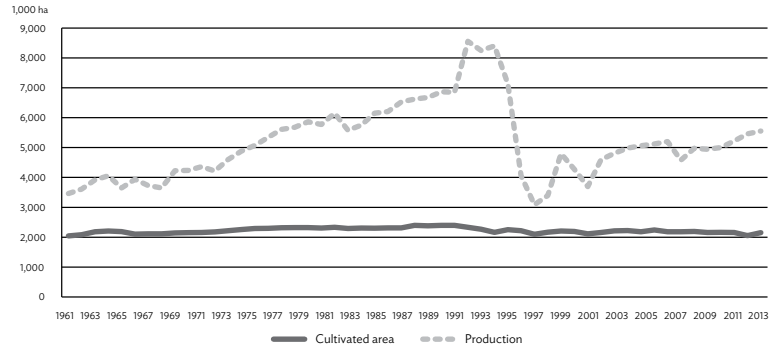
The government has never announced statistics about the food supply situation. Estimates by external organizations are remedial but cannot be relied on. Consequently, discussion of food security can only be carried out using limited available data and information. Given that food is "nutrients taken to maintain, grow, run our body and recover our tissues" (WHO and FAO 1974), anything that fulfills these purposes can be regarded as food. As such, grain, meat, fish, milk, eggs, vegetables, and sugar are all food. Not enough reliable data about all such food except for grain are available. In the rest of the discussion on food security in the Democratic People's Republic of Korea, the focus is therefore on grain.

6.3.2 Evaluation of Food Security

Food Availability

The government does not regularly announce statistics about its food production. It initially announced the volume of food production in the *Chosun Jungang Yearbook*. Since then, it has often only announced information of some percentage increases in comparison with the previous year in its New Year Message. The country is a member of FAO, which does publish the country's food production information, although it remains unknown how the FAO obtains the data. However,

Figure 6.10 Areas for Cultivating Food Crops and Production, Democratic People's Republic of Korea



ha =hectare.
Source: FAO (2014b).

there are no better alternatives. Figure 6.10 shows food grain production since 1961 based on the statistics from the FAO.

Many food research experts doubt the accuracy of the food production statistics from the FAO (e.g., Kwon 2003). As shown in Figure 6.10, food production increased rapidly from the early 1970s to the early 1990s. It dropped to almost one-third around the mid-1990s although the area sown had not declined notably.

Official or nonofficial statistics about the Democratic People's Republic of Korea's food production in 1995 are compared in Table 6.6. The FAO statistics are similar to the estimates based on information from the Democratic People's Republic of Korea, while the Central Intelligence Agency estimates are similar to those provided by the Ministry of Unification of the Republic of Korea. There are, however, significant gaps between the two sets of data. In 1995, the estimates from all four sources were very close to each other. It seems there is a big difference in how the Democratic People's Republic of Korea handled its grain statistics before and after 1995.

The FAO has estimated and announced the volume of the Democratic People's Republic of Korea's food production in cooperation with the WFP since 1995. Table 6.7 shows the estimates of food grain production in the Democratic People's Republic of Korea by FAO/WFP and the Republic of Korea's Statistics Korea. The gaps between the two sets of estimates have narrowed.

Table 6.6 Comparison of Grain Production[a] ('000 tons)

Year	Democratic People's Republic of Korea Data[b]	FAO Data[c]	CIA Data[d]	Republic of Korea Data[e]
1946	1,898	NA	NA	NA
1949	2,654	NA	NA	NA
1955	2,340	NA	NA	NA
1960	3,803	NA	NA	NA
1965	4,526	4,923	3,150	NA
1970	NA	5,141	3,500	4,644
1975	7,700	7,035	5,400	4,953
1979	9,000	8,585	6,300	5,177
1984	10,000	10,183	6,600	6,267
1990	10,000	10,205	NA	5,672
1995	3,764	4,077	4,025	4,060

CIA = Central Intelligence Agency, FAO = Food and Agriculture Organization.
Notes:
[a] Sum of rice, maize, barley, beans, and other minor grain, unmilled equivalent.
[b] Based on Kim Il-Sung's New Year Message, Chosun Jungang Yearbook, and the Democratic People's Republic of Korea's Economic Statistics Book.
[c] FAO. Production Yearbook.
[d] US CIA. Handbook of Economic Statistics.
[e] The data from the South Korean Ministry of Unification to 1975 is the back calculation from the data in "Analysis of Agricultural Base in South and North Korea, and Comparison of Production Capacity, 1977" (p. 105) to unpolished grain. The data from 1979 to 1984 is back calculated from the data in "Comparison of the South Korea and North Korea Economy" to unpolished grain. The polished grain conversion ratio of 85% was applied to the data between 1990 and 1995 to back-calculate them to unpolished grain.
Source: Kim (1997).

Table 6.7 Comparison of Grain Production, Democratic People's Republic of Korea

Year	FAO/WFP		Statistics Korea	
	Cultivated area ('000 ha)	Production ('000 tons)	Cultivated area ('000 ha)	Production ('000 tons)
1995	NA	4,077	1,846	3,451
1996	NA	3,032	1,466	3,690
1997	NA	2,838	1,499	3,489
1998	NA	3,783	1,523	3,886
1999	NA	3,420	1,550	4,222
2000	1,377	2,573	1,572	3,590
2001	1,410	3,656	1,577	3,946
2002	1,433	3,969	1,569	4,134
2003	1,429	4,159	1,595	4,253
2004	1,428	4,235	1,597	4,311
2005	NA	4,540	1,608	4,537
2006	NA	4,480	1,609	4,484
2007	NA	4,210	1,614	4,005
2008	1,542	3,460	1,614	4,306
2009	1,441	4,335	1,614	4,108
2010	1,461	4,227	1,661	NA
2011	1,788	4,450	1,862	NA
2012	2,018	4,847	1,862	4,676
2013	2,005	5,030	1,862	4,806

FAO/WFP = Food and Agriculture Organization/World Food Programme; ha = hectare.

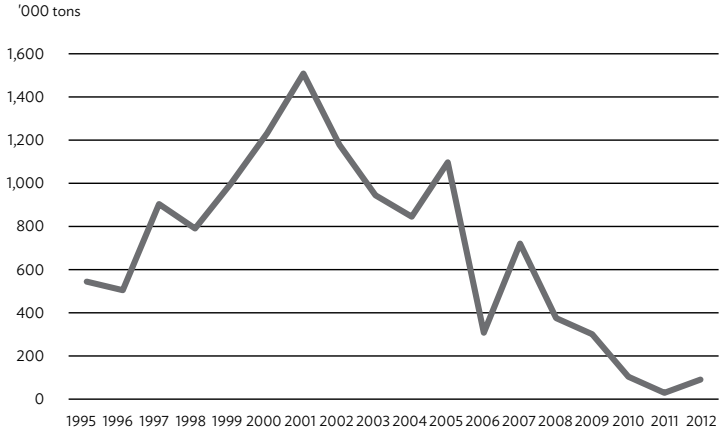
Notes: The cultivation area after 2011 includes the slope cultivation areas. The production statistics based on FAO/WFP did not include beans prior to 2001 but have since included beans. Calendar year (1 January to 31 December); polished grain.

Sources: FAO/WFP (2013); Statistics Korea (2014).

Food aid affects the Democratic People's Republic of Korea's food availability. The WFP has published statistics of food aid provided by the international community since 1995. The volume of the food aid experienced a major increase between 1995 and 2001. It has, however, dropped significantly since then (Figure 6.11).

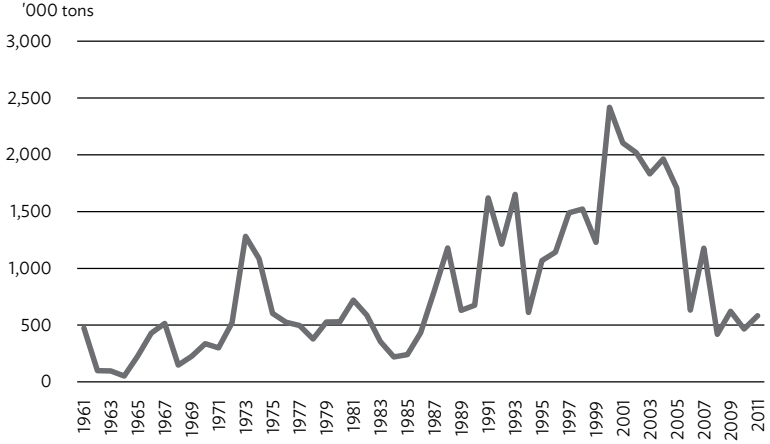
Food imports are another source affecting food availability in the Democratic People's Republic of Korea. The FAO has been publishing statistics on imported food since 1961. However, FAO statistics do not distinguish between commercial imports and food aid. Figures 6.11 and 6.12 show similar patterns in "food imports" and foreign food aid received (see the years between 1995 and 2011), with the quantity of food aid smaller than that of food imports. This suggests that it is most likely that the FAO statistics on food imports also include

Figure 6.11 Food Aid from the International Community for the Democratic People's Republic of Korea



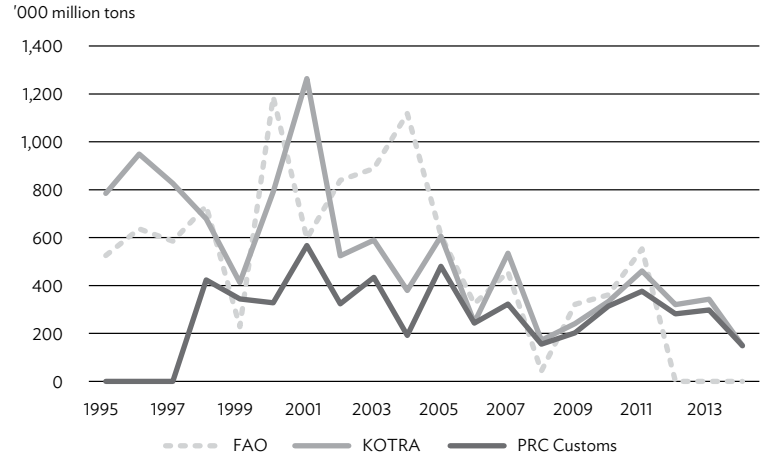
Source: WFP Interfais (2015).

Figure 6.12 Imported Grain, Democratic People's Republic of Korea



Source: FAO (2014d).

Figure 6.13 Volume of Imported Grain, Democratic People's Republic of Korea



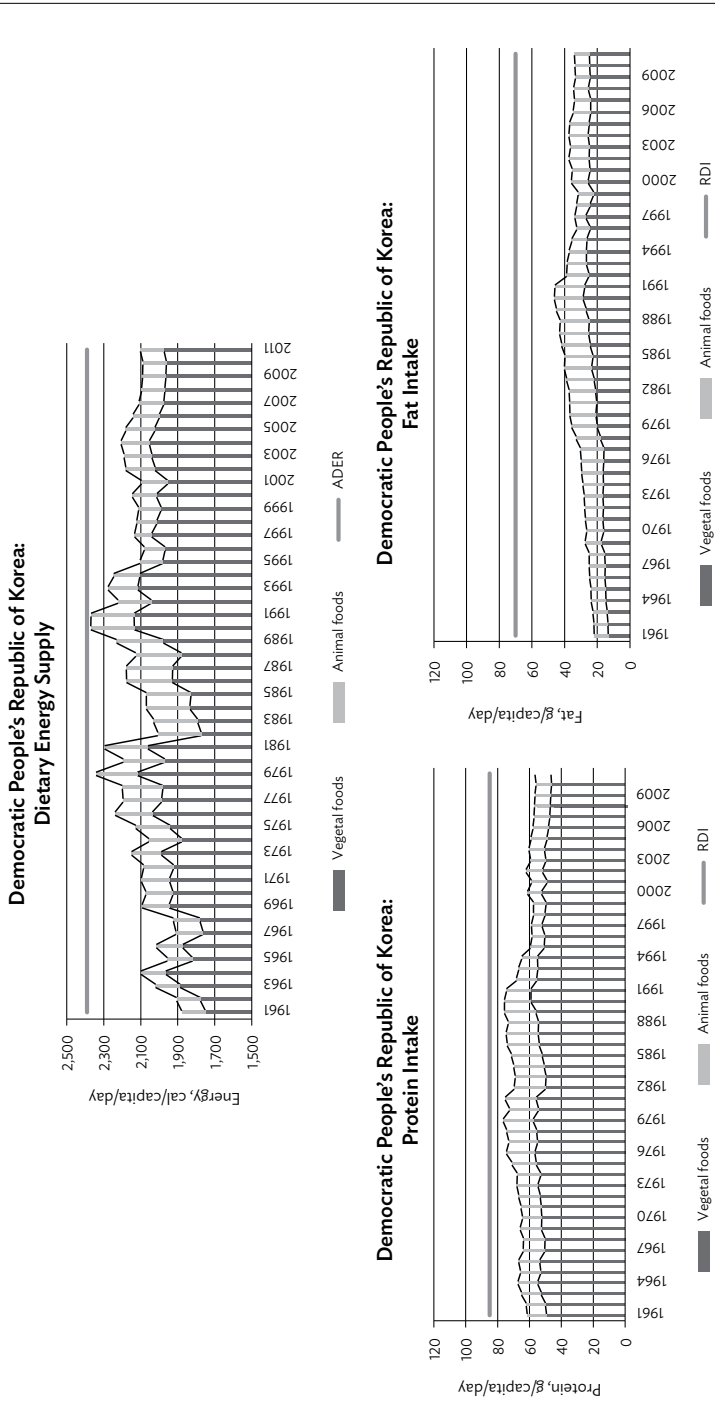
Sources: FAO (2014d); KOTRA (2015); WFP Interfais (2015); KITA (2015).

food aid; its food imports ranged between 0.4 million tons and 1 million tons.

The Korea Trade–Investment Promotion Agency of the Republic of Korea, through its branches all over the world, has estimated food imports of its northern neighbor since 1995. Most of the Democratic People's Republic of Korea's food imports are from the PRC. The General Administration of Customs of the PRC publishes statistics about trade between the Democratic People's Republic of Korea and the PRC. Figure 6.13 confirms that most of the Democratic People's Republic of Korea food imports are from the PRC and that the estimates of total food imports by the Korea Trade–Investment Promotion Agency and the FAO are similar (Commercial "food import" estimates for the FAO are calculated by subtracting the volume of aid from the international community estimated by the WFP from the volume of total imported food by the FAO, including food aid).

The first issue that should be settled in terms of food security is food required for a human body's metabolism. According to the FAO, the ADER for people in the Democratic People's Republic of Korea is about 2,380 kcal per day. At the national level, the country has not met this requirement (Figure 6.14). Protein and fat intake also fall short of basic requirements. The country is therefore vulnerable in terms of availability of food.

Figure 6.14 Dietary Intake per Day per Capita, Democratic People's Republic of Korea



ADER = average dietary energy requirement, g = gram, kcal = kilocalories, RDI = reference daily intake.
Source: FAO (2014b).

Food Accessibility

The government has operated a public distribution system (PDS) since its establishment. People cannot buy food as they want even if they have enough money. The PDS has been enforced since the Regulation on Public Food Distribution was announced on 6 January 1947 (Kim 2013). Initially it was introduced to provide stability to employees of nationalized industries. Later, the PDS was used to control people's lives. Today, it is still enforced, but it has become less effective in reality since the mid-1990s.

Jangmadang, a type of farmers' market, existed even before the government partially liberalized the market in the early 2000s. Grain transactions were illegal in such markets. Nonetheless, farmers sold grain that they privately harvested. Smuggled grain was also sold at *Jangmadang*. However, ordinary people did not have enough money to buy food, and the grain sold in *Jangmadang* was 100 times more expensive than the statutory price. The volume of sales was generally not large.

Food transactions in the *Jangmadang* were officially allowed from early 2003. The country carried out some measures to improve its economic management in 2002. The relaxation of market control was part of the reform measures as reflected in Measures for Economic Management Improvement. The measures affected agriculture from three important perspectives. First, prices, wages, and exchange rates were adjusted to more realistic levels by reflecting market forces, and subsidies were reduced or abolished. Second, a direct tax payment was introduced on enterprises on the basis of their revenues, and the land-use fee was collected. Third, the government reduced the volume and increased the price of purchased grain from collective farms, and extended farms' self-regulated management. These measures helped reduce distortions in the economic systems, which in turn provided better incentives for agricultural industries to grow and also improved residents' access to food.

Before these reform measures were introduced, all economic activities had official and unofficial prices, with the gaps often being greater than 500 times. The government intended to introduce market forces into the state-operated distribution network systems through the Measures for Economic Management Improvement to make them more effective and efficient. However, the performance of state-operated distribution networks remained too poor and was not well received. The intended change was not impressive, either. As a result, the government restructured the farmers' market as a general market or local market in March 2003. In late 2003, at least 300 new markets were opened throughout the country. This further improved residents' access to food; they were able to buy as much food as they wished as

long as they had the money. The government was still keen to keep a close control over these markets, through, for example, limiting market opening hours, market participants, prices of goods, and the volume of transactions. So far, the control has not been as successful as the government had intended.

Currently, the market in the Democratic People's Republic of Korea has become an essential part of people's daily lives. Most people trade goods to make money through the market. One survey revealed that most citizens spend at least 80% of their monthly expenditure and earn at least 70% of their income through the market (Kim and Yang 2012). The PDS is still enforced, but most people purchase at least half of their food from the market. Although the government still exercises control over the market, physical access to food has become a less acute problem. However, economic access is still a big issue. The gap between the distributed food prices and market food prices is enormous. The market price of staple food, rice, is W5,000 per kg (or $0.60), which is more than the average monthly earnings of a non farm worker. Therefore, it is impossible for most people to buy as much food as they wish in the market unless they have other private income sources. Therefore, the people's economic ability is still a barrier to access food through non government channels.

Accessibility to food through the PDS varies greatly between "classes" and areas. Residents in Pyongyang have more opportunities to obtain distributed grain from government channels than residents in other areas. They are in a better position in terms of the amount and quality of distributed food. The PDS does not cover farm workers who work on collective farms. All other residents are classified from Class 1 to 9 for the amount of daily distribution depending on their work. During the severe food shortages of the early 1990s, the PDS further differentiated areas and classes. People have no right to move to another dwelling or to choose a different occupation. When a child is born, his or her food ticket has been largely determined, depending on what his or her parents do and where they live.

Food Utilization

In terms of food security, utilization means the right to adequate and safe nutritional intake required by an individual's body. The PDS was originally designed to establish a quantitative distribution standard for each individual in consideration of such an aspect. However, the PDS specified only the amount of distribution based on calories and did not take into consideration food quality and nutritional balance. When the PDS operated reasonably adequately, the distributed food was close to the level of the ADER on a few occasions (Figure 6.14). The food

shortage in the mid-1990s, however, led to the collapse of the system.[4] Daily energy intake was well below the ADER. Those people who could not adapt to the situation tragically starved to death.

While the illegal distribution of food through the market happened following the collapse of the PDS, vulnerable people including children, elderly people, pregnant women, and breastfeeding mothers as well as some others (including white-collar workers) who were not used to the market had poor chances of access to the market. They could not use the food tickets because of family relationships or their social reputation. During the critical food shortage period from 1994 to 2000, hundreds of thousands of people died, and most of them starved to death because they did not have the minimum amount of food required for staying alive (Lee 2004). It was revealed that half of the deaths were due to diseases. However, it is the lack of nutrition that makes people prone to diseases (Park 2012). Young people and elderly people comprised the majority of the deaths at that time.

Food Stability

The food supply has often been short of minimum requirements (and below normal requirements) and unstable as well (Figure 6.15). According to the World Health Organization, it is essential for a person to have 2,130 kcal per day on average for normal living, and 1,600 kcal, 75% thereof, per day is essential to meet the basal metabolic rate. In cold areas, 1,640 kcal is needed to meet the basal metabolic rate (FAO/WFP 2010). To meet this standard, 167 kg of grain and 7 kg of beans are required per annum for each person. This 174 kg minimum falls short of 213 kg, which is the annual food consumption target per capita by the government. Nonetheless, death due to starvation is avoidable if this 174 kg minimum is secured.

At the national level, a minimum of 5.4 million tons of food (based on milled grain) is needed annually to maintain the minimum level of grain supply for human consumption, feed for livestock, grain for seeds, and unavoidable losses. Food can be secured through domestic production, imports, or foreign aid. The Democratic People's Republic of Korea is not able to produce enough food for its people (Figure 6.15). While it is short of natural resources, it is also short of other essential

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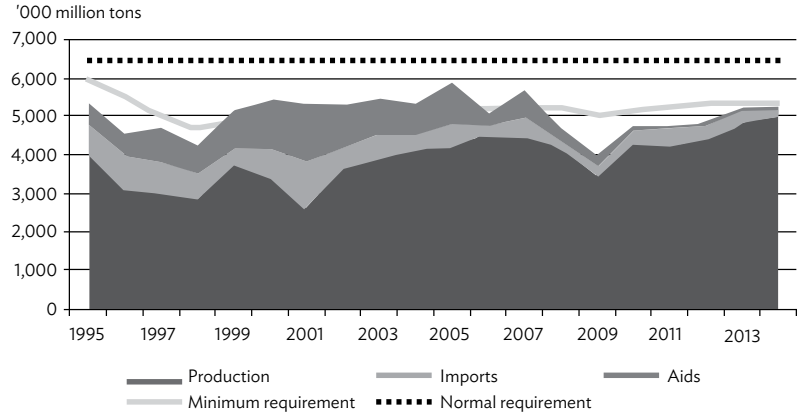
[4] The PDS reportedly supplied to over 60% of the population before the famine in 1994. Those who are not wholly reliant on the PDS include the elite and wealthy classes and those who are not covered by the PDS include all farmers. However, because the government seizes farmers' food production for redistribution through the PDS, food availability for farmers' own consumption has remained highly tenuous. After the famine, the PDS could reportedly supply to only 6% of the population in the mid-1990s (Haggard and Noland 2006).

Figure 6.15 Food Demand and Supply Changes, Democratic People's Republic of Korea, 1995–2014



Note: Because of the great famine during 1995–1997, the minimum requirement was set at 75% of the normal requirement in the Democratic People's Republic of Korea. The recent increment reflects changes in consumption patterns, such as the increase in seed and feed consumption.

Source: FAO/WFP (2013); Statistics Korea (2014).

agricultural inputs and modern agricultural technology. Agricultural production infrastructure is also in short supply. This shortage has been further aggravated by a lack of adequate maintenance, resulting in the poor status of such infrastructure (Kwon et al. 2002). Damage to the natural environment has also been serious and weakened its ability to produce more food. For example, to address food shortages, forests have been cleared for farming, and hilly areas have been developed into terraced fields for cultivating crops; to address fuel shortages, trees have been cut down for cooking and heating. Forest clearing is a serious issue. The area of cleared forest is 31.6% of the entire forest in the country (Park 2014).

Damage to the natural environment through such activities has profound consequences on stable and sustainable food production. Deforestation and tree cutting lowers the capacity of storing water and slowing down water flow when heavy rain falls. It leads to increased discharge of soil and sand to rivers and lakes. When there is less rainfall, droughts may occur more frequently due to the reduced capacity of the environment to store water in the soil. Between 1990 and 2012, there were 29 severe droughts, floods, and storms in the Democratic People's Republic of Korea. Due to the lack and poor

quality of infrastructure, the country could not properly handle such adverse weather conditions, resulting in enormous damage not only to food production but also to human life. The damage to properties was worth $23.7 billion; 1,841 people died; and 15.2 million people were affected (Myeong et al. 2013).

In addition to environmental protection, increased facilities of water supply and drainage can be helpful in coping with droughts or floods for more stable food production. Unfortunately, its investment in such facilities is low. Agricultural water supply depends heavily on water pumps. Its power supply is not very reliable, affecting regular water supply to agriculture. Since the late 1990s, efforts have been made to generate power hydraulically with some success. However, overall, the government is still not able to supply enough power for the country and agricultural sector.

Given that domestic production is insufficient to meet the demand as well as being unstable, food imports and foreign food aid are essential to overcome the shortage. While foreign food aid has fluctuated (and declined significantly in the recent years), imports have not been carried out to the extent that can help the country maintain a stable supply even to meet the minimum requirement (Figure 6.15), most likely due to financial constraints. In the most recent years, domestic food production has been increasing at a good pace, contributing significantly to lifting the total supply toward the minimum requirements (Figure 6.15).

6.3.3 Factors Affecting Food Security in the Democratic People's Republic of Korea

Cooperative Farming and Lack of Economic Incentives

Many factors have affected the Democratic People's Republic of Korea's food supply and thus its food security. One of the most fundamental factors is the adoption of the model of collective farming. Collective farms and state farms coexist. "Collective farms" have been referred to as "cooperative farms," but this terminology is inadequate according to the original concept of "cooperatives." This is simply because the operations of these farms are not based on the principles of cooperation but rather on government commands. Most farm output is purchased at mandatory but low prices by the government.

Like many other previously socialist states, farmers do not own land. The government carried out land reform by forcibly taking over large landowners' land, and then distributing it for free to farmers without land or with only a small piece of land. After the land reform, the government began to organize farmers into collectives, and the collectivization was completed in 1958. By then, individual farmers

had lost their land. Collective farming has since continued, which does not guarantee individual farming rights and lacks economic incentives for individuals in production. Lower agricultural productivity is a corollary.

The Democratic People's Republic of Korea's agricultural productivity experience is similar to many other previously socialist states like the PRC and Viet Nam. When the PRC and Viet Nam practiced collective farming, they had enough input for production on good farmland, yet it was difficult for them to achieve intended outcomes. Since the PRC and Viet Nam switched from collective farming to family farming, their agricultural productivity has improved, helping these countries boost their food supply and improve food security. Recently, the Democratic People's Republic of Korea has attempted to make some moderate changes to collective farming by allowing farmers some freedom in production, which has yielded some good results. However, the collective farming system needs a major change, but this is not forthcoming as the government still follows the principles of collective farming. The collective farming system will continue to undermine its ability to boost its food output.

Lack of Investment in Agriculture

After its establishment, the government followed an approach in which heavy and chemical industries were first developed. Less investment was made in agriculture and light industries. It was intended that after successfully developing the heavy and chemical industries, more support would be provided to agricultural and light industries for balanced development. The problem is that the economy became impoverished before heavy and chemical industries made steady headway. Subsequently, little money could be spared to invest in agriculture, especially in agricultural research and development, to boost output.

Damage to Natural Resources

Natural conditions are less favorable for agricultural production in the Democratic People's Republic of Korea. This, however, can be remedied by improving infrastructure for agricultural production and by providing innovative farming methods through strategic research and development. Unfortunately, the lack of funds has led to serious service shortages in these areas. Making matters worse, serious damage has been done to the natural resources due to the pressure of producing more food. As noted earlier, activities such as deforestation, converting slopes into terrace cropping fields, and cutting tress for fuel result in unsustainable use of natural resources. Further, they contribute to

higher probability of severe floods and droughts. Lack of attention and efforts to protect resources and revitalize the damaged environment may see the country falling into a vicious cycle in its attempt to produce more food.

Lack of Food Imports and Foreign Food Aid

The lack of food supply from domestic production can be addressed by means of imported food or food aid. If the Democratic People's Republic of Korea had imported 2 million tons of food grain every year, the food supply would have significantly improved. The government did not do so due to lack of foreign currencies. On the other hand, foreign currencies were used for purchasing foreign goods for the lavish lifestyle of the elite and military equipment for the political agenda.

The lack of food import capacity, or more accurately the lack of willingness to devote resources to import food, may be to some extent mitigated by the support of international food aid. However, food aid has been declining in recent years due to the refusal on the part of government or the lack of willingness of donors. In early 2000, the country had an opportunity to secure some food aid, and people in the Democratic People's Republic of Korea came to know more about the outside world. The government felt politically uncomfortable. It refused to continue receiving food aid as it did not want questions to be raised on its leadership. Its development of missiles and nuclear weapons also discouraged donors to continue providing food aid. Leaders in the Democratic People's Republic of Korea placed more importance on their own luxurious lifestyle, maintaining their political power, and building military muscle than on the provision of an adequate amount of food to the country's citizens.

Central Planning and Strict Control over the Economy

Central planning and strict control over the national economy have also had a negative impact on the country's food security. Like most socialist states, the Democratic People's Republic of Korea fully plans and controls its economy. The control over its agricultural sector is perhaps even stricter than in some other socialist states. The collective farms, which are grass-roots organizations of agricultural production, have no right to autonomous decision making. The central government determines everything for them including crop selection, seeding, cultivation, harvesting, and distribution. The government also emphasizes the importance of grain production, setting the collective farms' very high production goals with a high proportion of grain procured at prices that are often low and do not even cover the cost. This offers very limited incentives for farmers to work the land harder and smarter.

The country also has an ambition to achieve food self-sufficiency. For this purpose, farmers are encouraged to maximize food output rather than cater to consumer preference or food nutrition. This has resulted in agriculture striving mainly for higher grain output. Because the focus is on calories rather than nutrition, maize has been largely produced as food rather than beans or livestock products for supplying more fat and protein. In livestock production, the policy has been to reduce heads of pigs or chickens that need grain, but farmers are encouraged to raise more rabbits, goats, and ducks that mainly eat grass as feed.

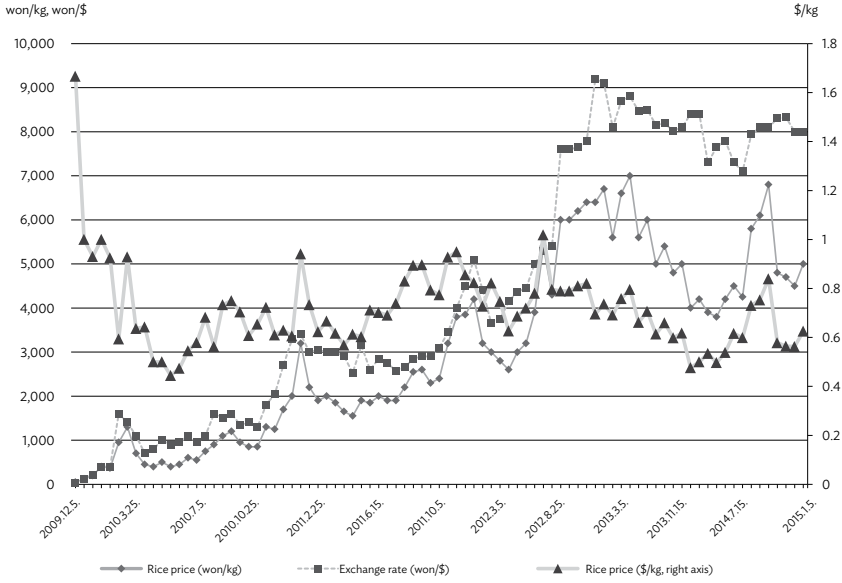
Following the collapse of the national food distribution system, the government has tried to revive it, perhaps with a view to regaining its control over people's access to food. In the meantime, it has also tried to exercise strict control over the market. Despite the fact that such attempts have been less successful, they lower the efficient use of resources and limit people's access to food. It also affects food prices, reducing the chance for farmers to earn higher income. If markets function properly with little government intervention, food prices could be lower with greater food diversity, thus enhancing the country's food security.

6.3.4 Prospects of the Democratic People's Republic of Korea's Food Security

In 2012–2014, there were improvements in the food supply. Grain production increased by almost 20%. Although international food aid fell, the increase in grain output can easily offset this decline. Food prices were relatively stable (Figure 6.16). If the forces that contributed to the increase in grain output stay or even strengthen, it is reasonable to anticipate that the food supply will continue to improve.

The recent agricultural growth is largely attributable to the preferential resource allocation to agriculture and the improved agricultural management system. Collective farms have been allowed to introduce the Pojeon Program (a kind of agricultural production responsibility system) after Kim Jong-un came to power. Although the program has not fully stabilized, it has been well received and has operated well in a significant number of collective farms. The program has reduced the size of a "subwork team," a group of farmers working together under a collective farm. A production group with fewer farmers makes it easier to designate responsibilities and attach rewards to a specific member, boosting economic incentives. The current practice is to reduce the number of members of a subwork team from 15 to 5. Farmers have also been allowed more freedom in disposing of their products, instead of just handing it over to the government. (The previous

Figure 6.16 Changes in Rice Prices in the Market after Currency Reform, Democratic People's Republic of Korea



kg = kilogram.
Source: DailyNK (2015).

arrangement was that farmers retained 30% of their output, with the remaining 70% being procured by the government at the government-set prices.) These changes have significantly altered farmers' motives, leading to higher output and increased grain availability in the market. When the Pojeon Program is fully implemented, it will further enhance agricultural productivity and increase grain output.

Although the country has not adopted a fully family-based farming system like the PRC and Viet Nam, it is predicted that the government will gradually move to a system similar to a family-based farming system. If a family-based farming system is introduced, food production is expected to increase further in view of the experiences of the PRC and Viet Nam. This would have a positive impact on food security.

It is noted, however, that the government still insists on a "military first" strategy. This will most likely jeopardize its capacity to produce more food and hence better food security for the future due to resource misallocation and other related problems. Even if a family-based

farming system is adopted in the near future, for it to be successful, the supply of essential agricultural inputs such as fertilizers, machinery, and pesticides is necessary. Such supply also needs to be stable and reliable. Unfortunately, the Democratic People's Republic of Korea has little domestic capital to invest in such input industries. Foreign investment is an alternative. However, with its military-first strategy, its hostile approach to many other countries, and its nontransparent policy environment, it is hard to anticipate that any foreign investors would invest there any time soon.

Food security cannot be achieved by just increasing grain production. It is also essential to increase the availability of diverse food, enhance accessibility to food, and provide safe and quality food. Food security can be better achieved through transparent and market-friendly policies. In this regard, the role of the market cannot be overstated. So far, markets have grown impressively and have gradually extended into many aspects of the lives of the people. Although the government is still trying to control the market, it is certain that the people who have benefited from the market and have been used to the market will not welcome the government's attempt to re-control the market (Jeong, Kim, and Lee 2012). In reality, it has become increasingly harder for the government to deny the existence and role of the market. The vitalized market will have a positive impact on the country's food security (Kim, Kwon, and Lim 2013).

It is hard to anticipate the longer-term food security status of the Democratic People's Republic of Korea due to its political institutions, which can be responsible for either social stability or instability. For the country to achieve a stable food supply and thus enhanced long-term food security, political institutional reforms are necessary. A government that places people's livelihoods first, has transparent policies, and has efficient administration will foster a stable and fair society, which will encourage greater farm output and foreigners to invest. It is yet to be seen whether and how such a transformation may take place in the Democratic People's Republic of Korea.

6.4 Food Security in the Republic of Korea and the Democratic People's Republic of Korea: Differences and Causes

6.4.1 Different Food Security Status

Since the division of Korea, economic performance in the two countries has been drastically different as opposed to the original similar level. This in turn has significantly affected their food supply and food

security status. The Republic of Korea achieved a per capita GDP of $26,482 in 2013, but the Democratic People's Republic of Korea's per capita GDP remained as low as $621. On the one hand, the Republic of Korea has made the transition from an aid-recipient country to a donor country long ago and became a member of the Development Aid Committee of OECD in 2010. The Democratic People's Republic of Korea, on the other hand, is still dependent upon international aid for its development.

Food security in the Republic of Korea has a far better status than that of the Democratic People's Republic of Korea in most aspects of food security indicators (Table 6.8). The Democratic People's Republic of Korea has a larger arable land area than its southern neighbor, but its cereal production is lower.

The rice yield of the Democratic People's Republic of Korea is 70% lower than that of the Republic of Korea. The differences in meat production are even bigger. Consequently, the percentage of energy derived from cereals, roots, and tubers is lower in the Republic of Korea, reflecting that the country's dietary intake has more nonvegetal food. In terms of prevalence of undernourished, the Democratic People's Republic of Korea

Table 6.8 Comparison of Food Security-Related Figures

Elements	Republic of Korea (A)	Democratic People's Republic of Korea (B)	A/B	Year	Source
Population ('000)	51,141	24,815	2.06	2013	BOK
Crop land ('000 ha)	1,756	2,555	0.69	2011	FAO
Cereal production ('000 t)	6,513	4,710	1.38	2011	FAO
Meat production ('000 t)	1,811	324	5.59	2011	FAO
Rice yield (kg/ha)	7,380	4,340	1.70	2011	FAO
Per capita GDP ($)	26,482	621	42.64	2013	UN
Food import ($ million)	23,438	625	37.50	2012	UN
Cereal import dependency ratio (%)	73.2	15.2	4.82	2007–2009	FAO
Value of food import over total merchandise export (%)	3.0	12.0	0.25	2008–2010	FAO
Prevalence of undernourished (%)	<5	31.0	NA	2011–2013	FAO
% of energy derived from cereals, roots, and tubers	45	68	0.66	2008–2010	FAO

GDP = gross domestic product, ha = hectare, kg = kilogram, NA = not available, t = tons.
Sources: BOK (2013); UN Data (2015); FAO (2014b).

has a 31% rate, while this is less than 5% in the Republic of Korea. Although the production of cereals and meat in the Republic of Korea is not enough to meet the demands of the people, it imports what is needed with no financial difficulties. The value of food imports over total merchandise exports is only 3% in in the Republic of Korea, but this value is much higher in the Democratic People's Republic of Korea at 12%.

6.4.2 Why the Differences?

The fundamental factor that has caused the huge difference between the two countries and in their food security status is institutions—different economic institutions and different government institutions. The Republic of Korea has chosen an open and market-oriented economy with a government elected by the people. The Democratic People's Republic of Korea has adopted a centrally planned and closed economy with the government ruled by a family.

The economy of the Democratic People's Republic of Korea was better than the Republic of Korea until the 1970s. The Democratic People's Republic of Korea originally had better natural resources and industrial infrastructure than the Republic of Korea. Before World War II ended, most power plants and fertilizer plants were located in the north part of the peninsula. At the time of separation, cultivated land size in both countries was similar, but the population in the Republic of Korea was twice that of the Democratic People's Republic of Korea. Not surprisingly, the Democratic People's Republic of Korea had a better food supply initially. As a communist country, however, it adopted a collective farming system for its agriculture, which did not provide incentives to farmers to produce more. While the government provides the collective farms with inputs such as fertilizers and machinery, it collects most of the production output in return. The government used the PDS for food distribution, but the private market was largely banned. It is believed that the food shortage was aggravated by the PDS's inefficiency.

The closed economy in the Democratic People's Republic of Korea has restricted foreign direct investment; thus agricultural infrastructure remains scarce and poor. Deficient electricity and fuel have caused widespread forest denudation and made agriculture in the country vulnerable to natural disasters. The hereditary succession of power through three generations of the Kim family has resulted in a significant portion of resources allocated for military purposes and less to agricultural development. The military-first policy is still in place, and economic development continues to be secondary. The closed nature of the system, both economically and politically, and the continued

inclination of the regime to flout international accords, has imposed tremendous obstacles for the country to achieve better food security.

In the Republic of Korea, the government's priority has been economic development for the people. Elected presidents and lawmakers cooperate to design the best policies for the country. The government has tried to employ various policies to boost domestic staple food production and to protect agriculture from foreign competition. Not all of its policies have been successful. Nonetheless, the government has always placed agriculture in an important position and tried to develop agriculture as much as possible despite limited resources and weak global competitiveness. Although the country is not able to produce all food needed due to scarce land resources, it imports food as much as it needs without financial difficulties.

6.5 Conclusions and Policy Recommendations

After 70 years of separation, the level of food security in the two countries has become drastically different. The Republic of Korea has achieved a high level of food security. It has largely managed to attain self-sufficiency in its staple food—rice. Imports of wheat and feed grain are large, due to scarce land resources. With a heavy dependence on imports, the people of the Republic of Korea are food-secure, although concerns remain that their food security could be threatened when sudden shocks in global food production and occasional food export restrictions occur due to the country's high import dependency ratio (over 75%). People in the Democratic People's Republic of Korea are still suffering from frequent and sometimes serious food shortages due to the country's military-first strategy. Many people are undernourished, and food insecurity remains an urgent and important problem to be resolved.

The fundamental reason for the difference in food security status in the two countries can be explained by their institutional differences, both economic and political. The Republic of Korea follows an open and market-oriented economy, with the government elected by the people. The Democratic People's Republic of Korea follows a closed and centrally planned economy with hereditary succession of power between members of a family.

The market helps the efficient allocation of resources and provides economic incentives to participants while frequently adjusting supply and demand. The market-oriented approach in the Republic of Korea has seen its economy expand impressively. The Democratic People's Republic of Korea has not allowed the market to function effectively. The lack of efficiency in the economy, lack of incentives for workers to produce, and lack of demand–supply adjustments are all undesirable

consequences. The recent partial relaxation of control over markets has generated notable benefits to the economy. It is yet to be seen whether and how soon the market will be allowed to freely operate.

Government or political institutions matter most to a country's food security. Ultimately, it is the government that decides the allocation of resources for different purposes. The government of the Republic of Korea is elected by the people and is held accountable to the people. One of the most important elements of a government's accountability is to ensure that citizens have an adequate amount of food to eat. The government has done well in this regard as reflected by the high level of food security, even by international standards. The government institutions in the Democratic People's Republic of Korea make it possible for the government not to be accountable to the citizens. There is little immediate consequence for the government if it mobilizes its limited resources to pursue a military-first strategy or import luxurious goods for the consumption of the elite, while leaving millions to suffer from food shortages.

OECD (2013) pointed out that to ensure a country's agricultural growth and thus contribute to its food supply and food security to the maximum extent possible, an enabling environment is essential. This environment should comprise a multifaceted setting for the agricultural sector and economy-wide stable policies, good governance through laws and regulations that are conducive to private sector economic activity, and strong and effective institutions through which government measures and actions are operationalized.

Reflecting on the experiences and lessons of the two countries in their management of food security, the following implications can be drawn.

- Governments need to be accountable to their people. They need to ensure that people have access to an adequate amount of food at all times. Supply from domestic sources is important, and policies should be developed to boost domestic supply as much as comparative advantages allow. Policies should enable farmers to earn an income that is comparable to that in other industries. Support to agriculture may be provided, but it should be done so it is consistent with international rules.
- Institutions should be set so that markets can function freely and properly. Governments should not interfere with the functions of the market unless there are market failures. A PDS may be necessary only in an emergency situation. Its use in normal times disturbs normal transactions in buying and selling food and causes inefficiencies.
- Setting up a self-sufficiency target for certain culturally and socially important food items can be valuable in achieving a

country's overall food security. Such a target does not need to be 100% of self-sufficiency but should take into consideration the country's comparative advantage in producing such a food item. Such an approach helps a government win over the support of citizens for various other trade liberalization measures that in turn help the country's overall food security and broad economic efficiency. Legitimate policy measures should be used to achieve such a target. It is noted that food security was considered a nontrade concern in the Uruguay Round and a criterion for the designation of special products in the Doha Development Agenda agricultural modality of fourth revision.

- Agricultural development is essential to enhance a country's food security. For agricultural development, sustained investments in public goods, such as research and development and rural infrastructure, are a prerequisite. Governments need to foster an environment to encourage investment in agriculture.
- Food aid can help alleviate food shortages, but it should be carefully utilized so that it does not have harmful effects on domestic production in the recipient country. When the quantity of food aid is excessive or when the donated food is sold cheaper than the market price, domestic production of the related commodities could be seriously hurt as happened in the Republic of Korea in the late 1950s and early 1960s.
- Food-importing countries should be proactive in setting rules at international forums to regulate food trade to avoid abrupt disturbances to the world market. Trade is important for a food-importing country's food supply and thus food security. The 2007–2008 global food market turmoil should serve as a warning to food-importing dependent countries.
- Diversifying sources of imports can also be a useful method to avoid risks when a country is dependent on imported food. It is necessary to hedge risks of price fluctuations by futures trading and to establish a strategy for participating in the global grain distribution system. A joint stock for emergencies with regional cooperation can be another method to enhance food security. For instance, the ASEAN Plus Three Emergency Rice Reserve is a good case, and developing it as an effective system can be beneficial to member countries.
- Reducing food loss and waste can also contribute positively to a country's food security. In many countries, large amounts of leftover food are thrown away, not only causing waste but also leading to pollution. There is also food loss between post-harvesting and before consumption. Reducing such waste

and loss is equivalent to increasing productive resources and boosting food availability.

- When a country is not food-secure due to lack of resources or lack of money to import, support from the international community can be sought. However, it is hard to expect external support to flow in if a country has a hostile relationship with other countries. A country must be a responsible member in the international community to gain or restore trust from other countries.
- Most importantly, government officials must respect the fundamental rights of the people to have access to an adequate amount of food. Food security can be achieved by preferentially allocating resources and increasing investment for addressing people's livelihoods, adopting market-oriented policies, and supporting a family-based farming system for agricultural production.

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7

Food Security in Israel

Miri Endeweld and Jacques Silber

> Most of the people in the world are poor, so if we knew the economics of being poor we would know much of the economics that really matter. Most of the world's poor people earn their living from agriculture, so if we knew the economics of agriculture we would know much of the economics of being poor.
>
> — T. W. Schultz's Nobel Lecture (Schultz 1979)

7.1 Introduction

In an article in memory of Nobel Prize laureate T. W. Schultz, the late D. Gale Johnson (1999) asked why traditional agriculture is so poor and seems to be so stagnant. As part of the explanation, he mentioned the lack of modern or effective technology, but he also stressed that this could not be the whole story, because one still has to explain why there is so little investment "in the discovery and development of more effective technology in a traditional context" (Johnson 1999). He then stated that this question is precisely what Schultz attempted to explain. Schultz (1964: 3) described the problem as follows:

> The man who farms as his forefathers did cannot produce much food no matter how rich the land or how hard he works. The farmer who has access to land and knows how to use what science knows about soils, plants, animals, and machines can produce an abundance of food though the land be poor...Farming based wholly upon the kinds of factors of production that have been used by farmers for generations can be called traditional agriculture.... How to transform traditional agriculture, which is niggardly, into

> a highly productive sector of the economy is the central problem.... Basically this transformation is dependent upon investing in agriculture.

Agricultural development in Israel is one of the best illustrations of the wisdom of Schultz, as the first part of this chapter will show. Section 7.1 explains why and how Israel solved the supply side of the food insecurity issue. Israel, a country that was considered a developing country in the first decades of its existence, now belongs to the set of countries with high human development. In fact, in 2013, Israel was ranked 19 in the classification of countries according to the Human Development Index (UNDP 2014).

Section 7.2 provides a short survey of the policies implemented by successive governments to overcome food insecurity, with emphasis on the "austerity period" of the first decade of Israel's existence, which was also a decade of massive immigration. Section 7.3 then explains how Israel managed in a relatively short period to considerably increase its agricultural production so that food insecurity is no longer a supply-side problem. Following a short description of the *kibbutz* and the *moshav*, the unique cooperative villages found in Israel, and important transformations in these during the past 30 years, we explain why agricultural production increased so much and in such a short time in Israel, emphasizing the role played by the high level of education of *kibbutz* and *moshav* members and by agricultural research.

The supply side is not the whole story of food security in Israel. In fact, during the past 3 decades, the consumption side has become the main problem, and this aspect of food insecurity cannot be ignored. Section 7.4 is therefore devoted to a macroeconomic analysis of food security in Israel and presents data on the average values of the different varieties of food consumption and their nutritive components, as well as on the import dependency ratios for various food categories. Section 7.5 takes a microeconomic view of food insecurity in Israel, looking at the answers given to subjective questions on food insecurity included in surveys conducted in 2011 and 2012. Several methodologies are utilized to analyze these data. We first adopt a distinction, made by the Household Food Security Measure developed in the United States, between moderately and severely food-insecure households. Then, borrowing techniques adopted in the literature on multidimensional poverty measurement, we present the results on food insecurity in Israel derived from the counting approach developed by Alkire and Foster (2011) as well as from the "fuzzy approach to multidimensional poverty." Finally, rather than computing food insecurity indexes, we estimate Probit and Tobit regressions to determine the main factors, on the demand side, of food insecurity in

Israel. The chapter ends with concluding comments and implications of the attempts made in Israel to overcome food insecurity.

7.2 Food Security

7.2.1 Food Security during the Austerity Period

Soon after its foundation, Israel found itself under exceptional military pressure and faced a serious financial crisis. Since it declared independence on 14 May 1948, Israel has confronted a double challenge, military and civilian. As the War of Independence ended around July 1949, the country's recovery was further slowed by an enormous flow of immigrants. Whatever their origin, most of these immigrants did not have any financial means. The government had to declare an economic emergency in the country. In early 1949, Israel's first elected government began preparations for an austerity regime to address immigrant absorption and Israel's dire economic conditions. In April 1949, in a statement read before the Knesset (Israel's 120-member parliament), the government declared its intention to ration food and to punish black marketers. The government believed that if supply and demand were allowed to determine the prices of goods, many people would not be able to afford basic goods such as food or clothing and that there would be starvation in parts of the population and high inflation. It should be stressed that such rationing policies were also enacted in many European countries during the years following World War II. In Israel, there may have been an additional rationale for enacting a rationing policy: at that time, the government in power was a socialist government with very strong egalitarian views.

Daily rations were determined by an American nutrition specialist and included the following items: simple standard bread (without any limitation), 60 grams of corn, 58 grams of sugar, 60 grams of flour, 17 grams of rice, 20 grams of beans or similar legumes, 20 grams of margarine, 8 grams of noodles, 200 grams of low-fat cheese, 600 grams of onions, and 5 grams of biscuits. The ration of meat was 75 grams per person per month. In addition, limited amounts of eggs, soap, chocolate, milk powder, herring or similar smoked fish, and jam were available. These rations depended on individual characteristics, with greater amounts being available to pregnant women and babies. The main shortages were milk and eggs, which were usually available only as powder. Ration tickets were distributed to citizens to make sure that the rationing policy would be implemented. The prices of the rationed goods were identical throughout Israel. This rationing policy was then extended to clothing

and furniture. Such a policy required also taking measures against the spread of black markets, but without much success. The rationing policy was progressively weakened until it was cancelled in 1959.

7.2.2 Food Security after the Austerity Period

Israel does not have a constitution, and the right to food security has not been included explicitly in any law. Nevertheless, the responsibility of the state, as far as food security is concerned, is mentioned in the 1966 International Covenant on Economic, Social, and Cultural Rights, which was ratified by Israel in 1991. This convention stipulates that states that have ratified the convention acknowledge the right of every individual to a decent standard of living for himself/herself and his/her family, including the right to food. Additional hints pertaining to the responsibility of the state regarding the food security of Israel's inhabitants is found in the Basic Law on Human Dignity and Liberty. The Supreme Court of Israel has thus ruled that the right to minimum subsistence with dignity is the basis of the right of an individual to dignity and even to all of his/her rights. Finally, the 2009 law that established the Council for Food Security states that the goal of the council is to promote food security to the inhabitants of Israel in the spirit of human dignity and principles of equality, justice, and decency.

In the late 1990s, it became progressively evident that some households and individuals were facing a problem of food insecurity. There was thus a dramatic increase in the number of nongovernment organizations (NGOs) providing food, more frequent reports in newspapers about families and individuals that were unable to feed themselves, and research findings confirming the seriousness of the problem.

One way to measure the extent of food insecurity is to conduct surveys that will collect data on food consumption and its composition so that information becomes available on aspects such as the diversity of food consumption and the amount of calories and proteins consumed. The Ministry of Health in Israel implemented such a survey on health and nutrition in 1999–2001, and Israel's Central Bureau of Statistics (CBS) with the cooperation of the Ministry of Health made a similar survey in 2015.

Another way of examining the issue of food insecurity is to obtain information directly from households on the problems that they face because of economic difficulties in having access to food. The United States, for example, developed a food security index that is based on the answers to 18 questions by individuals surveyed (Bickel et al. 2000). Israel adopted a similar approach in 2003 (Nirel et al. 2005) combining two approaches to the measurement of food security. The first approach

used the index developed in the United States on the basis of 18 questions, which are mainly subjective in nature and allow one to detect families that are food-insecure and to estimate the seriousness of such food insecurity. Nirel et al. (2005) also studied the food basket of the households and its composition in terms of variety and nutrients. Their research was based on a representative sample of 1,500 households and concluded that 22% of the population suffered from some level of food insecurity. This level of food insecurity is high by international standards and is twice as high as that in the United States.

In 2008, the Ministry of Social Affairs and Social Services established a committee in charge of checking the extent to which the state was responsible for the food security of its citizens. The committee included representatives from various ministries and the National Insurance Institute. The committee also invited representatives from universities and concluded that there was not enough updated information on the extent of food insecurity.[1] This committee then established the Council for Food Security in 2009.

To make up for this lack of information on food security, the research division of the National Insurance Institute, which has been in charge of publishing the National Poverty Report for the last 4 decades, decided to launch detailed national surveys on this topic. The first survey was implemented in 2011 and it included about 6,000 representative households, which filled a questionnaire similar to the US one, with additional questions allowing a segmentation of the population by socioeconomic categories. A second survey was conducted in 2012 using the same approach and with the same sample size. Surveys were not conducted in 2013 and 2014. The 2011 and 2012 surveys indicated that close to 20% of the families suffered from some degree of food insecurity (Section 8.5), a proportion that is similar to the incidence of poverty in Israel.

7.2.3 Food Insecurity Policy

Food security is taken care of not only by the government but also by the "third sector", that is, an economic sector consisting of NGOs and other nonprofit organizations. The government and the third sector have several means to guarantee food security, including

- Income support benefits that are supposed to guarantee a minimal level of subsistence, in particular as far as food is

[1] The report of this committee is available at http://www.molsa.gov.il/About/OfficePolicy/Documents/dc561a952c7e4bb8b65e07acf6a6c6fdBITACHONTZUNATYMARCH2008.pdf (in Hebrew) (accessed July 2015).

concerned. This allowance is paid to about 100,000 families with no or low income who report to the Employment Service but to whom no job or only a low-wage job is offered.
- Associations that specialize in providing hot meals to the needy and distributing food, in particular at the time of religious festivals. Such associations receive some financial aid from the government, which has increased in recent years.
- Programs aimed at providing at least one hot meal a day to needy pupils in schools. Until 2014, about 240,000 pupils participated in this program, but since 2014, the government increased the budget by about ILS30 million.[2] This will allow subsidized hot meals to be provided to an additional 80,000 children. This decision was made as compensation for the cut in child benefits that was implemented in 2013.
- Food subsidies that for many years were common for basic food. However, these have been drastically reduced since the 1980s.

Direct income support. Families with children where the parents are of working age but receive income support have a high level of food insecurity. According to the National Insurance Institute, it is clear that the economic policies introduced in the early 2000s, which led to cuts in subsistence and child allowances, increased and deepened food insecurity. It has therefore become indispensable to reevaluate these policies and to ensure that social policies guarantee a minimal level of food that will allow families to live in dignity.

Associations distributing food. Welfare officers advise families that complain about food insecurity to turn to NGOs specialized in the provision of food. Each year, the Ministry of Social Affairs and Social Services transfers some money to these NGOs from the allocation of funds from estates. Preference is given to NGOs that distribute food before the Jewish holiday of Passover, dispense food baskets on a monthly basis, and bring hot meals to schools. The ministry gave ILS12 million in 2012 and ILS7 million in 2013.

In 2012, the ministry launched the National Food Security Project that is directed by these NGOs under the guidance of the Council for Food Security and allocates monthly food baskets of ILS300–ILS600—depending on the size of the family—to 4,000 households in

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[2] The Israel shekel (ILS) is the currency of Israel. The shekel consists of 100 agorot. The Israel shekel has been in use since 1 January 1986 when it replaced the old shekel that was in use between 24 February 1980 and 31 December 1985 at a ratio of 1,000:1. In 1990, $1 = ILS2.0162. In 2014, $1 = ILS3.5779.

24 municipalities. This venture operates on the basis of eligibility tests (Endeweld and Shmueli 2013). These tests allow granting help to families whose income left for food—after deducting essential expenses on housing, electricity, water, gas, local property tax, medications, and some amount of debt—is smaller than the minimal expense on food as defined by the National Insurance Institute in a study defining poverty on the basis of expenditure. It is estimated that the improvement in food security among participating families is 25%–30%. Food security was defined solely on the basis of answers to the following two questions: one concerning the skipping of meals and the other the feeling of hunger.

Programs aimed at providing at least one hot meal to needy pupils in schools. The Knesset, passed a student daily meal law in 2005, which stipulates that in kindergartens and elementary schools with an extended school day, a meal would be provided to students, if the length of the school day is at least 8 hours. This initiative was then extended in 2013 to children aged 3 to 8 years who live in areas of low socioeconomic status and stay at school until 4 P.M. The number of students participating has increased significantly in recent years. In 2013, this number was around 310,000. Yet there are still students in need who are not included in such programs.

Food subsidies and controls. Laws enacted in 1957 and later in 1996 allowed price controls on food and services. In recent decades, the prevailing view among policy makers is that such controls should be minimal. In 1985, price controls were suppressed for 12 categories of food. Today price controls are limited to a few types of bread and to salt. Clearly, today price controls are no longer used as an important instrument for food security.

7.3 The Supply Side: Agricultural Production

Israel's natural resources are not favorable to agriculture since more than half of the land is desert, and its climate is not conducive to agriculture. Israel's agriculture is nevertheless highly developed, and the country is a leader in agricultural technologies. While the workforce in agriculture represents only 3.7% of the labor force, Israel produces 95% of its own food requirements, while the main imports are grain, oilseeds, meat, coffee, cocoa, and sugar. The weight of the agricultural sector in Israel's gross domestic product (GDP) is equal to 2.4%, a share not far from that found in many other developed countries. The corresponding weight is, for example, 1.7% in France, 0.9% in Germany, 0.6% in the United Kingdom, and 1.6% in the United States.

Although the agricultural sector is highly productive, Israel depends on imports for several important categories of food. While it does not import poultry, and there are almost no imports of milk and dairy products, the dependency ratios (the ratio of imports over the sum of local production and the difference between imports and exports) in 2012 (latest data available) were equal to 26% for vegetables, fruit, and potatoes; 37% for oils and fats; 54% for legumes, oil grains, and nuts; 58% for beef; 83% for fish; 97% for cereals and cereal products; and as high as 127% for sugar, sweets, and honey. More detailed data are presented in section 7.4.1.

Israel is home to two special types of agricultural communities, the *kibbutz* and the *moshav*.

7.3.1 Role of Cooperative Communities

The *Moshav* and the *Kibbutz*

Around 80% of Israel's agriculture is based on cooperative communities located on state-owned land. These cooperative communities were founded during the first quarter of the 20th century before the establishment of Israel, and their location was an important factor in determining the borders of Israel.

The first type of cooperative community is called a *kibbutz*. It is a rural community of a few hundred inhabitants involved in cooperative production. The first *kibbutz*, called Degania, was founded in 1909. *Kibbutz* members jointly own the means of production, and until recently, they ate meals together in a communal dining hall. Originally, an important characteristic of life in the *kibbutz* was that each *kibbutz* member received an equal budget according to his or her needs, regardless of his or her job. The lifestyle in the *kibbutz* used to be ascetic, and its members had to identify with its ideology and live under the motto "from each according to his ability, to each according to his need." An analysis of the allocation of resources in the *kibbutz* can be found in Sadan (1963).

The other important cooperative community is the *moshav*. It is also an agricultural cooperative, but cooperation is limited to the shared allocation of resources to family farms, such as farmland, water quotas, and other production inputs. A *moshav* often includes 50–120 individual and/or family farm units. The first *moshav*, Nahalal, was founded in 1922. It is important to stress that among the first-generation members of the *moshav*, there were important gaps in economic performance between those of Western and Asian origins. These differences, however, became smaller among the members of the second generation (Sadan and Weintraub 1980).

A specific type of *moshav* is the "collective *moshav*," an institution that shares characteristics of the *moshav* and the *kibbutz*—like the *moshav*, the consumption unit is the family, while like the *kibbutz*, there is full cooperation on the production side. The *moshav* supervises cooperative marketing of most of the farms' products, but, according to Haruvi and Kislev (1984), the most important function of the *moshav* is its role as a financial intermediary, because its members are in a weak position when acting alone in the credit market.

The *kibbutzim* (plural of *kibbutz*) and *moshavim* (plural of *moshav*) cultivate national land, and given that their size was not very big, even in the case of large *kibbutzim*, they could not use their assets as collateral and lacked direct access to the capital market in the 1950s and 1960s. As explained by Kislev (2000), what replaced the missing collateral was a set of mutual guarantees implemented at several levels between not only *moshav* members but also *kibbutzim* or *moshavim* and the regional cooperative associations that they had established. Moreover, in the 1950s and 1960s, the government bailed out the *kibbutzim* and *moshavim* that were in financial difficulties via government-backed long-term loans. Cooperative agriculture was therefore successful, and in fact, banks were interested in having cooperatives among their clients.

In addition to the *kibbutzim* and *moshavim*, the *moshava* is a different type of farming community. It is a noncooperative community of farmers who live on privately owned land. Nevertheless, *moshava* farmers often share services related to farm production, such as packing houses and wineries.

Finally, there is the case of Arab farmers who live in Arab villages. These farmers have livestock (sheep and goats) and grow vegetables, field crops, and olives. Many Arab farmers use modern agricultural technology such as greenhouses. Yaron, Dinar, and Hillary (1992) present an interesting analysis of the factors that affect innovativeness of family farms under Arab social and institutional systems.

The total number of rural farming communities in Israel rose from 769 in 1961 to 952 in 2010. Tables 7.1 to 7.3 give information on the number of these rural localities and their population in various years. The share of the rural population in the total population during the past 50 years has been declining. This is not unique to Israel; it has occurred in all developed countries. During the past 30 years, the socialist features of Israeli agricultural sector are also weakening.

Economic Development, Financial Crises, and the Modified Landscape of Farming Communities

The share of agriculture in the economy of the *kibbutz* has declined over time, and today, most *kibbutz* income derives from nonagricultural

Table 7.1 Population in Urban and Rural Localities ('000)

Type of Locality	1961	1972	1983	1995	2008	2013
Urban Localities	1,837.5	2,789.1	3,616.1	5,101.9	6,799.4	7,433.9
Rural Localities	341.9	358.5	421.6	510.4	612.8	700.6
Moshavim	120.6	125.1	140.8	165.4	243.3	282.3
Collective *Moshavim*	4.0	5.5	9.1	13.4	21.2	23.6
Kibbutzim	77.1	89.7	115.5	118.9	136.0	157.5
Other type	140.2	138.3	156.2	212.7	212.3	237.3
Total	2,179.4	3,147.6	4,037.7	5,612.3	7,412.2	8,134.5

Source: CBS (2015a).

Table 7.2 Number of *Moshavim* and *Kibbutzim*

Number	1961	1972	1983	1995	2008	2013
Moshavim (including collective *Mishavim*)	366	386	448	455	441	443
Kibbutzim	228	233	267	268	269	267

Source: CBS (2015a).

Table 7.3 Number of *Kibbutzim* and Their Importance in the Total Population

Year	Number of *Kibbutzim*	Share in Total Population (%)
1910	Creation of first *Kibbutz*	–
1920	12	1.5
1930	29	2.4
1940	82	5.7
1948 (census)	177	6.5
1961 (census)	228	4.0
1972 (census)	233	3.3
1983 (census)	267	3.4
1995 (census)	268	2.6
2005	267	2.2

Source: CBS (2015a).

activities. Moreover, over the past 3 decades, the *kibbutz* has undergone fundamental socioeconomic reforms, and today in many *kibbutzim*, economic activity and household ownership are at least partially privatized.

These changes became evident starting in the mid-1980s when the *kibbutz* had to face a crisis that was both economic and ideological (for more details, see Avrahami 2002).

The standard of living in Israel grew significantly in the 1960s and even more in the 1970s, and given the increasing share of industrial production in the *kibbutzim*, the latter managed to increase their living standards. During the same period, Israeli society became more individualistic, and such a shift in values was also felt in the *kibbutzim*. Moreover, in 1977, the Labor Party, which had been in power for almost 30 years and was a strong supporter of the *kibbutz* movement, lost the elections. The Likud, the new party in power, was in favor of strongly increasing the role of free markets in Israel. There was also a stock market crisis in 1982, and the early 1980s was a period of almost hyperinflation so that many *kibbutzim* lost a lot of money because quite a few *kibbutzim* had speculated in the stock market, which at that time seemed to be more profitable than investing in agriculture, among other reasons. Many *kibbutzim* were suddenly facing serious financial difficulties.

The *kibbutzim* bore part of the responsibility for accumulating the debts. The government and banks also had to share the responsibility. To fight inflation, the government, for example, controlled the price of agricultural products and set strict water allotments for a while (water was subsidized). As far as the banks were concerned, they took advantage of the fact that there existed guarantees between the *kibbutzim*, a system that had led to unjustified borrowing by many *kibbutzim* and to quite risky investments.

As a consequence, in 1989, the *kibbutzim*, the government, and the banks signed a debt restructuring agreement that allowed the *kibbutzim* to sell some land to pay their debts. An additional agreement was signed in 1996. On the whole, debts of the *kibbutzim* and *moshavim* amounting to ILS40 billion were erased to solve their financial crisis. In many *kibbutzim*, members started paying for electricity and food (common dining halls were suppressed). It became more common to see members working outside of their *kibbutz* and the *kibbutzim* hiring outside workers, both phenomena in contradiction with the original ideology of self-labor. Many members left the *kibbutz*, and the weight of agriculture in total production became even smaller. Solidarity and cohesion among *kibbutz* members became weaker. The *kibbutz* movement that had been powerful in the earlier decades lost much

of its political influence. At the same time, there was also a serious weakening of the degree of cooperation in the *moshav* (Ben-Dror and Sofer 2010).

Economic constraints, even before the financial crisis, had induced *moshavim* and *kibbutzim* to introduce nonagricultural branches. Most *kibbutzim*, for example, now also have an industrial sector. This allows finding employment for those who had to leave agriculture because of productivity increases. It also helps by giving work to elderly people and incentives to young people not to leave the *kibbutz* or *moshav*. Moreover, for the *moshavim* or *kibbutzim*, such transformations represent a useful diversification of risks.

7.3.2 The Declining Weight of Agriculture in the Economy

During the past 3 decades, there has been a steady decline in the number of individuals working in the agricultural sector: in 2010 around 64,000 people were directly employed in agriculture (one-third self-employed, the rest hired labor), and this represented about 2% of the country's total labor force. Similarly, the contribution of agriculture to the GDP is small, with total agricultural production accounting for only 1.9% of GDP in 2010. Nevertheless, agriculture plays a central role as the supplier of food in the local market and agricultural exports (fresh and processed), which amounted to $2.130 billion in 2010, representing 4.2% of the country's total exports. Fresh produce exports (essentially to the European Union) were equal to $1.33 billion, while processed food exports totaled $798 million. Israel also exported agricultural inputs (production factors, technologies, services), which had a value of $2.87 billion in 2010.

As far as the food supply is concerned, it is estimated that while one full-time agricultural worker supplied food for 17 people in the early 1950s, the figure had risen to 113 by 2010 (IEICI 2011). As will be stressed subsequently, agricultural research has been a critical determinant of such an increase in productivity. An analysis of the financing of agricultural research in Israel is presented in Gelb and Kislev (1982). A more general study of agricultural research, with an international comparison, can be found in Evenson and Kislev (1975).

7.3.3 Education and Agricultural Productivity

Education and the Ability to Deal with Disequilibria

In a ground breaking article on the role of "allocative ability" in economic development, Schultz (1975: 54) wrote that

> No matter what part of a modern economy is being investigated, we observe that many people are consciously reallocating their resources in response to changes in economic conditions. How efficient they are in their responses is in no small part determined by their 'allocative ability.' The ability to reallocate is not restricted to entrepreneurs who are engaged in business. People who supply labor services for hire or who are self-employed are reallocating their services in response to changes in the value of the work they do. So are housewives in devoting their time in combination with purchased goods and services in household production...

In another paper, Schultz (1980) argued that the ability of an entrepreneur to deal with disequilibria is part of the stock of human capital and that such ability is enhanced by experience, health, and schooling. Schultz also stressed that most empirical studies in this domain concerned the impact of the schooling of farmers on "their ability to perceive and to interpret new information and to decide to reallocate their resources to take advantage of new and better opportunities" (Schultz 1980). Schultz argued that as technology becomes more complex, the comparative advantage of schooling relative to that of learning from experience increases. Citing Welch (1970), Schultz concluded that the higher the level of agricultural research activity, the more rapid the changes in production opportunities and the larger the advantages of the entrepreneurial ability acquired from education.

In Israel in the 1950s and 1960s, important resources had already been devoted to agricultural research. In addition, *kibbutz* and *moshav* members, at least the male members, had a level of education that was higher than observed among farmers in countries with a level of development similar to that of Israel in the 1950s and 1960s. The reason is that literacy has been almost universal among male Jews for more than 1,500 years. Botticini and Eckstein (2005, 2012) explained why literacy became widespread among Jews. In addition, the repeated persecution of Jews may have developed skills favoring what Schultz (1975) called "the ability to deal with disequilibria," a quality that could explain why *kibbutz* and *moshav* members were quick to adopt new agricultural techniques.

Agricultural Research and the High Productivity of Israeli Agriculture

Some economists believed that there was not much opportunity for growth in agriculture. For them, agriculture can provide an unlimited supply of labor for industry at practically zero opportunity cost because its marginal productivity was supposedly zero, and, more generally,

because farmers do not respond to economic incentives. Schultz (1964), however, emphasized the role of investment in agriculture, contradicting other economists.

In his article in memory of Schultz, Nerlove (1999) explained why Schultz did not agree with such a view. He gave the following citation of Schultz:

> When the productive arts remain virtually constant over many years, farm people know from long experience what their own effort can get out of land and equipment. In allocating the resources at their disposal, in choosing a combination of crops, in deciding on how and when to cultivate, plant, water and harvest, and with what combination of tools to use draft animals and simple field equipment—these choices will embody a fine regard for marginal costs and returns... Furthermore, children acquire the skills that are worthwhile from their parents as children have for generations under circumstances where formal schooling has little economic value (Schultz 1964:16).

As emphasized by Johnson (1999: 11), the time and experience have confirmed Schultz's conclusions: "In those areas of the world where governments have provided reasonable incentives to farmers and where new methods of production that were more profitable than those they superseded have been made available, the people are much better fed today than ever before, and the farmers have substantially higher real incomes." Moreover,

> As the modernization of agriculture proceeds, the demand for the contribution of agricultural research becomes stronger and more effective...As the advances in science proceed, the agricultural research possibilities are enhanced, thus setting the stage for the supply of additional new information from agricultural research...The social rate of return to investment (expenditures) in nonprofit agricultural research is, in general, high relative to that on most alternative investment opportunities... (Schultz 1971: 238–241).

The importance of agricultural research is probably best illustrated by what happened to agriculture in Israel over the past 65 years. Gelb and Kislev (1982) explained why agricultural output in Israel had more than tripled in value (in constant prices) in a period of 20 years, despite the important reduction in the farm labor force. Since capital accumulation

hardly offset this decrease in the labor force, 90% of the growth in output was, according to Gelb and Kislev (1982), due to growth in productivity and only 10% due to growth in conventional inputs.

For Gelb and Kislev (1982: 322),

> Research was instrumental in enhancing agricultural productivity: new crop varieties were introduced and tried by the research system, new chemicals and methods were tested, and the basic knowledge and facilities available to the system enabled the development and successful introduction, for example, of trickle irrigation—perhaps the most important single technological innovation in agriculture to originate in Israel in the last two decades.

Gelb and Kislev also noted that the knowledge created in the agricultural research system is a public good, which can easily be transferred between farmers and as a consequence cannot be appropriated by a single farmer. This is why there has to be public provision of agricultural research. In addition, the consequent productivity growth will often be of greater benefit to the consumer than to the farmers so that if the demand for the product is inelastic, the total revenue of the farmers will decrease, unless the agricultural products benefit from government aid. Indeed, to overcome the shortage of water, land, and manpower, Israeli farmers have highly mechanized their production; made intensive use of greenhouses; and adopted complex, profitable, and computerized irrigation systems. Here are some illustrations of technological advances.

(i) The cattle and milk industry is automated. Almost all dairy farms are computerized. Every cow is connected to a sensor that transmits to the computer information on its health and the composition of its milk. It is hence not surprising that Israel holds the world record in the quantity of milk per cow.
(ii) The use of pierced irrigation pipes, an Israeli invention, has led to a considerable amount of water saving. These pipes are linked to a computer that can control the amount of water, fertilizers, and pesticides.
(iii) The intensive use of greenhouses allows computerized control of the temperature, humidity, light, and fertilizer amount. The use of greenhouses increases the yield of the crop.
(iv) Fish farming in greenhouse pools allows the production of fish in desert areas by using salt water. These pools are often covered with plastic to lessen the amount of evaporation.
(v) Biotechnological developments have enabled some varieties of vegetables and fruit to be transformed genetically so that they

can be sold in new colors (e.g., pepper) and be more resistant to diseases. More recently, there has also been an increasing production of organically grown food.

The Ministry of Agriculture, whose specialists give regular and often free help to farmers, has played an important role in these developments. Among the services that the ministry provides, the most important are instructing (providing updated agricultural knowledge to farmers), training (providing farmers with concentrated professional knowledge allowing the adoption of new and advanced technologies), and producing applied knowledge. The ministry's agricultural extension service, in cooperation with regional research and development units and universities, conducts many experiments aimed at finding solutions to problems faced by farmers in the fields of water use, including water recycling, adopting new technologies and automation, improving agricultural produce quality to meet international standards, and reducing the use of pesticides.

Of particular interest is the important role of post-harvest technologies. The idea is to use advanced scientific tools in domains such as physiology, chemistry, pathology, microbiology, entomology, and molecular biology and to combine them with traditional preservation technologies. There are also attempts to identify and develop alternatives to chemical methods for the control of post-harvest pathogens and pests (see IEICI 2011).

All of these research efforts explain why Israel's agricultural sector can supply enough food to inhabitants and also become export-oriented. Export activities are an important source of income to Israeli farmers.

7.3.4 Impact of Declining Government Intervention

In the past, the government used to impose price controls for agricultural products, determine production quotas for most agricultural products, and give subsidies to those in agriculture who followed these production quotas. Production quotas have almost disappeared, and government financial help to agriculture has become less important. However, as stressed by Kachel and Finkelshtain (2010), the agricultural sector in Israel enjoys far-reaching exemptions from antitrust regulation.

Government intervention in agriculture was not limited to the determination of prices and/or quantities. Up to the early 1980s, there was also a specific Israeli approach to rural development that was implemented in the 1950s and 1960s when hundreds of thousands of new immigrants had to be absorbed and became employed in rural regions in Israel. Raanan Weitz, the Jewish Agency's director of the Land Settlement Department between 1963 and 1984, advocated

this approach. More details can be found in Weitz (1965, 1979). This approach was also applied to developing countries, as mentioned in Kreinin (1963).

Having surveyed agricultural production and the supply side of food security, we now examine the consumption side of food security. We make a distinction between analyzing the macroeconomic level that gives information only on the average consumption of various food components and studying the microeconomic level that stresses differences in food security between individuals and socioeconomic categories.

7.4 Food Security at the Macro Level: An Objective Analysis of Food Consumption and Security

7.4.1 Food Consumption

Table 7.4 gives the share of food expenditure in total consumption in the first decade of the 21st century. Total expenditure on food, including fruit and vegetables, amounted to about 16% of the consumption of households in 2010. The corresponding percentage in 1968–1969 was 28%. Such a decline in food expenditure reflects the rise in the living standards of households.

Table 7.5 shows the breakdown of food consumption into major food groups for 2012. On average, in 2012, 200 kilograms (kg) of vegetables and 186 kg of fruit were available to each person in Israel. For other major food items, the annual availability is 182 kg of milk and dairy products, 116 kg of grain bread and cereal products (representing almost one-third of the daily calories), and 71 kg of meat and related products. In 2012, animal products—milk and dairy products, meat, fish, and eggs—provided more than one-fifth of the total daily energy per capita.

Table 7.6 presents the calorie intake in Israel between 1950 and 2012. It appears that during this 62-year period, the consumption of calories increased by 40%, from 2,610 to 3,630 per person per day. The data show that even during the austerity period in the early 1950s, the average per capita calorie intake was much higher than the minimum dietary energy requirement (kilocalories per person per day) set by the Food and Agriculture Organization (FAO) in accordance with the structure by age of the population of each country (about 1,820 kilocalories per person for Israel for the past 20 years). In 2012, the amount of calories per person per day in Israel was among the highest in developed countries (CBS 2015a).

Table 7.4 Share of Food Expenditure in Total Consumption during the Last Decade

	2000	2005	2010
Consumption expenditures—total	**100.0**	**100.0**	**100.0**
Food (excluding vegetables and fruits)	**13.6**	**13.2**	**13.3**
Bread, cereals, and pastry products	2.4	2.3	2.3
Vegetable oils and products	0.4	0.3	0.4
Meat and poultry	2.6	2.6	2.7
Fish	0.5	0.5	0.6
Milk, milk products, and eggs	2.6	2.4	2.4
Sugar and sugar products	0.6	0.5	0.5
Soft drinks	0.8	0.7	0.7
Alcoholic beverages	0.3	0.2	0.3
Meals away from home	2.1	2.2	2.3
Miscellaneous food products	1.4	1.3	1.2
Vegetables and fruit	**3.4**	**3.2**	**3.1**
Thereof:			
Potatoes and sweet potatoes	0.2	0.2	0.2
Vegetables, fresh	1.2	1.1	1.1
Fruit, fresh	1.0	0.9	0.8
Vegetables frozen, pickled, and canned	0.6	0.6	0.5
Fruit, dried	0.3	0.3	0.3
Fruit juices, natural	0.1	0.1	0.1

Source: CBS (2015b).

Table 7.5 Food Supply Balance, 2012 (per capita)

Commodity	Kilograms per Year	Grams per Day	Nutritional Energy (kilocalories per day)	Protein (grams per day)	Fats (grams per day)
TOTAL			**3,629.70**	**109.7**	**140.5**
Thereof:					
Cereals and cereal products	116.4	318.9	1,092.10	33	5.9
Potatoes and starches	40.1	109.8	118.9	1.5	0.1

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Table 7.5 *continued*

Commodity	Kilograms per Year	Grams per Day	Nutritional Energy (kilocalories per day)	Protein (grams per day)	Fats (grams per day)
Sugar, sweets, and honey	42.8	117.4	452.2	0	–
Oil grains and nuts	11	30.1	60.4	4.4	12
Vegetables	200.4	549.2	138.2	5	1.4
Fruit	185.8	509.2	132	2.9	3.4
Beverages	67.2	184.2	223.3	0	0
Stimulants	6	16.6	20.4	0.8	0.8
Oils and fats	25.2	69.1	14.7	0	68.7
Meat	71	194.4	607.9	35.5	28.2
Eggs	13.8	37.8	48	4	3.2
Fish	7.1	19.5	20.9	3.5	0.7
Milk and dairy products	181.6	497.6	295	15	15.6

Source: CBS (2015a).

Table 7.6 Supply of Macro Nutrients (per capita per day)

Commodity	1950	1960	1970	1980	1990	2000	2010	2012
TOTAL CALORIES (kcal)	**2,610**	**2,772**	**2,988**	**2,979**	**3,089**	**3,556**	**3,669**	**3,630**
Cereals and cereal products	1,260	1,157	1,067	1,048	986	1,095	1,202	1,092
Potatoes and starches	98	77	79	89	66	85	139	119
Sugar, sweets, and honey[a]	265	379	460	413	482	651	351	452
Legumes,[b] oil grains, and nuts	62	85	96	114	152	142	199	199
Vegetables and melons[c]	65	67	77	69	103	103	124	132
Fruit	105	147	164	150	169	186	208	223
Oils and fats	343	406	452	496	486	629	669	608
Meat	95	143	264	284	317	344	393	406
Eggs	61	73	89	77	72	49	49	48
Fish	58	18	16	12	18	26	20	21
Milk and dairy products	197	220	224	227	238	246	278	295
Beverages	–	–	–	–	–	–	37	35

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Table 7.6 *continued*

Commodity	1950	1960	1970	1980	1990	2000	2010	2012
TOTAL PROTEIN (grams)	**83.9**	**85.1**	**91.5**	**92.2**	**97.4**	**104.3**	**110.9**	**109.7**
Animals[a]	32.2	34.0	44.3	45.4	49.9	52.2	55.8	58.0
Cereals and cereal products	41.4	39.7	34.6	34.1	31.7	35.2	36.8	33.0
Potatoes and starches	2.2	1.7	1.8	1.9	1.4	1.8	1.5	1.5
Sugar, sweets, and honey[b]	0.2	0.1	0.3	0.4	0.5	1.3	0.0	-
Legumes,[c] oil grains, and nuts	3.2	4.0	0.3	5.0	6.8	6.6	8.6	8.5
Vegetables and Melons	2.9	3.5	3.7	3.5	5.1	4.8	4.7	5.0
Fruits[d]	1.8	2.1	2.3	1.9	2.0	2.4	2.8	2.9
Meat	7.4	11.8	20.8	22.5	25.6	28.4	34.2	35.5
Eggs	4.6	5.5	6.8	5.9	5.5	3.8	4.1	4.0
Fish	7.1	3.0	2.7	2.4	3.4	4.5	3.3	3.5
Milk and dairy products	13.1	13.7	14.0	14.6	15.4	15.5	14.2	15.0
Beverages	–	–	–	–	–	–	0.8	0.9
TOTAL FAT (grams)	**73.9**	**86.7**	**104.3**	**111.5**	**117.6**	**139.6**	**145.5**	**140.5**
Animals[a]	23.9	27.9	38.3	38.7	42.6	43.3	46.1	47.7
Cereals and cereal products	5.4	4.8	4.4	4.3	4.1	4.5	6.7	5.9
Potatoes and starches	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Sugar, sweets, and honey[b]	1.3	0.8	1.8	2.0	2.2	6.6	0.0	-
Legumes,[c] oil grains, and nuts	2.9	5.0	5.5	7.0	9.2	7.9	12.4	12.5
Vegetables and Melons	0.2	0.4	0.7	0.6	1.0	0.8	1.3	1.4
Fruits[d]	1.1	1.4	2.0	2.5	3.2	5.0	2.6	3.4
Oils and fats	39.0	46.3	51.5	56.3	55.3	71.4	75.6	68.7
Meat	6.9	10.3	19.3	20.7	22.9	24.7	27.4	28.2
Eggs	4.4	5.2	6.4	5.6	5.2	3.6	3.3	3.2
Fish	3.3	0.6	0.4	0.3	0.4	0.8	0.7	0.7
Milk and dairy products	9.3	11.8	12.2	12.1	14.0	14.2	14.7	15.6
Beverages	–	–	–	–	–	–	0.7	0.8

[a] Including meat, eggs, fish, milk, and its products.
[b] Until 2000, the group included chocolate, sweets, sugar, jam, and honey.
[c] Including soya beans.
[d] Until 2000, "Fruits" included melons.

Source: CBS (2015a).

Table 7.7 Daily per Capita Food Consumption (grams per day)

Daily Food Consumption per Capita	1960	1970	1980	1990	2000
Products:					
Wheat and related products	313.7	285.5	282.2	257.3	282.2
Rice	15.6	18.1	15.9	19.7	26.3
Sugar	79.7	95.9	82.7	97.3	120.5
Vegetables	314	331.2	311.2	441.9	449.6
Citrus fruit	161.9	116.2	95.6	90.9	129.3
Meat	88.2	154.3	170.4	193.8	216.2
Eggs	50.4	61.6	53.7	49.9	34.2
Milk and dairy products	275.9	267.7	272.0	277.8	275.8

Source: CBS (2015c).

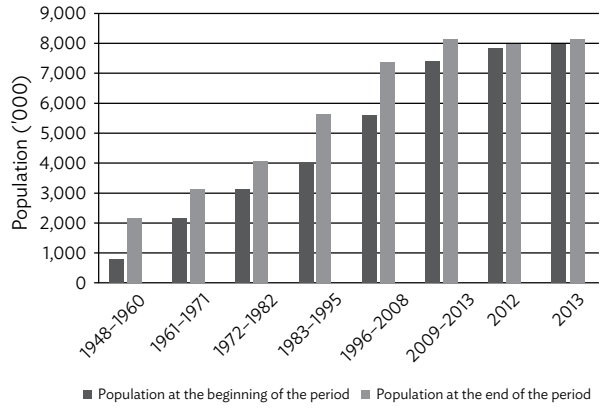
Proteins consumed have increased about 30% during the past 60 years. Most of the increase comes from animal product consumption, while the amount of proteins derived from grain and related products has declined. At the same time, fat intake has increased sharply (an increase of 90% during the same period). The amount of calories derived from grain and related products declined regularly between 1950 and 1990, but it rose afterwards to reach its 1980 level in 2012. The contribution of oils and fats has increased gradually from 13% in 1950 to 16% in 2012, while that of meat has increased significantly from 4% in 1950 to 9% in 1970 and 11% in 2012. The calorie intake has increased for all food groups, except for fish and eggs. For fish consumption, there is a high level of dependence on imports (more than 80%).

Table 7.7 displays food consumption by major food groups for 1960–2000. However, CBS stopped publishing the data in this form since 2002. It appears that the consumption of wheat and related products fell between 1960 and 1990 but rose afterward. We also note a significant increase in the consumption of rice and sugar between 1990 and 2000. As far as vegetables are concerned, we observe a sharp increase in consumption between 1980 and 1990. These data confirm the data on the sources of calories. We notice, for example, that the consumption of meat almost doubled between 1960 and 1970 but increased at a much slower pace afterwards, while the consumption of eggs decreased by about two-thirds between 1960 and 2000. Finally, it appears that the consumption of milk and dairy products remained more or less stable throughout the period surveyed.

It is important to stress that the 20% rise in the per capita intake of calories that took place between 1990 and 2000 occurred despite the fact that, during this period, Israel absorbed about 1 million immigrants, most of them coming from what used to be the Soviet Union (a minority of immigrants came from Ethiopia and other countries). This immigration flow represented about one-sixth of Israel's total population at the time. In fact, it is possible that the changes in consumption patterns that have been observed since 1990 are the consequence of this significant change in the composition of the population.

Figure 7.1 illustrates the great changes in the size of the population that took place during the last decade of the 20th century and shows the importance of immigration flows during 1948–1960 and 1983–1995.

Figure 7.1 Population Growth in Israel during the Past 65 Years



Source: Authors' compilation based on CBS (2015a).

7.4.2 Food Import Dependency

Table 7.8 presents data on the quantities of the different types of food that were produced, imported, and exported in 2012. The last column of Table 7.8 gives the value of the import dependency ratio (IDR), which provides information on the extent to which Israel is dependent on the import of food. The computation of the IDR follows the international definition by the FAO and is defined as

$$IDR = \{Imports / [(Production + Imports) - Exports]\} 100$$

Table 7.8 Food Supply by Product, 2012

Commodity (tons per year)	Total	Imports	Exports	Production	Import Dependency Ratio
CEREALS AND CEREAL PRODUCTS—TOTAL	**1,889,331**	**1,829,922**	**191,736**	**253,813**	**97%**
Wheat and Rice (milled)	1,832,544	1,828,350	191,631	198,493	100%
Other cereals	56,787	1,573	106	55,320	3%
POTATOES AND STARCHES—TOTAL	**350,801**	**9,541**	**243,728**	**600,032**	**3%**
Potatoes and potato starch	307,010	9,541	228,159	540,628	3%
Corn starch	43,791	0	15,569	59,404	0%
SUGAR, SWEETS, AND HONEY— TOTAL	**353,479**	**488,632**	**108,865**	**6,583**	**126%**
Sugar and sweets	350,338	488,590	108,865	3,483	128%
Honey	3,141	41	0	3,100	1%
LEGUMES (INCL. SOYA BEANS), OIL GRAINS AND NUTS—TOTAL	**158,004**	**85,079**	**11,675**	**84,608**	**54%**
Legumes, dry	67,836	20,716	1,757	48,886	31%
Sesame, groundnuts, and sunflowers	73,639	51,882	7,925	29,681	70%
Nuts	16,529	12,481	1,993	6,041	76%
VEGETABLES AND MELONS—TOTAL	**1,746,512**	**571,572**	**414,604**	**1,647,544**	**32%**
Watermelons and other melons	127,422	100	5,396	132,718	0%
FRUIT—TOTAL	**1,579,039**	**388,181**	**348,575**	**1,539,433**	**25%**
Citrus	770,103	350,159	192,104	612,048	45%
Fresh fruit, excl. citrus	808,936	38,022	156,471	927,385	5%

continued on next page

Table 7.8 *continued*

Commodity (tons per year)	Total	Imports	Exports	Production	Import Dependency Ratio
OILS AND FATS —TOTAL	**200,975**	**69,426**	**1,147**	**121,688**	**37%**
Vegetable oils, refined	194,310	68,125	1,096	115,792	37%
Butter	6,665	1,301	51	5,896	18%
MEAT—TOTAL	**562,646**	**64,231**	**18,404**	**516,818**	**11%**
Beef, fresh and frozen, carcass weight	99,020	57,797	10,225	51,448	58%
Sheep and goats, carcass weight	18,376	1,853	789	17,312	10%
Pigs	13,577	0	0	13,577	0%
Poultry	353,793	24	4,791	358,560	0%
Turkey	66,125	0	2,599	68,724	0%
Beef, offal, and other edible parts	11,754	4,557	0	7,197	39%
EGGS	**109,150**	**4,990**	**0**	**104,160**	**5%**
FISH	**57,381**	**47,523**	**1,145**	**11,003**	**83%**
MILK AND DAIRY PRODUCTS—TOTAL	**1,461,094**	**7,398**	**1,736**	**1,455,746**	**1%**
Cow's milk	1,410,131	0	0	1,410,131	0%
Sheep and goat's milk	44,552	187	0	45,615	0%
Powdered milk (imports)	6,411	7,211	1,736	0	132%

continued on next page

Table 7.8 *continued*

Commodity (tons per year)	Total	Imports	Exports	Production	Import Dependency Ratio
BEVERAGES—TOTAL	**53**	**8**	**3**	**48**	**15%**
Water	49	2	1	48	4%
Wine and alcohol (imports)	1	3	2	0	354%
Beer (imports)	3	3	0	0	100%
STIMULANTS—TOTAL	**47,839**	**52,553**	**4,714**	**0**	**110%**
Coffee	35,667	39,686	4,019	0	111%
Tea	5,002	5,019	17	0	100%
Cocoa	7,170	7,848	678	0	109%

Source: Authors' compilation based on CBS (2015a).

Note that when the IDR is higher than 100%, this implies that exports are higher than local production. This occurs generally when an important input of the good exported is imported. This is, for example, the case of jam, which depends on imports of raw sugar (there is no production of sugar in Israel).

Table 7.9 gives the value of the IDR for several food categories for various years during 1960–2012. Until 1990, the IDR for wheat was between 80% and 90% but was equal to 100% in 2012 and 103% in 2012. For sugar, sweets, and honey, the IDR was always higher than 100%, with the exception being 1960. We also observe a gradual increase in the IDR for fish (from 0% in 1960 to 83% in 2012). Starting in 1970, the IDR for beef was also high (around 60%–80% throughout 1970–2012). Israel has, however, produced enough to cover the consumption of eggs, milk, and poultry over the years. These data clearly show a shift in the structure of food consumption in Israel, which is now more in line with that of developed countries.

Table 7.10 presents the breakdown of the imports of wheat by the country of origin. Note that some of these countries, like Switzerland, are not important wheat producers, but the companies via which wheat was imported are located in these countries.

Table 7.9 Import Dependency Ratio for Various Food Categories, 1960–2012

	1960	1970	1980	1990	2000	2012
Wheat[a]	92%	84%	78%	83%	103%	100%
Rice	97%	142%	196%	159%	170%	[a]
Potatoes	7%	8%	8%	4%	7%	3%
Sugar, sweets, and honey[b]	76%	109%	140%	146%	142%	128%
Vegetables	0%	0%	11%	2%	10%	32%
Citrus	0%	0%	4%	58%	5%	45%
Vegetable oils	21%	0%	15%	11%	22%	37%
Beef	15%	79%	65%	53%	65%	58%
Poultry	0%	0%	0%	0%	0%	0%
Eggs	0%	1%	0%	0%	0%	5%
Fish	0%	0%	37%	56%	58%	83%
Cow's milk	0%	0%	0%	0%	0%	0%

[a] Wheat, including rice in 2012.
[b] Sugar and honey only, until 1990.
Source: Authors' compilation based on CBS (2015).

Table 7.10 Imports of Wheat by Country of Origin, 2011

Country of Origin	Quantity Imported (tons)	Quantity Imported (%)	Value of the Imports ($ '000)
Austria	3,246	0.47	828
Australia	13,500	1.9	4,144
Belize	1,510	0.22	458
Cyprus	11,747	1.7	3,100
France	32,255	4.6	8,272
Germany	21,693	3.1	6,268
India	200	0.029	103
The Netherlands	104,617	15	25,340
Panama	5,000	0.72	1,712
Russian Federation	37,781	5.4	10,619
Singapore	14,351	2.1	3,807
Switzerland	386,311	56	108,212
Turkey	417	0.06	181
Ukraine	35,477	5.1	10,095
United Kingdom	17,809	2.6	5,509
United States	2,200	0.32	629
Virgin Islands	7,036	1	1,840
Total Imports		100	

Source: Authors' compilation based on CBS (2015a).

7.4.3 Food Stocks

In normal times, food availability is not an issue in Israel, therefore the concept of food stocks is mentioned only in relation to wars and natural disasters. In fact, no detailed data on food stocks are available, as this is considered as an important national security issue.

The Emergency Administration, which is part of the Ministry of the Economy, is in charge of implementing the policy in emergency situations to guarantee the delivery of goods and services of which the ministry is in charge and to make sure the economy continues to function in such situations. One of the departments in this administration is the Supreme Authority for Food, whose duty is to ensure that essential food factories are ready to perform in emergency situations. This authority is also in charge of checking that food stocks

are adequate and that local authorities are prepared in case of a mass disaster such as earthquakes, flood, epidemics, disastrous water pollution, and terrorist attacks.

The activities of this authority include the requisition of labor, vehicles, and equipment for factories considered vital; training representatives of the Emergency Administration in those vital factories and in local emergency committees; the regular tracking of additional factories that may be vital in an emergency; and preparing (together with the civil defense institutions) these factories for emergency situations. About 200 factories may find themselves under requisition in states of emergency (such as bakeries, flour mills, dairies, refrigeration units, and supermarket companies), and they cover meat production, rice, coffee, tea, canned food, and baby food. The Ministry of the Economy also makes sure that there is always a big enough stock of basic food (e.g., for baby food, the instructions are to have a stock that would last for 1 month). Although the implementation of such guidelines for cases of emergency is in principle at the level of local authorities, the army and civil defense institutions may also intervene, as has been the case in the past in war periods.

7.5 Food Security at the Micro Level

In recent years, because of the increase in income inequality, food security has increasingly become a problem for households at the bottom of the income distribution. To address this issue, we start with a simple analysis of the extent of food insecurity in Israel, using the Household Food Security Measure developed in the United States.

7.5.1 A First Approach Based on a Distinction between Moderate and Severe Food Insecurity

The FAO measure of food security includes four dimensions: availability, stability, access, and utilization. According to these criteria, food security depends not only on the availability of and access to food at the national level but also at the individual level. More precisely, the goal is to find out whether individuals have enough resources to enjoy proper food on a regular basis as well as to smooth consumption during financially difficult periods (Schmidhuber and Tubiello 2007).

Israel's food supply is large enough to guarantee a significantly higher per capita calorie intake than that recommended by FAO. In recent years, Israel has destroyed more than 30 tons of agricultural products in excess supply, such as fruit, vegetables, and eggs. This excess supply

is a consequence of policies aimed at guaranteeing a minimal price of agricultural products. Such policies are also implemented in many other countries, and their goal is to favor local production and make sure that fresh and healthy food is available. Environmental and ecological considerations also play a role. However, these policies, leading to artificial excess supply and food destruction, have been criticized, given the high poverty rates observed in Israel in recent years. Given the amount of food that is destroyed every year to guarantee minimal food prices for food producers, there is a need to better coordinate the activities of the Ministry of Agriculture and those of third-sector organizations whose goal is to distribute food to the needy. Measures could be implemented that would lead to the employment of these people in periods of harvest.

According to the 2012 annual report of the Bank of Israel, food prices in Israel are 15% higher than average food prices in Organisation for Economic Co-operation and Development (OECD) countries. Moreover, the decrease in food prices in recent years has not led to any change in the prices of processed food. Attempts have been made during the past decade to save at least part of the food that is destroyed and give it to third-sector organizations that distribute food to indigents. The food saved is given to an organization called Gather Israel, which then distributes it to more than 200 NGOs in charge of distributing food to the poor. Yet the quantity of food saved is small when compared to what is destroyed.

As mentioned previously, two surveys on food insecurity were conducted in recent years in Israel, one in 2011 and the other in 2012. These surveys are the most updated sources of information on food security in Israel. For a more detailed picture of the situation, we have combined both surveys, and this is why the results that will be reported here are different from results based on only one of these two surveys. The classification into three categories ("food secure," "moderately food insecure," and "severely food insecure") is derived from the answers given to the questions in the questionnaire (Appendix 7A.3). The classification has been borrowed from the United States survey on household food security. The 18-item core module is a stable, robust, and reliable measurement tool (Bickel et al. 2000).

Households without children had to answer 10 questions, while those with children were asked 18 questions. Any household who did not answer yes (that is, who did not feel food-insecure) to more than two questions was considered food secure. Among households without children, those who answered yes to between three and five questions were considered "moderately food-insecure," while those who answered yes to more than five questions (out of 10) were considered

Table 7.11 Food Insecurity in Subpopulations, 2011-2012 (%)

Subpopulation	Food Insecure (moderately or severely)	Severely Food Insecure
Households		
Whole population	19.0	9.4
Jewish population	14.0	6.4
Arab population	47.2	26.6
Ultra-Orthodox Jewish population	26.1	9.2
Single parents	45.5	21.8
Individuals		
Whole population	23.5	10.8
Jewish population	16.4	6.4
Arab population	52.9	28.9
Ultra-Orthodox Jewish population	31.4	9.5
Single parents	46.3	21.9

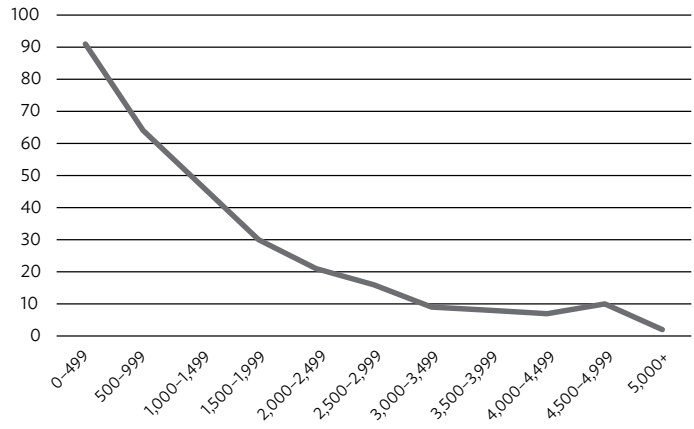
Source: Authors' own compilation based on 2011 and 2012 food security surveys.

"severely food-insecure." Among households with children, those who answered yes to between three and seven questions were considered "moderately food-insecure," while those who answered yes to more than seven questions (out of 18) were considered "severely-food insecure".

In 2011–2012, 19.0% of households and 23.5% of individuals suffered from some degree of food insecurity, 9.6% of households had a moderate degree of food insecurity, while 9.4% had a more serious problem of food insecurity (Table 7.11). In these surveys, a household is defined as a couple or a single person, with or without children, living in the same housing unit. This definition is consistent with the term "family" (as opposed to some CBS surveys where a distinction is made between the two terms). The terms "household" and "family" when used in this chapter hence refer to the same concept.

About 14.0% of Jewish households suffered from food insecurity, while the corresponding percentage was 47.2% in the Arab population. In the Jewish population, the percentage of households suffering from severe food insecurity is rather small (6.4%), while it is quite high (26.6%) in the Arab population (Table 7.11).

Figure 7.2 Food Insecurity as a Function of Per Capita Income, 2011–2012 (ILS per month)



Source: Authors' compilation based on 2011 and 2012 food security surveys.

Finally, when the percentage of individuals rather than households who are food-insecure is computed, the percentages are much higher for the subpopulations of Arabs and ultra-Orthodox because of their larger family sizes.

Food insecurity is particularly high among large households with four or more children, among Arab households[3] (that have many children), among single-parent households, and among households that receive an income support allowance from the National Insurance Institute (Endeweld et al. 2014). The 2011–2012 surveys show also that 50% of those who do not have food security receive some help from NGOs that receive financial aid from the government.

Figure 7.2 shows the direct link between food insecurity and income. At the low end, with a per capita income up to ILS499 per month, food insecurity is around 90%. When the income increases, food insecurity steadily decreases. Food insecurity disappears for per capita income higher than ILS5,000.

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[3] As far as the difference between the nonelderly and the elderly is concerned, food insecurity, whether severe or not, is 47.8% among nonelderly Arabs and 32.8% among elderly Arabs. The corresponding percentages in the Jewish population are 15.1% among the nonelderly and 8% among the elderly.

Endeweld et al. (2014) also found that in most population subgroups, there was an overlap between the data on poverty and food-insecurity. This overlap is, however, much less striking among ultra-Orthodox Jews who often have a high poverty level but a much smaller degree of food insecurity. Several factors may explain such a discrepancy: tastes (which lead them to give a higher priority to food than to other goods), a higher occurrence of help from outside sources, and cultural factors that may induce them to be more frugal and as a consequence more often satisfied with smaller amounts of food.

Finally, it should be mentioned that while these results based on the Household Food Security Measure reflect food insecurity mainly from the quantitative point of view, there is also empirical evidence on food insecurity from a diet-quality perspective. Shahar et al. (2004) found lower intakes of protein and mono-unsaturated fatty acids among low socioeconomic groups.

7.5.2 Applying Multidimensional Poverty Analysis to the Study of Food Insecurity

Table 7.12 presents the results obtained when applying the methodology proposed by Alkire and Foster (2011) (Appendix 7A2.1) to the surveys on food insecurity. The highest degree of food insecurity is observed in the Arab population. Note also that when giving different weights to the questions, along the lines suggested by the literature on the fuzzy approach to poverty (Appendix 7A2.2), the Alkire and Foster food insecurity indexes are smaller. Finally, as expected, the higher the value of the parameter k (k indicates the number of questions to which an individual has to declare to be food-insecure to be considered as overall food insecure), the lower the value of the index H (H refers to the proportion of individuals/households that are overall food insecure). Note, however, that the index A (A is a measure of the "average food insecurity frequency," i.e., of the proportion of questions to which households declared to be "food insecure," among the households classified as overall food insecure), increases with k. This should not be surprising because when k is low, we include, among the "overall food insecure," individuals/households who may be food insecure to only a small number of questions so that A is more likely to be small in such a case. Given that H decreases while A increases with k, the product $M_0=H\times A$, which here is our measure of overall food insecurity, may increase or decrease with k (Table 7.12).

Table 7.12 Food Insecurity in Israel Measured via the Alkire and Foster Approach

Weighting Procedure and Index	Whole Population	Jewish Population	Arab Population	Ultra-Orthodox Jews	Single Parents
Equal weights to all questions					
Index *H*					
k=2	8.7%	5.1%	23.6%	11.6%	23.0%
k=5	6.4%	3.3%	19.1%	7.5%	18.5%
k=10	0.8%	0.3%	2.8%	0.5%	3.4%
Index *A*					
k=2	0.514	0.514	0.511	0.412	0.459
k=5	0.697	0.637	0.672	0.652	0.663
k=10	1	1	1	1	1
Index M_0					
k=2	0045	0.026	0.121	0.048	0.106
k=5	0.045	0.021	0.128	0.049	0.123
k=10	0.008	0.003	0.028	0.005	0.034
Different weights for the various questions					
Index *H*					
k=2	6.5%	3.7%	18.1%	8.4%	17.8%
k=5	5.0%	2.6%	15.2%	5.8%	15.0%
k=10	0.8%	0.3%	2.8%	0.5%	3.4%
Index *A*					
k=2	0.514	0.514	0.511	0.412	0.459
k=5	0.697	0.637	0.672	0.652	0.663
k=10	1	1	1	1	1
Index M_0					
k=2	0.033	0.019	0.093	0.035	0.082
k=5	0.035	0.017	0.102	0.038	0.100
k=10	0.008	0.003	0.028	0.005	0.034

Note:The idea of using different weights when taking a multidimensional approach to poverty was first raised by Desai and Shah (1988). Here we adopt the suggestion made in several papers (Cerioli and Zani 1990, Cheli et al. 1994, Cheli and Lemmi 1995) dealing with the fuzzy approach to multidimensional poverty. More precisely, the weight given to a specific question is equal to the ratio of the inverse of the logarithm of the percentage of individuals who are food insecure on this question divided by the sum, over all questions, of the inverse of these logarithms (see the Appendix for the exact mathematical formulation).

Source: Authors' own calculation.

7.5.3 Applying the Fuzzy Approach to Multidimensional Poverty to the Analysis of Food Insecurity

This methodology is described in Appendix 7A2.2. There have been quite a few studies (Deutsch and Silber 2005, 2006; Silber and Sorin 2006; Deutsch, Israeli, and Silber 2007) that adopted a fuzzy approach to the study of multidimensional poverty in Israel. There, however, does not seem to have been any study that adopted a fuzzy approach to the study of food insecurity in Israel.

We now present the results of such a study. We used both the Totally Fuzzy Approach (TFA) and the Totally Fuzzy and Relative Approach (TFR) (Appendix 7A2.2). Our investigation is based on the 10 questions that were answered by both categories of respondents: those with children who answered a questionnaire with 18 questions and those without children who had 10 questions to answer. Households who did not give an answer to a given question because they had previously indicated that they did not have any food insecurity problem were assumed to have indicated on all questions that they did not have any food insecurity problems. We also supposed that those who answered "do not know" or refused to answer were households without any food security problems. (The percentage of households who answered do not know or refused to answer was never higher than 1% of the sample for any question that they were asked to answer.) The 10 questions to which every household answered, whether it has or does not have children, are those with the following numbers in the questionnaire (Appendix 7A3): 21, 22, 23, 27, 28, 29, 30, 31, 32, and 33. The score given to each answer is described in the appendix. In addition, the weight given to each family is assumed to be a function of the number of individuals in the household.

Table 7.13 gives the results derived from the TFA and TFR (second version). We first note that according to both approaches, the two questions with the highest weight are questions 32 and 33 where the individual is asked whether during the past year he/she or other adults in the household did not eat during a whole day because there was not enough money to buy food (question 32) and how often such a situation occurred (question 33).

However, since the values of the TFA and TFR indexes for these two questions were low, the relative contribution of these two questions to the overall value of the TFA and TFR indexes is small. The questions that contribute most to the overall value of these two indexes are questions 21 (Did you fear that you would finish the food before money would again be available to buy food?), 22 (Was the

Table 7.13 Results Based on the Totally Fuzzy Approach and Totally Fuzzy and Relative Approach

Approach	TFA	TFA	TFA	TFA	TFR	TFR	TFR	TFR
Question	Value of the TFA index	Weight of the question	Absolute contribution of the question to the overall TFA index	Relative contribution of the question to the overall TFA index	Value of the TFR index	Weight of the question	Absolute contribution of the question to the overall TFR index	Relative contribution of the question to the overall TFR index
21	0.1459	0.0648	0.0094	0.1603	0.175	0.060	0.011	0.165
22	0.1038	0.0762	0.0079	0.1342	0.145	0.066	0.010	0.152
23	0.1048	0.0759	0.008	0.1349	0.139	0.068	0.009	0.148
27	0.1014	0.077	0.0078	0.1325	0.101	0.079	0.008	0.126
28	0.0821	0.0841	0.0069	0.1172	0.077	0.088	0.007	0.107
29	0.1029	0.0765	0.0079	0.1336	0.103	0.078	0.008	0.127
30	0.0342	0.1136	0.0039	0.0659	0.034	0.116	0.004	0.062
31	0.0438	0.1052	0.0046	0.0782	0.044	0.108	0.005	0.074
32	0.0085	0.1605	0.0014	0.0231	0.009	0.164	0.001	0.022
33	0.0071	0.1663	0.0012	0.0201	0.007	0.173	0.001	0.018
Total		1	0.0589	1		1	0.064	1

TFA = Totally Fuzzy Approach; TFR = Totally Fuzzy and Relative Approach.

Source: Authors' calculation.

food that you bought not enough, and you did not have money to buy more food?), and 23 (Did you not have enough money to buy balanced meals?).

7.5.4 Determinants of Food Insecurity

The main determinants of food insecurity in developed countries like Israel are essentially the socioeconomic characteristics of families. Table 7.14 presents the results of a probit regression where the dependent variable in the first column is the probability of being food-insecure, while that in the second column is the probability of being severely food-insecure. It appears that families that are large, Arab, and with a single parent as well as those that receive a subsistence allowance have twice as high a probability of being food-insecure. One may also note that every additional year of education of the head of the household leads to a 9% decrease in the probability for the family to be food-insecure. Finally, it appears that households whose heads are elderly are less likely to be food-insecure than those headed by an individual of working age.

Given that for a majority of individuals, the TFA and TFR scores are equal to zero, we have implemented a Tobit regression here. The results are presented in Table 7.15. It appears that these results are very similar to those of Table 7.14. The coefficients are thus high for Arab households, large families, and single-parent households. The coefficients are lower for old people and decrease by 2% for every additional year of schooling of the head of the household. We also observe that the coefficients are high for households receiving income support or disability allowances. On the whole, the results based on the TFA approach are very similar to those derived from the TFR approach.

7.5.5 Summary of the Key Findings of the Analysis of the Demand Side of Food Security

Given the high similarity between the results based on the different approaches, we can conclude our microeconomic analysis of the consumption side of food insecurity in Israel as follows. Food insecurity is higher among Arab households, large families, single-parent households, and households receiving income support or disability allowances but lower for old people. We also observed that the higher the level of education of the head of the household, the lower the degree of food insecurity.

Table 7.14 Results of Probit Regression (Odds Ratios) where the Dependent Variable Indicates Whether the Household Is Food-Insecure or Severely Food-Insecure

Explanatory Variable	Dependent Variable: Household Is Food-Insecure	Dependent Variable: Household Is Severely Food-Insecure
Arab	2.141*** (0.090)	2.106*** (0.101)
Ultra-Orthodox	1.359*** (0.087)	1.261** (0.104)
Immigrant	1.230*** (0.053)	1.129* (0.061)
Old age	0.833 (0.080)	0.892 (0.097)
Single parent	1.818*** (0.126)	1.718*** (0.142)
Age up to 30 years	0.887 (0.079)	0.822 (0.087)
Age 31–45 years	1.016 (0.092)	1.020 (0.108)
Age 46 years–retirement age	1.118 (0.098)	1.181 (0.119)
1–3 children	1.620*** (0.061)	1.012 (0.047)
4+ children	2.225*** (0.135)	1.288*** (0.092)
Number of years of schooling	0.905*** (0.004)	0.915*** (0.005)
Not working household	1.411*** (0.096)	1.230** (0.092)
Household receives income-support allowances	1.861*** (0.136)	1.848*** (0.141)
Household receives disability allowances	1.442*** (0.065)	1.377*** (0.071)
N	1.2e+04	1.2e+04
ll	-4.4e+03	-2.9e+03
df_m	14.000	14.000
R2	0.185	0.155

Source: Authors' own calculation.

Table 7.15 Results of Tobit Regressions Where the Dependent Variable Is the Individual Score Obtained When Using the Totally Fuzzy Approach or Totally Fuzzy and Relative Approach

Explanatory Variable	Dependent Variable: Individual Score on TFA	Dependent Variable: Individual Score on TFR
Arab	0.211*** (0.011)	0.220*** (0.011)
Ultra-Orthodox	0.080*** (0.016)	0.085*** (0.017)
Immigrant	0.051*** (0.013)	0.054*** (0.013)
Old Age	-0.029 (0.037)	-0.033 (0.039)
Single Parent	0.151*** (0.013)	0.157*** (0.015)
Age up to 30 years	-0.065*** (0.028)	-0.067*** (0.013)
Age 31 to 45 years	-0.033** (0.011)	-0.034** (0.012)
With 1–3 children	0.711*** (0.026)	0.742*** (0.027)
With 4 or more children	0.771*** (0.028)	0.805*** (0.029)
Number of years of schooling	-0.023*** (0.001)	-0.024*** (0.001)
Not working household	0.093*** (0.022)	0.097*** (0.023)
Household receives income support allowances	0.119*** (0.020)	0.125*** (0.021)
Household receives disability allowances	0.107*** (0.014)	0.110*** (0.014)
Constant	-0.533***(0.031)	-0.552*** (0.032)
Number of observations	11,935	11,935
R-square	0.58	0.57

TFA = totally fuzzy approach, TFR = totally fuzzy and relative approach.
Note: **Standard errors in parenthesis** (*p<0.05; ** p<0.01; *** p<0.001).
Source: Authors' own calculation.

7.6 Concluding Comments

This chapter looked at the evolution of food insecurity over time in Israel. It started by examining the supply side of food security and the development of agricultural production in Israel during the past 65 years, stressing the impact of the high level of education of Israeli farmers and the contribution of agricultural research in Israel.

We then focused our analysis on the demand side. We stressed that looking at the average consumption of various food components and at the average intake of calories and other nutritive components

gives an incomplete picture of food security. Given that income inequality grew during the past 2 to 3 decades, there is a need to look also at the distribution of food consumption between households and individuals. To do so, we borrowed the Alkire and Foster (2011) counting approach to multidimensional poverty and computed measures based on the fuzzy approach to multidimensional poverty measurement. Finally, an econometric analysis confirmed that, other things equal, food insecurity is more common among large families, Arabs, single-parent households, households whose head has a low level of education, and those who receive income support or disability allowances, but less widespread among elderly people.

As far as the supply side of food security is concerned, the case of Israel is a success story. What explains the remarkable achievements of the Israeli agricultural sector? We believe that two elements have played a key role. First, the government strongly encouraged and subsidized agricultural research. Second, Israeli farmers are highly educated. They are the direct descendants of Jews who had been persecuted for centuries and hence acquired, willingly or not, what the Nobel Prize and outstanding development economist T. W. Schultz called the "ability to deal with disequilibria," hence the amazing list of agricultural innovations introduced by Israeli farmers. Emphasizing education among farmers and making sure the government organizes and subsidizes agricultural research is the main lesson to be learned by less food-secure countries from the Israeli experience.

The rise in food insecurity observed at the household (individual) level in recent years is, however, not specific to Israel, although income inequality has become particularly high in this country. Israel faces problems that also need to be overcome in many developed countries that in the past 20–30 years have focused their attention only on efficiency issues, thus ignoring the importance of equity considerations. The section of this chapter covering food insecurity in Israel on the demand side at the microeconomic level is, however, original in the sense that it has introduced new techniques, borrowed from the literature on multidimensional poverty measurement, to measure the extent of food insecurity at the household and/or individual level.

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Appendix 7A.1. Estimating Food Insecurity on the Demand Side

There are various ways of estimating food insecurity, such as determining the extent of monetary poverty or the deficiency in calories. The most popular approach, however, is to rely on a subjective approach where the households themselves indicate whether have not always had access to food because of a lack of financial resources. In fact, during the Great Depression (1929–1939), a period during which a quarter of the United States (US) labor force was unemployed, attention had already been given in the US to food insecurity. In 1984, measures were taken in the US to start estimating food insecurity and implementing policies aimed at taking care of this problem. The US established a task force that stated "It has long been an article of faith among the American people that no one in a land so blessed with plenty should go hungry. ...Hunger is simply not acceptable in our society" (Government of the United States, 1984: 2).

In 1995, a definitive version of a survey questionnaire was agreed upon, and since then, such a representative survey is launched every year by the US Department of Agriculture. The questionnaire includes 18 questions concerning food security during the past 12 months. The goal of the survey is not to detect food shortages due to free choice such as one related to a specific diet or to fast, but to find out whether there exists food insecurity among children or adults living in the households participating in the survey.

The advantage of such an approach is that it is able to take into account the psychological aspect of the issue of food insecurity, not to mention the fact that it is a cheap way (in terms of time and money) of detecting it. Naturally, there are problems with such an approach, whether they concern sampling or coding errors or refer to the fact that such subjective surveys are not always accepted by researchers and may prevent any international comparison because of the impact of the local culture on the way individuals answer (see Headey and Ecker 2012; Headey 2013).

In recent years, such surveys have also been implemented in other developed countries, mostly in countries where the poverty rates are relatively high. Thus, there similar surveys in Canada (the Household Food Security Survey Module) and in Australia (where the answers to a specific question are the basis for the measure of food insecurity).

According to the last survey conducted in the US, 14.3% of the families suffer from some form of food insecurity and 6.0% from severe food insecurity. About 19.5% of the families with children suffer from food insecurity. The proportion is also high among single-parent families and those belonging to population groups with a low socioeconomic level (African-Americans and Hispanics). Among elderly people, on the contrary, the proportion is relatively low (8%).

Appendix 7A.2. Measuring the Extent of Food Insecurity on the Demand Side

Counting and Measuring Food Insecurity: The Alkire and Foster Approach

A first methodology consists of applying the counting approach to multidimensional poverty measurement to the measurement of food insecurity.

Following Sen (1976), unidimensional poverty is usually measured in two steps. First, the individual (or household) poverty function is defined, which involves identification of the poor; then a social poverty function is obtained by aggregating the individual poverty functions.

For the counting approach to multidimensional poverty, a three-step procedure has to be implemented. The first step identifies individual deprivations in each variable. The second step identifies the multidimensionally poor and produces the individual multidimensional poverty function. Finally, the third step generates the social poverty function through aggregation. Let us now apply these ideas to a food insecurity measurement.

When food insecurity is measured along several dimensions, i.e., on the basis of different questions, and assuming that the answer to each of these questions is either "yes" (indicating food insecurity in the corresponding dimension) or "no" (no food insecurity in this dimension), the problem is to find a way of aggregating these different answers. One possibility is to take an "intersection" approach; as long as an individual is not food insecure in every dimension (does not answer "yes" to each question), he or she will not be considered food-insecure. Another solution is to adopt the point of view of the union approach; as soon as an individual is food-insecure in one dimension (answered "yes" to at least one question), the individual will be classified as food-insecure. Alkire and Foster (2011), however, recommended an intermediate approach. Call Q the total number of dimensions (the total number of questions). An individual will then be considered food-insecure if the number of questions to which he or she answered "yes" is at least equal to k, where k lies between 1 and Q. If the number of questions to which he or she answered "yes" is smaller than k, the individual will not be considered food-insecure.

Computing the Alkire and Foster Index M_0: A Simple Illustration

Let us take the case of three households and three questions. Table A1 presents such a simple illustration. It will be assumed that a household is food insecure if he or she answered "yes" to at least two questions.

Table 7A.2.1 Simple Illustration of the Application of the Alkire and Foster Approach to Food Insecurity (The Original Data)

Household	Food-Insecure for Question 1?	Food-Insecure for Question 2?	Food-Insecure for Question 3?	Number of Questions for which Individual is Food-Insecure	Is Individual Food-Insecure?
A	1	0	1	2	Yes
B	1	1	1	3	Yes
C	0	1	0	1	No

Source: Authors' own calculation.

From Table 7A.2.1 we conclude that the percentage H (headcount ratio) of food insecure households is 66.6% (2/3). Moreover, Table 7A.2.2 indicates that the "average food insecurity frequency" A among the households classified as food insecure is equal to (5/6).

Table 7A.2.2 Simple Illustration of the Application of the Alkire and Foster Approach to Food Insecurity (Censored Data)

Household	Food-Insecure for Question 1?	Food-Insecure for Question 2?	Food-Insecure for Question 3?	Censored (ignoring food-secure individuals) Number of Questions for which Individual is Food-Insecure
A	1	0	1	2
B	1	1	1	3
C	0	0	0	0

Source: Authors' own calculation.

Alkire and Foster (2011) then suggested combining these two indicators and deriving a "dimension adjusted headcount ratio" M_0 defined as $M_0 = H \times A = \left(\frac{10}{18}\right) = (\frac{5}{9})$. Note that M_0 is equal to the ratio of the total number of questions to which the individuals classified as food-insecure answered "yes" (5) divided by the maximal number of answers in the total population that could have been "yes" (9).

Implementing the Alkire and Foster Counting Approach on Basis of the Food Insecurity Surveys Conducted in Israel

It is simple for the dichotomous questions. Since we grouped the answers "do not know" and "refuse to answer" with the answer "no", it turns out that questions 27, 29, 30, 31, and 32 are in fact dichotomous. For the other questions (21, 22, 23, 28, and 33), we can proceed as follows. For questions 21, 22, and 23, we group the answers "generally true" and "sometimes true" so that that these questions become dichotomous. For questions 28 and 33, we can group the answers "almost every month," "some months yes, some other months no," and "only one or two months during the year," and then again the question becomes dichotomous.

Here, we have to decide how many positive answers (out of 10) will be necessary to consider an individual as food-insecure. We considered three possible thresholds: k=2, k=5, and k=10. The results of such an investigation are given in Table 8.12.

A Fuzzy Approach to the Measurement of Food Insecurity

The theory of "fuzzy sets," originally developed by Zadeh (1965), starts from the idea that certain classes of objects may not be defined precisely. In other words, there are cases where it is difficult to decide which elements belong to a given set and which ones do not. According to Zadeh (1965), a fuzzy set class is "a class with a continuum of grades of membership."

Let there be a set Y and let y be any element of Y. A fuzzy subset A of Y is defined as the set of the couples $A=\{y, \mu_A (y)\}$ for all $y \in Y \in$, where μ_A is an application of the set Y to the closed interval [0,1], which is called the membership function of the fuzzy subset A. In other words, a fuzzy set or subset A of Y is characterized by a membership function $\mu_A (y)$ that will link any point of Y with a real number in the interval [0,1], the value of $\mu_A (y)$ denoting the degree of membership of the element y to the set A.

If A were a set in the usual sense of the concept "set," the membership function associated to this set would only take the values 0 and 1. One would then write that

$$\mu_A(y) = 1 \text{ if } y \text{ belongs to the subset } A$$
$$\text{and } \mu_A(y) = 0 \text{ if } y \text{ does not belong to the set } A$$

But if A is a fuzzy subset, we will say that $\mu_A(y) = 0$, if the element y does not belong to A and that $\mu_A(y) = 1$, if y completely belongs to A. But if $0 < \mu_A(y) < 1$, y belongs only partially to A, and the closer to 1 the value of $\mu_A(y)$, the greater the degree of membership of y to A.

These relatively simple ideas may be easily applied to the concept of food insecurity. There are certainly cases in which an individual is in such a state of food deprivation that he or she may be considered as food-insecure and other cases where his or her nutrition level is such that he or she certainly should not be classified as food-insecure. However, there are also instances where it is not clear whether a given individual is food-insecure. This is particularly true if one takes a multidimensional approach to the measurement of food insecurity, because according to some food insecurity criteria, one would certainly define a given person as food-insecure while according to others this individual should not be regarded as food-insecure. There are several ways of implementing such a fuzzy approach to the study of food insecurity and the methodologies are borrowed from the literature on the "fuzzy set" approach to poverty measurement.

A First Approach: The Totally Fuzzy Approach (TFA)

Cerioli and Zani (1990) were the first to apply the concept of fuzzy sets to the measurement of multidimensional poverty. Their approach is called the Totally Fuzzy Approach (TFA), and their ideas may be applied to the measurement of food insecurity.

Assume a whole series of variables supposed to measure a particular aspect of food insecurity. To define the "membership function," three cases may be distinguished.

Dichotomous Variables

For example, a typical case would be that where a variable indicates whether an individual skipped a meal during the past week because he or she did not have enough money to buy such a meal. Let then D_k be the subset of individuals who skipped such a meal. The subset D_k will not be a fuzzy set because the membership function will be defined as

$$\mu_{D_k} = 1 \text{ if } d_k = 0$$
$$\text{and } \mu_{D_k} = 0 \text{ if } d_k = 1$$

where d_k takes the value zero when the individual skipped a meal and 1 otherwise. The membership function is hence defined here as in the case of traditional sets.

Polytomous Variables

When studying food insecurity, there may be qualitative variables that could take more than two values. Let us assume we classify these values by increasing order, where higher values refer to a higher risk of food insecurity.

Let M_h be the subset of individuals who are in a situation of food insecurity with respect to some indicator h. Let also m_h be the set of polytomous variables $m_{h1}, \ldots, m_{hH}$ measuring the state of food insecurity of the individuals with respect to indicator h and let $\psi_{h1}, \ldots, \psi_{hj}, \ldots, \psi_{hH}$ represent the scores corresponding to these various H states, assuming that $\psi_{h1} < \ldots < \psi_{hH}$.

A good illustration of the use of polytomous variables would be that in which individuals are asked "which of the following sentences describes in the best way the food that was consumed during the past year". Possible answers are "there was enough food of the type we wish to eat", "we had enough food but not always of the kind we want to eat", "sometimes there was not enough food"; or "there was often not enough food."

Following Cerioli and Zani (1990), one would define the membership function $\mu_M(i)$ of individual i as

$$\mu_M(i) = 0 \text{ if } \psi_{hj} \text{ is} < \psi_{hLB} \qquad \text{(A-1)}$$
$$\text{and}$$
$$\mu_M(i) = 1 \text{ if } \psi_{hj} \text{ is} > \psi_{hUB} \qquad \text{(A-2)}$$

where ψ_{hLB} and ψ_{hUB} refer to some lower and upper bound respectively.

For the cases where $\psi_{hLB} < \psi_{hj} < \psi_{hUB}$, Cerioli and Zani (1990) suggest to define the membership function as

$$\mu_M(i) = \frac{\psi_{hj} - \psi_{hLB}}{\psi_{hUB} - \psi_{hLB}} \qquad \text{(A-3)}$$

Continuous Variables

In their approach to multidimensional poverty measurement, Cerioli and Zani (1990) also considered the case of continuous variables, but given that the survey questions on food insecurity are generally of a qualitative nature, we will not mention how Cerioli and Zani (1990) suggested proceeding in the case of continuous variables.

A Second Approach: The Totally Fuzzy and Relative Approach (TFR)

Basing their approach on the theory of "fuzzy sets," some authors have defined the membership functions differently. Cheli et al. (1994) and Cheli and Lemmi (1995) have thus defined the Totally Fuzzy and Relative Approach (TFR).

Let Γ_l represent the subset of individuals who are deprived with respect to some food insecurity indicator l, and let γ_l denote the dichotomous or polytomous variable assumed to measure the degree of food insecurity of the individual with respect to this indicator l. Let then γ_{lj} refer to the case where the individual gives answer j to the question on food security, $j = 1$ to J referring the possible states of food insecurity for variable l. Finally, let $F(\gamma_{lj})$ be the cumulative distribution of this variable γ_l. One may then define the membership function in two ways, depending on whether the degree of food insecurity increases or decreases with the value taken by the variable γ_l.

In the first case, the membership function $\mu_{\Gamma l}(i)$ for an individual i who is in state j of food insecurity will be defined as

$$\mu_{\Gamma l/\gamma_{lj}}(i) = F(\gamma_{lj}) \qquad \text{(A-4)}$$

whereas in the second case, it will be defined as

$$\mu_{\Gamma l/\gamma_{lj}}(i) = 1 - F(\gamma_{lj}) \qquad \text{(A-5)}$$

Cheli and Lemmi (1995) consider that such a formulation is less arbitrary than the one originally proposed by Cerioli and Zani (1990), especially for polytomous variables, because there is no need to define lower and upper bounds.

However, when the risk of food insecurity is very low, the value taken by the indicator of food insecurity may be too high for those who turn out not to be food-insecure. We may then adopt the solution proposed Cheli and Lemmi (1995) in the case of poverty measurement and proceed as follows.

Let, as before, $\gamma_{l,j}$, with $j = 1$ to J, refer to the various values, ordered by increasing risk of food insecurity, which the variable γ_l may take. Thus γ_{l1} represents the lowest and γ_{lj} the highest risk of poverty associated with the food insecurity indicator l. We may then define the degree of food insecurity of individual i as

$$\mu_{\Gamma l}(i) = 0 \text{ if } \gamma_{lj} = \gamma_{l1} \qquad \text{(A-6)}$$

and

$$\mu_{\Gamma l/\gamma_{lj}}(i) = \mu_{\Gamma l/\gamma_{lj-1}} + \left(\frac{[F_l(\gamma_{l,j}) - F_l(\gamma_{l,j-1})]}{1 - F_l(\gamma_{l,j})} \right) \qquad \text{(A-7)}$$

for $\gamma_{l,j} > \gamma_{l,1}$,

where $\mu_{\Gamma/\gamma_{l,j-1}}$ denotes the membership function of an individual for whom the food security variable takes the value γ_{lj} and F_j is the distribution function of the variable $\gamma_{l,j}$.

The next step in the analysis is to decide how to aggregate the various food insecurity indicators. Let $\mu_{\Gamma l}(i)$ refer as before to the value taken by the membership function for the variable l and individual i. Let represent the weight one wishes to give to indicator l. The overall (overall indicators l) food insecurity membership function $\mu_{FI}(i)$for individual i may then be defined as

$$\mu_{FI}(i) = \sum_{l=1}^{L} w_l \, \mu_{\Gamma l}(i) \qquad \text{(A-8)}$$

For the choice of the weight w_l, Cerioli and Zani (1990) as well as Cheli and Lemmi (1995) have proposed to define w_l as

$$w_l = \frac{ln\left(\frac{1}{\overline{\mu}_{\gamma_l}}\right)}{\sum_{l=1}^{L} ln\left(\frac{1}{\overline{\mu}_{\gamma_l}}\right)} \qquad \text{(A-9)}$$

where $\overline{\mu}_{\gamma_l} = \left(\frac{1}{n}\right)\sum_{i=1}^{n} \mu_{\Gamma l}(i)$ represents the fuzzy proportion of food-insecure individuals according to the food insecurity indicator l and L is the total number of variables taken into account to measure food insecurity. One may observe that the weight w_l is an inverse function of the average degree of food insecurity in the population according to the food insecurity indicator l. Thus the lower the frequency of food insecurity according to a given food insecurity indicator, the greater the weight this indicator will receive.

Having computed for each individual i the value of his or her membership function $\mu_{FI}(i)$, that is, degree of belonging to the set of food-insecure individuals, the TFR, following Cerioli and Zani (1990), defines the average[4] value FI of the membership function as

$$FI = \left(\frac{1}{n}\right) \sum_{i=1}^{n} \mu_{FI}(i) \qquad \text{(A-10)}$$

Combining (A-8) and (A-10), we then derive that expression (A-10) may be also written as

$$FI = \left(\frac{1}{n}\right) \sum_{i=1}^{n} \sum_{l=1}^{L} w_l \, \mu_{Fl}(i) = \sum_{l=1}^{L} w_l \left[\left(\frac{1}{n}\right) \sum_{i=1}^{n} \mu_{Fl}(i)\right] \qquad \text{(A-11)}$$

A Simple Illustration of the Various Fuzzy Set Approaches to Estimating Food Insecurity

The Case of a Polytomous Variable

The question: "The food we bought was not enough and we did not have money to buy more food".

Assume the answers given were as follows:

Given Answer	Number of Respondents
Generally true	18
Sometimes true	7
Not true at all	50
Do not know	10
Refuse to answer	15
Total	100

The Ceriol and Zani Approach: The Totally Fuzzy Approach

Given that among those who answer there are only three possibilities, one has to decide which score to give to each answer. This is an important issue since the estimation of the extent of food insecurity in the population will depend on the choice of scores. This is one reason why the Cheli and Lemmi approach (TFR) may be preferred, despite the fact that a priori for food insecurity an absolute approach makes more sense than a relative approach.

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[4] This average membership indicates somehow the percentage of food-insecure individuals in the population.

In any case, let us assume the following scores: generally true, 1; sometimes true, 0.5, and not true at all, 0.

We therefore have 18 individuals for whom in equations (A-1) to (A-3), the membership function $\mu_M(i)$is equal to 1, 7 individuals for whom $\mu_M(i)$ is equal to 0.5, and 50 individuals for whom $\mu_M(i)$ is equal to 0. Let us now assume that we group the answers "do not know" and "refuse to answer" with the answer "not true at all" so that we will have not 50 but 75 individuals for whom $\mu_M(i)$ is equal to 0.

Assume now another question with the following answers.

The question: "We did not have enough money to buy balanced meals".

Given Answer	Number of Respondents
Generally true	20
Sometimes true	10
Not true at all	40
Do not know	10
Refuse to answer	20
Total	100

As before, we assume the following scores: generally true, 1; sometimes true, 0.5, and not true at all, 0.

We therefore have 20 individuals for whom in equations (A-1) to (A-3) the membership function $\mu_M(i)$ is equal to 1, 10 individuals for whom $\mu_M(i)$ is equal to 0.5, and 70 individuals for whom $\mu_M(i)$ is equal to 0.

Suppose there are only two questions in the survey, the two mentioned previously. For the first question, the fuzzy proportion of food insecure individuals is then

$$\overline{\mu} = \left(\frac{18}{100}\right)(1) + \left(\frac{7}{100}\right)(0.5) + \left(\frac{75}{100}\right)(0) = \frac{18+3.5}{100} = \frac{21.5}{100} = 0.215.$$

For the second question, we derive

$$\overline{\mu} = \left(\frac{20}{100}\right)(1) + \left(\frac{10}{100}\right)(0.5) + \left(\frac{70}{100}\right)(0) = \frac{25}{100} = 0.25.$$

As a consequence, the weights for each question will be:

First question: $w_1 = \frac{ln(1/0.215)}{ln(1/0.215) + ln(1/0.250)} = 0.526$

Second question: $w_2 = \frac{ln(1/0.25)}{ln(1/0.215) + ln(1/0.25)} = 0.474$

Before computing the average degree of food insecurity in the population, we need to know what each individual answered. We cannot rely only on anonymous tables like the one described previously. For simplicity, let us assume that all those (18 individuals) who answered "generally true" to the first question answered "generally true" to the second question as well. In addition, assume that there were two individuals who answered "not true at all" to the first question but answered "generally true" to the second question.

Similarly, assume that all those (7) who answered "sometimes true" to the first question answered "sometimes true" to the second. In addition, assume that three individuals who had answered "not true at all" to the first question answered "sometimes true" to the second.

In other words, we have the following data:

Answer Combinations	Number of Respondents	Weighted Score
"Generally true" to both questions	18	(0.526×1)+(0.474×1)= 1
"Not true at all" to the first question and "generally true" to the second question	2	(0.526×0)+(0.474×1)=0.474
"Sometimes true" to both questions	7	(0.526×0.5)+(0.474×0.5)=0.5
"Not true at all" to the first question and "sometimes true" to the second question	3	(0.526×0)+(0.474×0.5)=0.237
"Not true at all" or "do not know" or "refuse to answer" to either question	70	(0.526×0)+(0.474×0)=0

Finally, using (A-11), we conclude that the average degree of food insecurity in the population is

$$FI = \left(\frac{18}{100}\right)1 + \left(\frac{2}{100}\right)0.474 + \left(\frac{7}{100}\right)0.5 + \left(\frac{3}{100}\right)0.237 + \left(\frac{70}{100}\right)0 = 0.2316$$

The Totally Fuzzy and Relative Approach

Using the data mentioned previously, we derive the following tables.

The membership function on the basis of the first TFR approach (Equation (A-4)):

Given Answer	Value of Membership Function (which is the cumulative relative frequency) for First Question	Value of Membership Function (which is the cumulative relative frequency) for Second Question
Not true at all or do not know or refuse to answer	0.75	0.70
Sometimes true	0.82	0.80
Generally true	1	1

The membership function for the second TFR approach: (Equations (A-6) and (A-7))

Given Answer	Value of Membership Function for First Question	Value of Membership Function for Second Question
Not true at all or do not know or refuse to answer	0	0
Sometimes true	0 + ((0.82-0.75)/(1-0.75)) = 0.28	0 + ((0.80-0.70)/(1-0.70)) = 0.333
Generally true	0.28 + ((1-0.82)/(1-0.75)) = 0.28 + 0.72 =1	0.333 + ((1-0.80)/(1-0.70)) = 0.333 + 0.666 = 1

As before, the weights, defined in Equation (A-9), are

First question: $w_1 = 0.526$
Second question: $w_2 = 0.474$

Using (A-8), we then derive the following summary tables.
The first TFR approach

Answer Combinations	Number of Respondents	Weighted Score
"Generally true" to both questions	18	(0.526×1)+(0.474×1)=1
"Not true at all" to the first question and "generally true" to the second question	2	(0.526×0.75)+(0.474×1)=0.8685
"Sometimes true" to both questions	7	(0.526×0.82)+(0.474×0.80)=0.8105
"Not true at all" to the first question and "sometimes true" to the second question	3	(0.526×0)+(0.474×0.80)=0.3792
"Not true at all" or "do not know" or "refuse to answer" to either question	70	(0.526×0)+(0.474×0)=0

Using (A-10) we conclude that, according to the first TFR approach, the average degree of "food insecurity" in the population is

$$FI = \left(\frac{18}{100}\right)1 + \left(\frac{2}{100}\right)0.8685 + \left(\frac{7}{100}\right)0.8105 + \left(\frac{3}{100}\right)0.3792 + \left(\frac{70}{100}\right)0 = 0.2655$$

The second TFR approach

Answer Combinations	Number of Respondents	Weighted Score
"Generally true" to both questions	18	(0.526×1)+(0.474×1)=1
"Not true at all" to the first question and "generally true" to the second question	2	(0.526×0)+(0.474×1)=0.474
"Sometimes true" to both questions	7	(0.526×0.28)+(0.474×0.333)=0.3051
"Not true at all" to the first question and "sometimes true" to the second question	3	(0.526×0)+(0.474×0.333)=0.1578
"Not true at all" or "does not know" or "refuses to answer" to either question	70	(0.526×0)+(0.474×0)=0

Using again (A-10), we conclude that according to the second TFR approach, the average degree of "food insecurity" in the population is

$$FI = \left(\frac{18}{100}\right)1 + \left(\frac{2}{100}\right)0.474 + \left(\frac{7}{100}\right)0.3051 + \left(\frac{3}{100}\right)0.1578 + \left(\frac{70}{100}\right)0 = 0.2156.$$

Appendix A7.3. Questionnaire Used in the Food Security Survey in Israel

1. Gender: Male/Female
2. Year of birth:
3. Who lives in your house/apartment?
   Couple with child (children)
   Couple without children
   One parent with child (children)
   A person alone
   Other (specify)
   Refuse to answer
   Three generations (grandparents, parents, children)
4. How many people live on a regular basis (i.e., eat from a common food budget) in the apartment/house?
5. How many adults between the ages of 18 and 24?
6. What is your family connection with the head of the household (a head of household is the person in the household with the highest income. If nobody in the household works, it is the oldest person)?
   I am the head of the household
   I am his/her spouse
   I am a son
   I am a daughter
   I am the grandfather
   I am the grandmother
   Other (specify)
7. Are there children under the age of 18 in the household?: Yes/No
8. How many?

Stage 0 of the Construction of the Food Security Index

The following questions refer to the household's food consumption during the past year.

9. Which of the following sentences describes in the best way the food that was consumed during the past year?
   There is enough food of the type we wish to eat
   We have enough food but not always of the kind we want to eat
   Sometimes there is not enough food
   There is often not enough food
   I do not know
   Refuse to answer

You will find below reasons for which people do not always have enough to eat. Indicate each time the reason is relevant to you.

10. There is not enough money to buy food (concerns those who answered in question 9 "sometimes there is not enough food" or "there is often not enough food"): Yes/No; Do not know.
11. There is not enough time to buy food or to cook (concerns those who answered in question 9 "sometimes there is not enough food" or "there is often not enough food"): Yes/No; Do not know.
12. It is too difficult to get to the grocery store or supermarket (concerns those who answered in question 9 "sometimes there is not enough food" or "there is often not enough food"): Yes/No; Do not know.
13. One or more members of the household is on diet (concerns those who answered in question 9 "sometimes there is not enough food" or "there is often not enough food"): Yes/No; Do not know.
14. There is no oven that works (concerns those who answered in question 9 "sometimes there is not enough food" or "there is often not enough food"): Yes/No; Do not know.
15. It is difficult to cook or eat because of health problems (concerns those who answered in question 9 "sometimes there is not enough food" or "there is often not enough food"): Yes/No; Do not know.
16. There is not enough money to buy food (concerns those who answered "We have enough food but not always of the kind we want to eat"): Yes/No. Do not know.
17. The type of food I want is not available (concerns those who answered "We have enough food but not always of the kind we want to eat"): Yes/No. Do not know.
18. There is not enough time to buy food or to cook (concerns those who answered "We have enough food but not always of the kind we want to eat"): Yes/No. Do not know.
19. It is too difficult to get to the grocery store or supermarket (concerns those who answered "We have enough food but not always of the kind we want to eat"): Yes/No. Do not know.
20. One or more members of the household is on diet (concerns those who answered "We have enough food but not always of the kind we want to eat"): Yes/No. Do not know.

First Stage of the Construction of the Food Security Index

I will read a few sentences that people stated about their food situation. For each sentence, tell me whether, during the last year, this sentence was generally/sometimes/not at all true for you or the members of your household.

21. "I (we) feared that we will finish the food before money would again be available to buy food."
    Often true
    Sometimes true
    Never true

Do not know
Refuse to answer

22. "The food we bought was not enough and we did not have money to buy more food."
    Often true
    Sometimes true
    Never true
    Do not know
    Refuse to answer
23. "We did not have enough money to buy balanced meals."
    Often true
    Sometimes true
    Never true
    Do not know
    Refuss to answer
24. "We relied on a few cheap types of food to feed the children because we were quickly short of money."
    Often true
    Sometimes true
    Never true at all
    Do not know
    Refuse to answer
25. "We were not able to give balanced meals to our children because we did not have money."
    Often true
    Sometimes true
    Never true
    Do not know
    Refuse to answer

Second Stage of the Construction of the Food Security Index

26. "The children did not eat enough because we did not manage to buy enough food" (question for households with children).
    Often true
    Sometimes true
    Never true
    Do not know
    Refuse to answer
27. During the past year, did you or some other adult in your household reduce the amount of food you had for meals or did you skip a meal because you did not have enough money to buy food? Yes/No; Do not know; Refuse to answer.

28. How often does this happen?
    Almost every month
    Some months yes, some other months, no
    Only 1 or 2 months during the year
    Do not know
    Refuse to answer
29. During the past year, did you eat less than you wanted because there was not enough money to buy food? Yes/No; Do not know; Refuse to answer.
30. During the past year, were you and other adults in the household hungry and did you not eat because there was not enough money to buy food? Yes/No; Do not know; Refuse to answer.
31. During the past year, did you and other adults in the household lose weight because there was not enough money to buy food? Yes/No; Do not know; Refuse to answer.

Third Stage of the Construction of the Food Security Index

32. During the past year, did you and other adults in the household not eat during a whole day because there was not enough money to buy food? Yes/No; Do not know; Refuse to answer.
33. How often did this happen?
    Almost every month
    Some months yes, some other months, no
    Only 1 or 2 months during the year
    Do not know
    Refuse to answer
34. During the past year, did you reduce the amount of food you gave your child (children) during meals because there was not enough money to buy food? Yes/No; Do not know; Refuse to answer.
35. During the past year, did your child (children) skip meals because there was not enough money to buy food? Yes/No; Do not know; Refuse to answer.
36. How often did this happen?
    Almost every month
    Some months yes, some other months, no
    Only 1 or 2 months during the year
    Do not know
    Refuse to answer
37. During the last year, was (were) your child (children) hungry and you could not buy him/her (them) food? (question to households with children) Yes/No; Do not know; Refuse to answer.
38. During the past year, did your child (children) not eat during a whole day because there was not enough money to buy food?

(question to households with children) Yes/No; Do not know: Refuse to answer.

Additional Questions on Food Security

39. During the past year, how often did you receive help from family members or friends to get food for you or the members of your household?
    Almost every month
    Some months yes, some other months, no
    Only 1 or 2 months during the year
    Do not know
    Refuse to answer
40. During the past year how often did you receive help from an NGO that provides food to get food for you or the members of your household?
    Almost every month
    Some months yes, some other months, no
    Only 1 or 2 months during the year
    Do not know
    Refuse to answer
41. Did you have to show some certificate attesting that you were taken care of by the welfare services to receive the help of the NGO[5]? Yes/No
42. Did the welfare services in your area refer you to some NGO? Yes/No
43. Is it true that you did not ask for the help of an NGO despite the fact that you would have needed such help? Yes/No
44. During the past year did your child (children) suffer from a lack of concentration and attention? Yes/No; Do not know; Refuse to answer
45. Do you think this happened because of a lack of food? Yes/No; Do not know; Refuse to answer
46. How often do you renounce buying special food or buy less of it since you do not have money for such a purchase, given your economic hardship?
    It does not happen
    It seldom happens
    It happens sometimes
    It often happens
    It always happens
    Do not know
    Refuse to answer

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5 NGO = Nongovernment organization.

47. Did you reduce your food consumption or did you give up food consumption to buy other goods or services during the last 3 months? Yes/No; Do not know; Refuse to answer.

Demographic Questions and Questions Relative to the Economic Situation of the Respondent

48. What is the average net monthly income of your household (income from all sources: work, pension, allowances, capital, etc.)
    Less than IS65,000
    Between IS5,000 and IS10,000
    Between IS10,000 and IS15,000
    More than IS15,000
    Refuse to answer
49. What is the average net monthly income of your household (income from all sources: work, pension, allowances, capital, etc.) (more detailed)
    Less than IS1,000
    Between IS1,000 and IS2,000
    Between IS2,000 and IS3,000
    Between IS3,000 and IS4,000
    Between IS4,000 and IS5,000
    Between IS5,000 and IS6,000
    Between IS6,000 and IS7,000
    Between IS7,000 and IS8,000
    Between IS8,000 and IS9,000
    Between IS9,000 and IS10,000
    Between IS10,000 and IS15,000
    More than IS15,000
50. What was the household food expenditure during the last month?
    Refuse to answer
    Less than IS500
    Between IS500 and IS1,000
    Between IS1000 and IS1,500
    Between IS1,500 and IS2,000
    Between IS2,000 and IS2,500
    Between IS2,500 and IS3,000
    More than IS3,000
51. What is the minimal net income that your household would need to make ends meet?
    Refuse to answer
    Less than IS500

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[6] Israeli shekel.

Between IS500 and IS1,000
Between IS1,000 and IS2,000
Between IS2,000 and IS3,000
Between IS3,000 and IS4,000
Between IS4,000 and IS5,000
Between IS5,000 and IS6,000
Between IS6,000 and IS7,000
Between IS7,000 and IS8,000
Between IS8,000 and IS9,000
Between IS9,000 and IS10,000
More than IS10,000

52. In which country were you born?
53. In which country was your father born?
54. If you immigrated to Israel, in which year did you immigrate?
55. Are you Jewish? Christian Arab? Muslim Arab? Christian? Druze? Other? Refuse to answer
56. Does your family define itself as
    Very religious
    Religious
    Traditionalist
    Nonreligious
    Refuse to answer
57. How many members of your household have a labor income?
58. What is your educational level?
    Elementary
    Went to high school but did not complete it
    Completed high school
    Studied after high school but without an academic degree
    Academic degree
    Attended a purely religious orthodox school
    Other
59. How many years as a whole did you study?
60. Does one of your relatives receive an allowance/income support from the National Insurance Institute (excluding children and birth allowance)?
61. Which type of allowance?
    Income support
    Disability
    Survivor
    Old-age pension with income support
    Old-age pension without income support
    Unemployment benefits
    Refuse to answer
    Do not know
    Other

62. Indicate which answer below is correct
    - The person who conducted the interview spoke directly with the respondent
    - The person who conducted the interview spoke with someone else in the household (not with the person who was in the random sample)
    - The person who conducted the interview was obliged to make another appointment with the person who was in the random sample because originally he or she was not available
    - The person who conducted the interview was obliged to fix another appointment with the person who was in the random sample but at the end did not manage to meet him or her and had to interview another member of the household.

8

Food Security in Pakistan, Bangladesh, Indonesia, and Singapore

Meenchee Hong, Zhang-Yue Zhou, and Guanghua Wan

8.1 Introduction

Apart from the People's Republic of China and India, Pakistan, Bangladesh, and Indonesia are among the most populous countries in the world. In 2014, together they had a population of about 600 million, accounting for about 14% of Asia's total population (World Bank 2015a). Singapore's population of 5.5 million, on the other hand, is small. Comparatively, Pakistan and Indonesia have a larger land area and higher per capita arable land. They also have a lower population density, indicating more natural resources on a per capita basis (Table 8.1).

Table 8.1 Level of Food Security and Available Resources in Selected Asian Countries, 2014

Country	Global Food Security Index (%)	Total Population ('000)	Population Density (persons per km^2)	Per Capita Arable land (ha per capita)
Bangladesh	36.5	158,523	1,217.7	0.05
Indonesia	46.6	252,812	139.6	0.09
Pakistan	44.0	185,133	240.2	0.11
Singapore	84.8	5,470	7,813.9	0.00

ha = hectare, km^2 = square kilometer.

Notes and sources:

Global Food Security Index: the higher the index, the higher the level of food security; obtained from EIU (2015).

Population density is total population of the country divided by total land area of the country in km^2, calculation based on data from World Bank (2015a).

Per capita arable land is total arable land area of the country divided by population of the country, in ha, calculation based on data from World Bank (2015a).

In terms of food security achievements, Singapore's is the highest, although it has limited natural resources for food production. Its population density was as high as 7,814 persons per square kilometers (km^2) in 2014. Yet, its food security level was as high as 85% in 2014. Not only is this Asia's highest, it is also high globally. Bangladesh, Pakistan, and Indonesia have lower levels of food security.

Resource availability and food security levels in these four Asian countries exhibit many similarities with the situation in countries analyzed in the previous chapters. For instance, better resource endowment in Pakistan and Indonesia (like in the People's Republic of China, and the Democratic People's Republic of Korea) has not resulted in higher levels of food security; the lack of resource endowment in Singapore (like in Israel, Japan, and the Republic of Korea) has not led to a lower level of food security. As such, the inclusion of these four Asian countries in our analysis should provide valuable additional references for comparing food security practices in very populous or resource-poor countries in Asia. We follow the Food and Agriculture Organization (FAO) evaluation framework (see Chapter 2 of this volume) when evaluating the food security status in these four countries.

8.2 Food Security in Pakistan

Pakistan came into being in 1947 after its separation from India. It is the world's sixth most populous country with a population of over 185 million. Pakistan is the 36th largest country in the world with a landmass of 770,880 km^2, of which 27.5% is arable (World Bank 2015a).

Pakistan is a low-middle-income country. The reported unemployment rate of 5.1% in 2014 is low (World Bank 2015a). However, this does not capture the true picture of the existing situation, because many of its economies are informal, and the real unemployment rate is much higher (CIA 2015). Corruption is high (Corruption Perceptions Index at 29% in 2014; the lower this index, the high the corruption) (Transparency International 2015). Generally, there is a lack of law and order, and it is unstable politically.

Compared with other Asian countries, the country is rich in arable land and has a high food self-sufficiency rate. However, its level of food security is low. There is a lack of economic access to food by many low-income people. The prevalence of undernourishment is high. According to Ahmad and Farooq (2010), a high proportion of pregnant women are malnourished, and 25% of babies had a low birth weight in 2001–2002.

8.2.1 Food Security Status

The major food crops produced in Pakistan (in 2013) include wheat (24.23 million tons [mt]), rice (6.77 mt), and maize (4.53 mt) and to a smaller extent, sugar and barley (cotton is another major crop in Pakistan). Wheat by far is the most important food crop in Pakistan. Major animal products produced in 2013 were beef (1.65 mt), followed by poultry (0.91 mt), and then mutton and goat meat (0.46 mt). Wheat is the staple food followed by rice. Beef is the major meat consumed. Pulses and beef provide the major sources of protein (FAO 2015a).

For most of the food items consumed, Pakistan has a high level of food self-sufficiency (around 100% or higher). It has been a major rice exporter in the world market. For many years, however, its wheat self-sufficiency was below 100%, and its wheat import dependency ratio (IDR) was sometimes as high as 20%. Pakistan has accepted food aid to help bridge its wheat shortage (Ahmad and Farooq 2010). Since the early 2000s, there has been an improvement in its wheat self-sufficiency ratio (SSR) (Figure 8.1).

Despite generally high SSRs in most food items, the prevalence of undernourishment is still tenaciously high in Pakistan. In the past 2 decades, its prevalence of undernourishment has been high and fluctuating, as high as 25% in some years (Table 8.2). Pakistan did not succeed in achieving either of the two 2015 international hunger targets.[1] With regard to the World Food Summit goal, the number of undernourished people in 2015 did not decrease compared with that in 1990; instead it went up from 28.7 million in 1990–1992 to 44.2 million in 2014–2016 (FAO 2015b). For the Millennium Development Goal (MDG) 1, Pakistan only managed to reduce the proportion of the undernourished in the total population by 12.4%, 37.6% off the target

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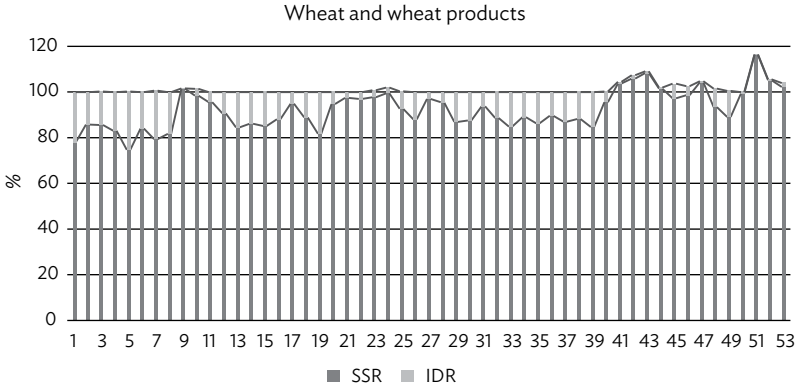
[1] The year 2015 was the end of the monitoring period for the two internationally agreed targets for hunger reduction. The first is the World Food Summit goal. At the summit held in Rome in 1996, 182 governments pledged "to eradicate hunger in all countries, with an immediate view to reducing the number of undernourished people to half their present level no later than 2015." The second is the Millennium Development Goal (MDG) 1 hunger target. In 2000, 189 nations pledged to free people from multiple deprivations, recognizing that every individual has the right to dignity, freedom, equality, and a basic standard of living that includes freedom from hunger and violence. This pledge led to the formulation of eight MDGs in 2001. The MDGs were then made operational by the establishment of targets and indicators to track progress at the national and global levels over a reference period of 25 years, from 1990 to 2015. The first MDG, or MDG1, included three distinct targets: halving global poverty, achieving full and productive employment and decent work for all, and cutting by half the proportion of people who suffer from hunger by 2015 (FAO 2015b).

Figure 8.1 Self-Sufficiency Ratios and Import Dependency Ratios of Wheat, Pakistan, 1961–2013



IDR = import dependency ratio, SSR = self-sufficiency ratio.
Source: FAO (2015a).

(from 25.1% in 1990–1992 to 22.0% in 2014–2016; the target should be from 25.0% to 12.5%, thus a reduction by half).

Most other key indicators also point to the low level of food security in Pakistan. Its protein supply is still below satisfactory levels, although it has improved its fat supply. Its domestic food price volatility is relatively high. As for the indicators on children under 5 years of age who are wasting, stunted, and underweight, none of these rate favorably for Pakistan. The improvement in these three indicators in the past 25 years has also been slow (Table 8.2). In addition, the prevalence of anemia among pregnant women went up steadily from 46.4% in 2001 to 50.5% in 2011 (FAO 2015c). The prevalence of anemia among children under 5 years of age also went up, from 55.6% in 2001 to 61.1% in 2010.

8.2.2 Factors Affecting Food Security

A number of factors are responsible for the low level of food security in Pakistan. Some of the major ones include the high level of poverty incidence, the high level of corruption, and political instability.

Poverty incidence. At the national level, the supply of dietary energy is more than adequate, with the average dietary energy supply

Table 8.2 Key Indicators of Food Security, Pakistan (5-year average)

	1990–1994	1995–1999	2000–2004	2005–2009	2010–2014
Dietary energy supply (kcal/capita/day)	2,346	2,393	2,323	2,415	2,439
Average protein supply (g/capita/day)	59.6	61.8	59.6	62.6	NA
Average fat supply (g/capita/day)	61.0	64.4	67.0	72.8	NA
Average dietary energy requirement (kcal/capita/day)	2,134	2,161	2,204	2,241	2,265
Average dietary energy supply adequacy (%)	110.0	110.8	105.4	107.8	108.0
Prevalence of undernourishment (%)	24.0	22.0	24.9	22.5	21.9
Number of people undernourished (million)	28.9	30.2	38.0	37.5	39.9
Political stability and absence of violence (index)	NA	–1.2	–1.5	–2.3	–2.7
Domestic food price volatility (index)	NA	NA	8.3	11.1	10.9
Children under 5 years of age affected by wasting (%)	14.9	NA	14.2	NA	12.7
Children under 5 years of age who are stunted (%)	48.6	NA	41.5	NA	44.0
Children under 5 years of age who are underweight (%)	37.2	34.2	31.3	NA	31.3
GDP per capita (in PPP) (constant 2011 international $)	3,098	3,284	3,467	4,119	4,318

g = gram, GDP = gross domestic product, kcal = kilocalories, NA = not available, PPP = purchasing power parity.

Sources: Based on FAO (2015c) and World Bank (2015a).

adequacy (ADESA) being over 100% since the early 1990s (Table 8.2).[2] Fat supply is also largely satisfactory. Protein supply is low, although there has been an improvement not far from the required level. This comfortable food supply situation at the national level would

[2] The ADESA expresses the dietary energy supply as a percentage of the average dietary energy requirement.

imply that there is enough food for people to maintain an active and healthy life. The fact that there are high levels of wasting, stunted, and underweight children under 5 years of age and that there exists a high prevalence of undernourishment suggest that some people do not have sufficient economic access to the required amount of food.

The level of poverty is high in Pakistan. In 1998, the poverty headcount ratio at national poverty lines (% of population) was 30.6%. It then climbed to 34.5% in 2001 (World Bank 2015a), dropping to 22.3% in 2005. These percentages of the population living below the poverty line were based on income per adult in Pakistan being $1.25 per day. A report by the Asian Development Bank (ADB) in 2014, on *Poverty in Asia: A Deeper Look*, however, argued that the use of the $1.25 poverty line is no longer adequate for Asia considering the rapid economic growth in the past decades and associated rising living costs. It estimated and proposed an Asia-specific poverty line of $1.51 per person per day. Using this poverty line, Pakistan's population under poverty would be 36.4% for 2005, 36.2% for 2008, and 26.5% for 2010 (ADB 2014).

Whichever poverty line is used, the total number of persons living in poverty is sizable considering Pakistan's total population of 185 million. Poverty and lack of economic access to food are major causes for the high level of food insecurity and also the seemingly high SSRs in most food items. Had these poverty-stricken people been able to increase their food purchases, Pakistan's food security level could have been expected to improve and its SSRs to drop. A number of other studies have also pointed out that in Pakistan the main cause of food insecurity is access, chiefly economic and sometimes physical, to food by the poor people (Ahmad and Farooq 2010; Food Security Portal 2012; Gera 2004; Hussain and Routray 2012; WFP and VAM 2013).

Corruption. Corruption affects food security directly or indirectly. Directly, corruption fosters the production, distribution, and selling of unsafe foods. It leads greedy individuals to abuse the national food reserve or the public distribution system for personal gain. Indirectly, corruption causes the misuse or misallocation of resources and the inequitable distribution of income, which then affect the achievement of a higher level of food security. Pakistan is one of the most corrupt countries in the world, which in turn hampers its food security (Goldenberg 2014; World Bank 2015b).

Political instability. Pakistan has been politically unstable since its inception in the late 1940s. The FAO index of "political stability and absence of violence" measures perceptions of the likelihood that a government will be destabilized or overthrown by unconstitutional or

violent means, including politically motivated violence and terrorism. It provides a measure of political shocks that might have implications for national food security. According to this index, Pakistan is unstable politically, with the index steadily increasing (in absolute value) (Table 8.2).

Other factors also affect the level of Pakistan's food security to a varying extent, e.g., conflicts in the border areas, militant activities, and natural disasters. These are, however, unlikely the determining forces. Other countries with very high levels of food security, such as Israel and the Republic of Korea, have always been subject to similar conditions.

8.2.3 Existing and Emerging Challenges

To improve its food security, Pakistan is facing formidable challenges, in particular, in the area of poor governance, the lack of economic growth, and instability in the country and its borders. Pakistan has to overcome these challenges to achieve durable societal development outcomes, which are fundamental to stable economic growth and future food security.

Environmental pollution and degradation present additional challenges for Pakistan to improve its future food security. Major environment issues include water pollution from raw sewage, industrial waste, and agricultural runoff; rising deforestation; soil erosion; and desertification (CIA 2015).

The pressure resulting from population increase has also worsened the environmental and resource problems. Between the 1970s and the 1980s, Pakistan experienced very high population growth (over 3.0% per annum). In the early 1990s, the growth rate dropped below 3.0% but was still above 2.5%. Since the early 2000s, despite its further decline, it was still above 1.8% (World Bank 2015a). How to coordinate the population growth to match the country's economic and environmental capacity requires attention from the government and the public.

In addition, there has been a shortfall of investment in agriculture infrastructure and research and development (R&D), leading to limited innovation in the agricultural sector (Gera 2004). Antiquated farming methods and the inefficient use of resources have contributed to poor productivity (Saleem 2012). The slow, or absence of, improvements in agricultural productivity is detrimental to the rural population, especially the rural poor. Two-thirds of the country's population and 80% of the poor live in rural areas. The lack of development in

agricultural infrastructure and advancement in farming methods has made agricultural production difficult and inefficient, aggravating poverty in rural areas. In the mountainous areas, many rural residents still do not have adequate access to food and other essential services (Food Security Portal 2012; Gera 2004).

8.2.4 Further Discussion

In the early days following the partition, Pakistan faced chronic food insecurity due to insufficient agriculture production and political instability. The country has been able to increase its food production since the 1970s and now exports staple food such as rice. Today, overall, Pakistan is in a comfortable situation in terms of food supply and availability, particularly for rice. It has SSRs for most food items over 100%. Yet, the country's food security level is still low. This shows that a country's ability to produce food is not a critical reason for a country's food security or insecurity.

In Pakistan, the lack of purchasing power and access rights to an adequate food supply by many of its poor people is the key reason for the country's low level of food security. To improve its level of food security, achieving stable economic growth and equitable income distribution should be Pakistan's foremost priority; central to this is the need to improve governance and eliminate corruption. Investment in agricultural infrastructure and R&D also needs to be carried out urgently to improve productivity in agriculture and to better cope with natural disasters. Efforts are needed to reduce and avoid environmental pollution and use resources sustainably. Population control should also be on the agenda of the government and society.

In the foreseeable future, Pakistan is most likely to continue to be subject to sociopolitical, economic, and environmental volatility. Deep reforms and improvements in governance must be carried out soon to unleash the country's growth potential. Without substantial improvements in governance and a reduction in corruption, decent economic growth is hard to anticipate, and hunger and malnutrition will continue to prevail because of the maldistribution of resources and the lack of purchasing power among the poor.

8.3 Food Security in Bangladesh

Bangladesh was a part of Pakistan when the latter partitioned from India in 1947. It is a vast alluvial floodplain with low hills. Most of the

country is situated on deltas of large rivers flowing from the Himalayas: the Ganges unites with the Jamuna (main channel of the Brahmaputra) and later joins the Meghna to eventually empty into the Bay of Bengal (Ruane et al. 2013; CIA 2015).

While it has a large population of 160 million (the eighth largest in the world), its land area is small at 130,170 km^2, making it a country with a high population density (1,218 persons per km^2 in 2014). Administratively, it has seven divisions—Barisal, Chittagong, Dhaka, Khulna, Rajshahi, Rangpur, and Sylhet (World Bank 2015a).

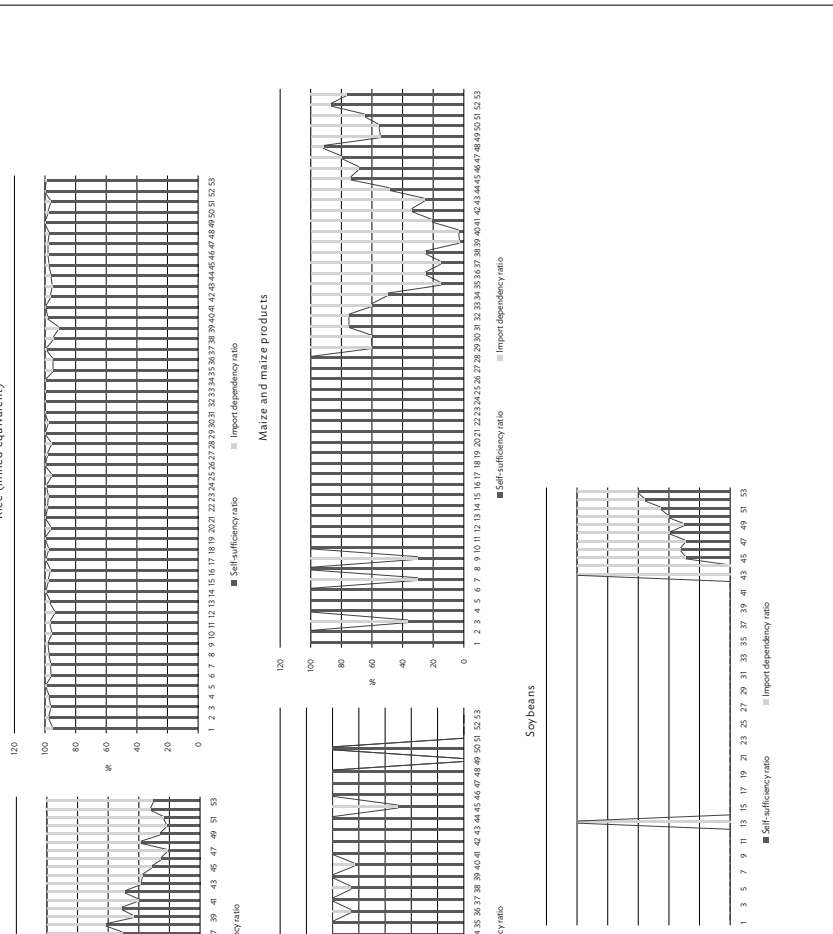
Bangladesh is a lower-middle-income country. Its gross domestic product (GDP) per capita (at purchasing power parity, PPP) was $2,991 in 2014 (2011 constant) (World Bank 2015a). Major problems facing Bangladesh include political instability, poor infrastructure, severe corruption, insufficient power supplies, and slow implementation of economic reforms (CIA 2015). In 2014, the Corruption Perceptions Index for this country was 25%, making it one of the most corrupt countries in the world. Its overall food security level is very low. Its Global Food Security Index was only 36.5% out of 100 in 2014, dropping by one percentage point from 37.5% in 2013 (EIU 2015).

8.3.1 Food Security Status

Crops produced in Bangladesh include rice, jute, cotton, tea, wheat, sugarcane, potatoes, tobacco, pulses, oilseeds, spices, and fruit. Rice is the single most important agricultural product (the output of rice in 2013 was 34.4 mt compared with wheat at 1.23 mt and maize at 1.49 mt). It also produces beef, mutton, goat meat, and poultry. The output of meat is small with each item being around 0.2 mt per annum. Rice is the staple food in Bangladesh. Fish, meat, milk, eggs, and pulses are the major sources of protein. The output of pulses at 0.25 mt per annum is low, and their consumption relies heavily on imports (net imports being around 0.8 mt per annum). The total pulse consumption of around 1 mt per annum is low given the size of the total population and as a major source of protein for many vegetarians in the country (FAO 2015a).

For most food crops, Bangladesh has a low level of food self-sufficiency except for rice. The SSR for rice is about 99%. For wheat, maize, and soybeans the SSRs are 27%, 68%, and 46%, respectively (Figure 8.2). The SSRs for beef, mutton, goat meat, and poultry have always been around 100%. The IDRs for these meat items are minimal, suggesting that the meat intake of Bangladesh is low given that the total output was only about 0.6 mt per annum.

Figure 8.2 Self-Sufficiency Ratio of Cereals, Bangladesh, 1961–2013

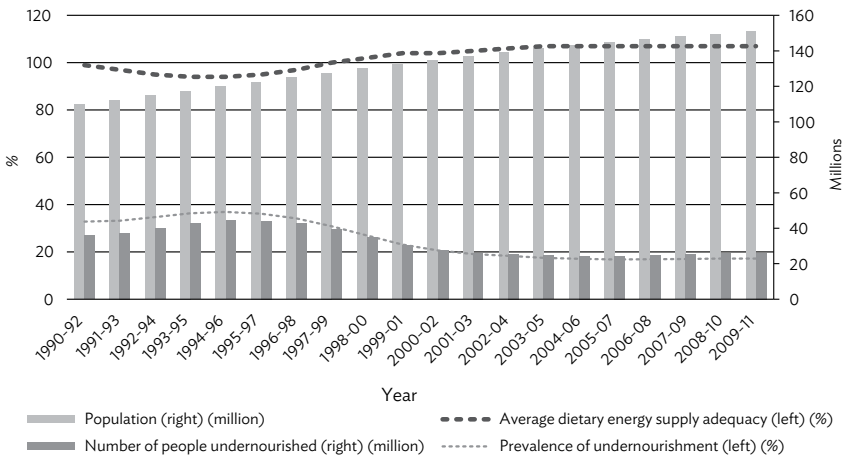


Source: FAO (2015a).

Although Bangladesh is short of natural resources and has low SSRs for most food crops, it has managed to improve its ADESA since the mid-1990s (Figure 8.3). The prevalence of undernourishment also dropped steadily during the same period. However, the decline in this prevalence was not sufficient to meet the two international hunger reduction targets. For the World Food Summit goal, Bangladesh only managed to reduce the number of undernourished people from 36 million in 1990–1992 to 26.3 million in 2014–2016, a reduction of 27%, 23% short of the target. For the MDG1 goal, the reduction of 49.9% in the proportion of the undernourished in the total population nearly met the target (from 32.8% in 1990–1992 to 16.4% in 2014–2016) (FAO 2015b). The change in the level of the prevalence of undernourishment can be seen in Figure 8.3.

Overall, the level of food security in Bangladesh is low and unstable. According to the GFSI, Bangladesh's food security level does not show a steady improvement, and sometimes even moves backward. Many other key food security indicators by FAO in Table 8.3 also suggest a low level of food security. The level of protein

Figure 8.3 Population and Food Security, Bangladesh, 1990–2011



Sources: FAO (2015c); World Bank (2015a).

and fat intake by Bangladeshis is low and below the desired level (Table 8.3). Domestic food price volatility is high. The rates of wasting, stunted, and underweight children under 5 years of age are still high, although progress to reduce them has been made (Table 8.3). The rate of anemia among pregnant women in the early 2010s was still over 48% (FAO 2015c). For children under 5 years of age, this rate is as high as 56%.

Table 8.3 Key Indicators of Food Security, Bangladesh (5-year average)

	1990–1994	1995–1999	2000–2004	2005–2009	2010–2014
Dietary energy supply (kcal/capita/day)	2,057	2,171	2,345	2,407	2,456
Average protein supply (g/capita/day)	44.0	46.6	51.4	53.8	NA
Average fat supply (g/capita/day)	19.8	25.8	26.4	28.6	NA
Average dietary energy requirement (kcal/capita/day)	2,153	2,185	2,216	2,246	2,283
Average dietary energy supply adequacy (%)	95.8	99.6	105.8	107.0	107.4
Prevalence of undernourishment (%)	34.8	30.2	18.5	17.0	17.0
Number of people undernourished (million)	40.1	38.3	25.7	25.2	26.7
Political stability and absence of violence (index)	NA	−0.5	−1.1	−1.6	−1.4
Domestic food price volatility (index)	NA	NA	4.0	8.0	6.8
Children under 5 years of age affected by wasting (%)	16.4	16.4	13.2	14.1	12.7
Children under 5 years of age who are stunted (%)	71.4	63.8	52.0	46.0	41.7
Children under 5 years of age who are underweight (%)	61.9	54.5	42.9	40.1	34.4
GDP per capita (in PPP) (constant 2011 international $)	1,285	1,457	1,718	2,150	2,656

g = gram, GDP = gross domestic product, kcal = kilocalories, NA = not available, PPP = purchasing power parity.

Source: Based FAO (2015c) and World Bank (2015a).

8.3.2 Factors Affecting Food Security

Poverty incidence. There is enough food for people in the country to consume—the ADESA has been over 100% since the early 2000s.There is also a high prevalence of anemia among pregnant women and children under 5 years of age. These facts suggest that some people do not have sufficient economic access to the required amount of food.

The level of poverty is high in Bangladesh. In 1991, the poverty headcount ratio at national poverty lines (% of population) was 56.6%. Over the years, progress has been made to alleviate poverty, and that ratio has steadily come down (World Bank 2015a). It dropped to 40.0% and 31.5% in 2005 and 2010, respectively. Like in the case of Pakistan, using the Asia-specific poverty line of $1.51 per person per day, ADB estimated Bangladesh's population in poverty to be 64.5% for 2005, 61.2% for 2008, and 58.0% for 2010 (ADB 2014).

If the poverty line of $1.25 is used, the number of persons living in poverty in 2010 was 47.77 million. If $1.51 is used, this number would increase to 86.24 million in 2010 (World Bank 2015a). The number of people experiencing food insecurity is sizable no matter which poverty line is used. Other studies have also pointed out that poverty is a major cause for food insecurity in Bangladesh (Smith, El Obeid, and Jensen 2000; Hossain, Naher, and Shahabuddin 2005; McIntyre et al. 2011).

Corruption. The Corruption Perceptions Index of 25% in 2014 suggested corruption is severe in Bangladesh (Transparency International 2015). As noted earlier, corruption causes the misuse or misallocation of resources and an inequitable distribution of outcomes resulting from economic growth. Without serious cleaning up of corruption in this country, accelerating economic growth and alleviating income inequality will be difficult. This, in turn, will hold back a higher level of food security.

Political instability. Political instability is slightly less severe in Bangladesh compared with Pakistan. The index of political stability and absence of violence compiled by the FAO was about half of Pakistan's in the early 2010s. Nonetheless, it is still severe, and the severity varies over time, negatively affecting Bangladesh's level of food security (Table 9.3).

Various other factors may also affect Bangladesh's food security, including the frequent occurrences of natural disasters (droughts and cyclones), the large number of landless rural people, soil degradation and erosion, deforestation, and water problems (water pollution resulting from the use of commercial pesticides, groundwater contamination by naturally occurring arsenic, intermittent water shortages because of falling water tables in the northern and central parts of the country, and waterborne diseases) (CIA 2015). Again, like in Pakistan, these factors

cannot be held as fundamental to Bangladesh's lack of food security. These problems are just symptoms of a lack of political will to fix them but are not the root causes for the country's food insecurity.

8.3.3 Existing and Emerging Challenges

Bangladesh has to deal with the root causes of food insecurity. The root causes are the lack of good governance in society, which in turn promotes corruption. Without major efforts to fix these problems, it will be difficult for the country to expand its economy and thus to improve its food security. Fixing poor governance and the resultant corruption must be given top priority.

Bangladesh also needs more efforts to coordinate its population growth to match its economic and environmental capacity. Its population density is one of the highest in the world, which translates to low per capita natural resources. This creates pressure on the environment and the use of natural resources, making it difficult for sustainable development. After decades of high population growth (over 2% and sometimes close to 3% per annum), Bangladesh has made good progress in bringing the growth rate down to about 1% in recent years (World Bank 2015a). However, due to the already very large population, an additional 1.6 million people need to be fed each year, even if the growth rate is 1%.

The challenge resulting from global warming for Bangladesh can be potentially enormous, and carrying out preparations to cope with this challenge is expensive. There have been media reports about the threats of rising sea levels to Bangladesh. According to Faisal and Parveen (2004), in Bangladesh the sea level may increase by around 30 centimeters to 50 centimeters by 2050. Problems that may arise from higher sea levels are more frequent damage to farmland from high tides, storm surges and floods, soil erosion, salt-water intrusion and thus increased soil salinity, and land loss (existing medium lowland will become lowland and will not be suitable for high-yielding varieties of rice plantation; some highland and medium highland will become medium lowland). These problems will lead to lower food production (Faisal and Parveen 2004; Ruane et al. 2013).

The impact of climate change and global warming on Bangladesh's food security will become more noticeable by 2050 if the situation gets worse. By then, wheat production will be most affected because wheat is sensitive to temperature change. Increasing temperatures will also have substantial effects on the yields of boro rice (winter season). Moreover, production will also suffer due to potential land loss and the decline in land quality (Faisal and Parveen 2004; Sarker, Alam, and Gow 2012; Ruane et al. 2013).

Efforts are needed to fight widespread inequality and poverty, especially in rural areas. To alleviate the rural poverty problem, land ownership must be addressed innovatively. About three-fourths of Bangladesh's population live in rural areas. Among rural households, 59% are functionally landless (defined as ownership of less than 0.2 hectare of land—an area insufficient to fulfill basic subsistence needs), and 28% of rural households have no cultivable land (Dixon et al. 2003). Landless households in rural areas are prone to fall into the poor household category (Hollema and Begum 2002). In addition to land ownership, land fragmentation has also become increasingly serious and needs to be addressed (Belton, Ahmed, and Murshed-e-Jahan 2014).

8.3.4 Further Discussion

Bangladesh has pursued a strategic goal of self-sufficiency in cereal production for decades (Begum and D'Haese 2010). The government has been promoting high-yielding varieties of rice and wheat, subsidizing agriculture inputs, and extending the coverage of irrigated agriculture through public and private initiatives (Faisal and Parveen 2004). As a result, the availability of food grain at the national level has improved (Begum and D'Haese 2010). The food production index has increased from 41.12 in 1971 to 135.36 in 2013 (2004–2006 as the base year) (World Bank 2015a). In the long run, Bangladesh needs to address whether to pursue self-sufficiency in cereal production. Pursuing a high level of self-sufficiency in cereals may become costly if the country's economy further expands in the future.

Past experience suggests that food availability deteriorates in the dry season when water availability is low. Investments need to be made to increase water storage capacity to prepare for such occasions. Increased investment also needs to be made in agricultural infrastructure, research, and development to improve productivity and raise food output.

According to a report by the International Rice Research Institute (IRRI 1997), the 1 million hectares of coastal rice lands, with varying degrees of salinity, offer an opportunity for future exploitation. The adoption of new biotechnology tools and products and hybrid rice technology can help raise and maintain yields in an irrigated ecosystem. The report also recommended that an overall economic environment that provides economic incentives to farmers for higher rice production should be maintained. At the same time, efforts should be made to reduce production costs to make rice cultivation in Bangladesh internationally competitive.

In the past decades, a long-term expansion in the winter season (boro) rice crop has reduced the country's dependence on the

flood-susceptible monsoon season (aman) rice crop. Conducive agricultural and investment policies enabled this expansion to happen. Some trade and market policy reforms have also helped develop efficient and competitive food grain markets that are able to quickly respond to any impending production shortfall (Ninno, Dorosh, and Smith 2003). Hence, food insecurity in Bangladesh today is merely the economic access of the poor (Begum and D'Haese 2010). Ensuring good governance and curtailing corruption is the key to reducing economic inequality and widespread poverty, hence, improving the country's food security.

8.4 Food Security in Indonesia

Indonesia is an archipelagic nation containing over 18,000 islands. The larger islands include Sumatra, Java, Kalimantan (which comprises two-thirds of the island of Borneo), Sulawesi, and Irian Jaya. These islands are also mountainous (Worldatlas 2015). Indonesia has a long history, and the Indonesian archipelago was inhabited tens of thousands of years ago. From the early 17th century until 1942, the Dutch colonized Indonesia. From 1942 to 1945, Japan occupied the islands. In August 1945, Indonesia declared its independence.

Indonesia has a land area of a little over 1.8 million km^2. It had a population of around 255 million in 2014, the world's fourth most populous country (World Bank 2015a). Its population density is 140.5 persons km^2. Administratively, Indonesia consists of 34 provinces, 5 of which have special status.

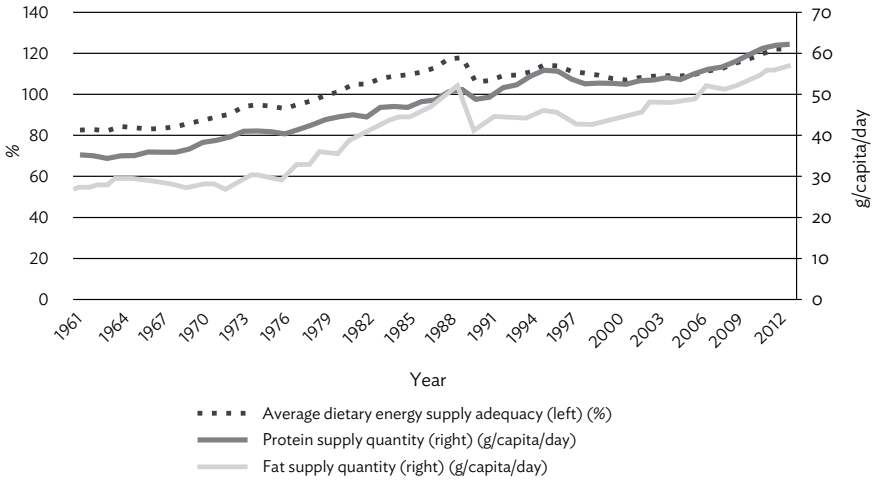
In 2014, its per capita GDP (purchasing power parity) was $10,099 (2011 constant) (World Bank 2015a). Poverty, unemployment, inadequate infrastructure, corruption, and a complex regulatory environment are some of the major issues that Indonesia has to deal with (CIA 2015). Its corruption level is high (with the Corruption Perceptions Index being 34%). Its Global Food Security Index was only 46.6% (EIU 2015). The number of people undernourished stood at 19.4 million in 2014 (FAO 2015c).

8.4.1 Food Security Status

Since independence, Indonesia has been trying to ensure an adequate amount of food is available for its people. This has not been smooth nor easy. Famines still occurred often. Van der Eng (2012) and EM-DAT (2015) provided details on the occurrence of famines and associated mortality since independence.

In the early 1970s, the pursuit of full food self-sufficiency became a major policy commitment of the government (Bourgeois and Kusumaningrum 2008). In 1980, for the first time since independence,

Figure 8.4 Average Dietary Energy Supply Adequacy, Protein Supply, and Fat Supply, Indonesia, 1961–2013



g = gram.
Sources: FAO (2015a, 2015c).

the per capita availability of energy exceeded the average dietary energy requirement as reflected by the ADESA being over 100% (Figure 8.4). However, the per capita intake of both protein and fat has been low, although the improvement is also remarkable.

In 1997, the Asian financial crisis hit, and Indonesia's GDP growth dropped sharply by 1998. By May 1998, the price of food had increased by 74% over prices a year before (Studdert, Frongillo, and Valois 2001), and the prevalence of undernourishment kept increasing from 14.5% in 1997 to 18.5% in 2007. Since 2007, the prevalence of undernourishment has declined.

Today, rice remains the major cereal crop produced in Indonesia, with an output of 47.5 mt in 2013. Maize production is about 19 mt. Indonesia does not produce wheat and barley due to unsuitable agro-ecological conditions. It also produces soybeans at about 0.8 mt per annum. Its meat output is still low. In 2013, it produced 0.59 mt of beef, 0.11 mt of mutton and goat meat, and 0.74 mt of pork. The only meat with higher production is poultry, being 1.87 mt in 2013. While rice continues to be the staple food, the consumption of wheat products is also on the increase (FAO 2015a).

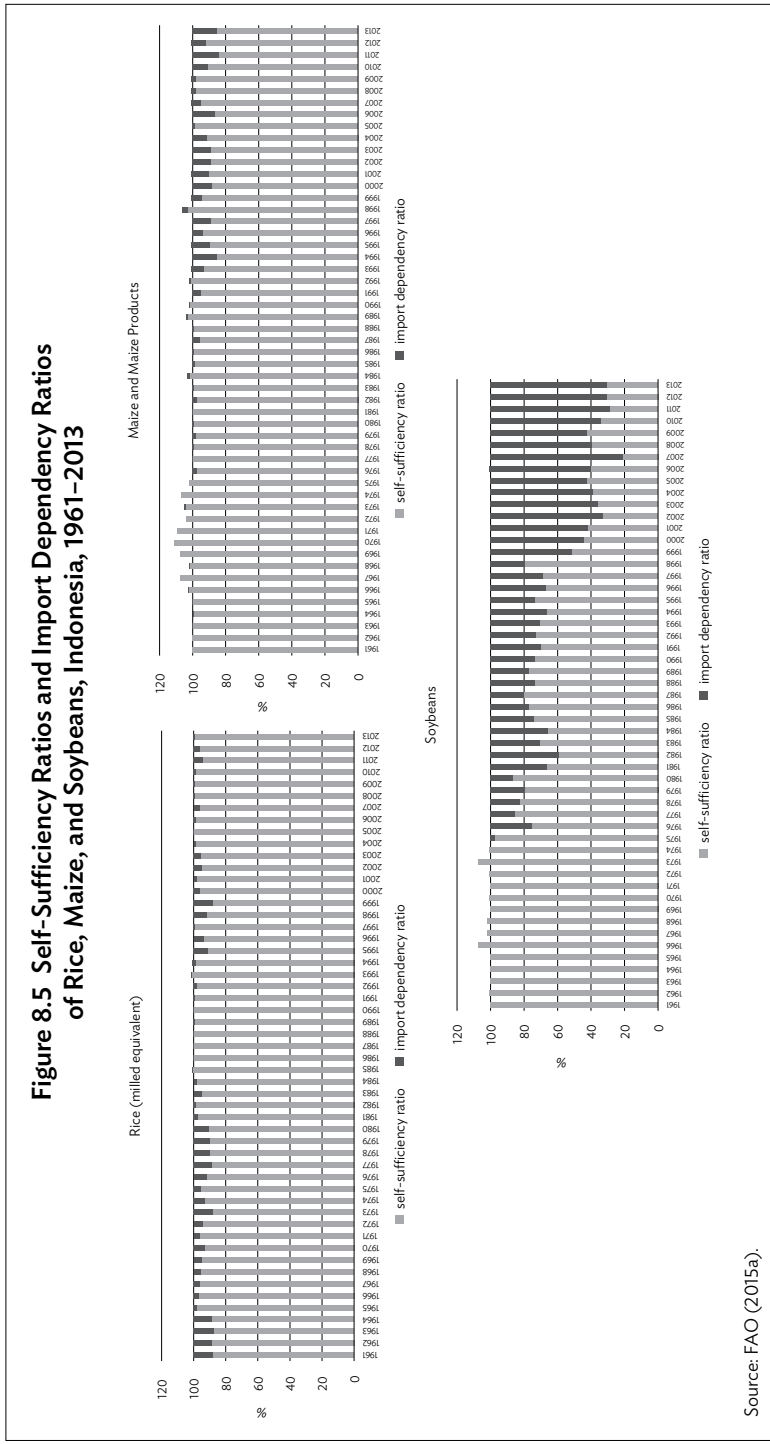


Figure 8.5 Self-Sufficiency Ratios and Import Dependency Ratios of Rice, Maize, and Soybeans, Indonesia, 1961–2013

Source: FAO (2015a).

Rice used to have a low SSR, 88% in 1961. By the mid-1980s, the SSR significantly improved, reaching 100% briefly (Figure 8.5). It has since maintained a high level most of the time except for 2 years in the late 1990s due to the Asian financial crisis. During the crisis, the rupiah dropped in value heavily (from around Rp2,400 per $1 in mid-1997 to Rp15,000 per $1 in mid-1998, and finally settling at Rp8,000–9,000 per $1 at the end of 1998). These fluctuations in the exchange rate led to large increases in the prices of tradable commodities in Indonesia's domestic markets. Many farmers were not able to purchase fertilizers and seeds, negatively affecting the rice output. In 1999, its rice SSR dropped, to only 88%. It has since recovered quickly and has stayed at around 95% or higher. The SSRs for maize and soybeans are around 90% and 30%, respectively. The IDR for wheat and barley is 100% or higher. The SSRs of all meats are high, at 98% in 2013, despite its low level of meat output. This implies that the per capita consumption of meat is low in Indonesia.

The improvement in food security in Indonesia has been remarkable since the 1980s. Although it did not quite reach the World Food Summit goal (reducing the number of people of undernourished from 35.9 million in 1990–1992 to 19.4 million in 2014–2016, a reduction by 45.9% thus 4.1% short of the goal), it reduced the proportion of undernourished in the total population by 61.6% (from 19.7% in 1990–1992 to 7.6% in 2014–2016), 11.6% over the MDG1 goal. Despite this improvement, other FAO key food security indicators have suggested that more improvements are needed (Table 8.4). Some weak areas include the low levels of intake of protein and fat; high domestic food price volatility; and the high rates of wasting, stunted, and underweight children under 5 years of age (Table 8.4). In addition, the rate of anemia among pregnant women in the early 2010s was still as high as 30% (FAO 2015c). For children under 5 years of age, this rate is 33%.

8.4.2 Factors Affecting Food Security

Poverty incidence. Like in Pakistan and Bangladesh, the coexistence of an ADESA over 100% together with high levels of wasting, stunted, and underweight children under 5 years of age and a high prevalence of anemia among pregnant women and children under 5 years of age suggests that some people do not have the economic means to obtain the required amount of food (FAO 2015c). The poverty headcount ratio at national poverty lines (% of population) was 17.6% in 1996. It climbed to 23.4% in 1999 as a result of the 1997 Asian financial crisis. It has steadily fallen after that, coming down to 16.0% in 2005, 15.4% in 2008, and 13.3% in 2010 (World Bank 2015a). The number of people in poverty was

Table 8.4 Key Indicators of Food Security, Indonesia (5-year average)

	1990–1994	1995–1999	2000–2004	2005–2009	2010–2014
Dietary energy supply (kcal/capita/day)	2,444	2,486	2,458	2,564	2,756
Average protein supply (g/capita/day)	52.6	53.6	53.6	57.2	NA
Average fat supply (g/capita/day)	44.8	43.8	47.0	52.0	NA
Average dietary energy requirement (kcal/capita/day)	2,221	2,251	2,266	2,263	2,275
Average dietary energy supply adequacy (%)	110.0	110.4	108.6	113.2	121.2
Prevalence of undernourishment (%)	17.8	15.5	18.6	16.9	8.8
Number of people undernourished (million)	33.5	31.5	40.6	39.4	21.8
Political stability and absence of violence (index)	NA	−1.5	−1.9	−1.2	−0.7
Domestic food price volatility (index)	NA	NA	12.2	14.6	10.0
Children under 5 years of age affected by wasting (%)	NA	NA	8.4	14.8	12.9
Children under 5 years of age who are stunted (%)	NA	NA	37.5	40.1	37.8
Children under 5 years of age who are underweight (%)	29.8	25.3	22.8	22.0	19.3
GDP per capita (in PPP) (constant 2011 international $)	4,852	5,795	5,870	7,092	8,643

g = gram, GDP = gross domestic product, kcal = kilocalories, NA = not available, PPP = purchasing power parity.

Source: Based on FAO (2015c) and World Bank (2015a).

36.2 million in 2005, 36.2 million in 2008, and 32.1 million in 2010. Using the Asia-specific poverty line of $1.51 per person per day, ADB estimated Indonesia's population in poverty to be 32.9% for 2005, 34.6% for 2008, and 28.0% for 2010 (ADB 2014). The number of people in poverty in the corresponding years was 74.9 million, 81.2 million, and 67.2 million, respectively.

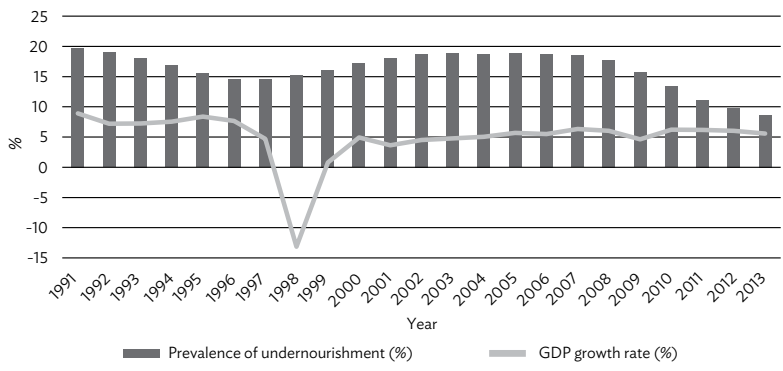
Corruption. In 2014, the Corruption Perceptions Index for Indonesia was 34%, which suggests corruption is severe in Indonesia

(Transparency International 2015). Like in many other highly corrupt countries, the high level of corruption impedes the achievement of a higher level of food security.

Fluctuations in economic growth. Steady economic growth helps improve food security. Following the improvements in its economy in the 1980s, Indonesia's food security continued to improve in the early 1990s as reflected by the continuing decline in the prevalence of undernourishment (Figure 8.6). The shock of the Asian financial crisis to the economy disrupted the trend, resulting in the reversal of the prevalence of undernourishment. The steady economic growth after the crisis led to a decline again in 2007.

Other factors. Political instability also affects a country's food security. In Indonesia, political instability has lessened, following the return of democracy in the early 2000s (Table 8.4). This is likely to render the country with a very important institutional guarantee for better and more sustainable food security. Other factors that also affect its food security include frequent natural disasters, environment pollution, and higher costs of food supply logistics (due to the isolation of islands). All these factors, however, are not fundamental. Any well-functioning government can overcome such challenges.

Figure 8.6 Gross Dometic Product Growth and Prevalence of Undernourishment, Indonesia, 1991–2013



GDP = gross domestic product.
Source: World Bank (2015a).

8.4.3 Existing and Emerging Challenges

The return of democracy in Indonesia has helped Indonesia improve its future food security. However, a country's democratic setting does not guarantee the reduction or eradication of corruption in a country. Efforts will be needed in Indonesia to reduce corruption and establish good governance to prevent further corruption. Without significantly curtailing corruption, further expansion of its economy can be difficult, and in turn food security will also suffer.

Indonesia also needs to curtail its population growth. From the mid-1950s to the mid-1980s, it had 3 decades of high population growth (over 2.0% and sometimes over 2.5% per annum). Since the mid-1980s, the population growth rate declined gradually from 1.9% to 1.4% in the early 2010s (World Bank 2015a). The 1.4% growth rate, however, is still high, considering Indonesia has a very large population base.

The population pressure has already led to increased activities that attempt to extract more from nature, stretching its capacity. One such activity is to destroy forests for arable land. While deforestation undermines Indonesia's long-term sustainable development, smoke and haze caused by forest fires also cause serious air pollution and thus health problems for many people.

Poverty and inequality remain major problems in Indonesia. Although economic growth in the past decade has been satisfactory, income inequality has worsened. The Gini coefficient has crept up from 28.99% in 1999 to 35.57% in 2010 (World Bank 2015a). Inequality and poverty hurt a country's social stability and harmony, and in turn, its food security.

8.4.4 Further Discussion

Indonesia has tried to pursue complete food self-sufficiency since the 1970s. Having high levels of food self-sufficiency remains on the government agenda. Recently, the government reaffirmed its commitment to rice self-sufficiency and, conversely, extended this commitment to other commodities such as maize, sugar, and soybeans. Subsequently, tariffs and other government intervention have been used (Bourgeois and Kusumaningrum 2008; Nugroho et al. 2013).

Bourgeois and Kusumaningrum (2008) argued that while this kind of policy may have been justified in the 1970s and 1980s, it is no longer relevant from a macroeconomic perspective when the country's economy has expanded. In earlier decades, the cost of food cereal imports reached 1.8% of GDP. However, a comparison of the cost of imports of the three cereals (rice, wheat, and maize) with two

contrasting alternative scenarios (high growth and low imports versus moderate growth and high imports) and with three international price configurations for four time periods between 1970 and 2020 has shown that the share has become lower—the expected share of food cereal imports ranging between 0.15% and 0.37% of GDP in 2020. As such, the pursuit of food self-sufficiency is no longer justified.

Warr (2011) also pointed out that policies of promoting food self-sufficiency by restricting food imports through tariffs or quantitative restrictions is not beneficial for the country to further improve its food security. Such policies reduce imports but raise domestic prices. As such the pursuit of self-sufficiency is done at the cost of food insecurity of the most vulnerable people in the country. He believed a preferable strategy for raising self-sufficiency is to promote improved agricultural productivity without raising the domestic price of food. Policies should be formulated and implemented without creating a conflict between the goals of higher levels of self-sufficiency and food security and poverty reduction.

Timmer (2004) also argued that sound government policies are more important in improving a country's food security. He pointed out that "a decade from now, Indonesia's food security will depend primarily on the rate and distribution of economic growth and targeted programs to alleviate poverty" (p. 2). He believed that "[a]t the level of development that Indonesia has reached, … [o]nly good economic policies can ensure food security on a sustainable basis" (p. 3). In addition, he also stressed the importance of good governance. What has happened in Indonesia during 2004–2014 has proved Timmer's assessment was right.

Hence, given the level of social, economic, and political development that Indonesia has achieved, achieving a higher level of food security in the future relies good governance and good economic policies. Pursuing a high level of self-sufficiency is a means to achieve better food security, but it is in itself not equal to food security. With a higher and more equitable distribution of economic wealth but low self-sufficiency, countries like Japan and the Republic of Korea have achieved high levels of food security. Indonesia could benefit by looking into how these countries have managed to achieve higher levels of food security.

8.5 Food Security in Singapore

Singapore is a city-state that came into being in 1965. It is made up of one main urbanized island and 60 small islands (Worldatlas 2015). Its total land area is 700 km^2, with agriculture land being 63 km^2 (World Bank 2015a). In 2014, its population was about 5.5 million. Population

density is extremely high, at 7,814 persons per km^2, due to its very small land area.

In 1965, when Singapore left Malaysia to become a separate nation, there were many uncertainties. Issues that were threatening this new country's growth were many, such as unemployment, lack of housing, a poor education system, and the lack of natural resources and arable land. The new government aimed at building the Singaporean identity as a multiracial and multilingual society. It made Malay, Mandarin, Tamil, and English official languages. Manufacturing was promoted as part of its economic strategies. The government intentionally prepared Singapore to become an investment and financial hub. It also invested heavily in an education system that adopted English as the language of instruction and emphasized practical training to develop a competent workforce well suited for industry needs (Lepoer 1991).

After a 50-year endeavor, Singapore has transformed into a modern and highly developed society. In 2014, its per capita GDP (purchasing power parity) reached $78,958 (2011 constant). Despite the fact that its food supply chiefly relies on imports, its food security level is very high. It has been ranked very high according to the Global Food Security Index. In 2014, its index was 84.8; in 2015, it increased to 88.2, the highest in Asia and the second highest in the world after the United States (EIU 2015).

8.5.1 Food Security Status

Due to the limited land available, food supplies from domestic production are low at around 10%. The rest comes from imports. Despite the heavy import dependence, Singapore's food supply is secure. Singapore was ranked number 1 in the world for food affordability, number 11 for food availability, and number 13 in terms of quality and safety (EIU 2015).

8.5.2 Factors Affecting Food Security

Corruption. Corruption is very low in Singapore. Its Corruption Perceptions Index in 2014 was 84%, making it the most "clean" country in Asia and the 7th cleanest in the world. Low levels of corruption encourage a more efficient allocation of resources and a more equitable distribution of benefits from economic growth. Singapore's economic growth benefits from the low level of corruption, while the more equitable income distribution improves residents' economic access to food.

Food supply. According to Teng (2013), Singapore resorts to three "food taps" to manage its food supply: imports, self-production, and

stockpiles, in that order of importance. Food imports account for about 90% of Singapore's food supply. If Singapore had insisted on having high food self-sufficiency, it could have significantly disadvantaged itself economically, hence reducing its financial ability to import foods.

Food security management. Despite its high level of food security, Singapore has never been too complacent. It has a designated body to take care of the country's food security operations and strategies, the Agri-Food and Veterinary Authority of Singapore. Recently, this authority, after extensive consultation, developed Singapore's food security road map. This road map consists of three strategies: core, supporting, and enabling. Core strategies emphasize the diversification of sources of imports, investments abroad, industry development, optimized local production, and stockpiling. Supporting strategies include food waste reduction, strengthening infrastructure, financial instruments, and affordability. Finally, enabling strategies focus on cross-government coordination; emergency planning; communications; market monitoring; and fiscal, legal, and regulatory frameworks (Agri-Food and Veterinary Authority of Singapore 2013/2014).

8.5.3 Existing and Emerging Challenges

Since Singapore relies heavily on imports for its food supply, the major challenge for food security is any disruptions, expected and unexpected, to its food imports. To handle this challenge, its main strategy is to have diverse sources to import key food items (Teng 2013). Singapore has also made a strategic decision to focus its R&D efforts to increase the domestic production of eggs, fish, and leafy vegetables. It has started promoting the use of product substitutes, particularly liquid or powdered eggs and frozen meat cuts instead of fresh chilled meat, contract farming through foreign investment, and the creation of designated food production and processing zones situated in other countries (Kassim 2011).

Singaporeans demand high-quality food, especially poultry, seafood, vegetables, and fruit. As such, the government has to make sure that the available food is safe to consume. However, as Singapore imports over 90% of its food, it is vulnerable to food safety incidences in the production countries.

8.5.4 Further Discussion

As a highly developed and largely corruption-free country, Singapore enjoys a high level of food security. If it has any food security problem, it is not really a matter of food shortages, but about excessive food

energy intake or the intake of foods without balanced nutrition. The combination of excessive food energy intake, together with a lack of physical activity, or imbalanced nutrition intake, has led to a higher incidence of obesity. This has led to the need for obesity prevention and control (Gan and Pang 2012).

Like in many other developed economies, food waste is also an issue in Singapore. Teng and Escaler (2010) pointed out that Singapore must minimize food waste. In reducing waste, Singapore is working toward educating food manufacturers, retailers, food importers, food producers, and other stakeholders along the food supply chain on waste management. Research and development in food waste reduction and recycling are also encouraged. Efforts are being made to reduce food waste through better post-harvest management and storage to prolong shelf life (Agri-Food and Veterinary Authority of Singapore 2013/2014).

Due to its high import dependence, Singapore is vulnerable to import disruptions. Supply interruptions caused by widespread epidemics such as severe acute respiratory syndrome (SARS), wars, and natural disasters are beyond Singapore's control and can be devastating to its food supply. To mitigate food shortages caused by import disruptions, one option for Singapore is to ensure the supply of some essential foods from domestic production. According to Teng (2013), Singapore has set targets to domestically produce 15% of its total requirements of finfish, 30% of eggs, and 10% of fresh vegetables. However, he admitted that this would not be adequate should supplies be disrupted for a prolonged period (Teng 2013). The other option is to diversify its sources of imports. This should be an easy and inexpensive option. Key products used to be imported from just one or two sources (Teng and Escaler 2010). Singapore has now adopted a strategy to reduce its dependency on a single or a few exporting countries. Yet, another option is for Singapore to play a significant role in promoting and contributing to regional food security (Kassim 2011; Teng and Escaler 2010). Through regional efforts such as the ASEAN Plus Three Emergency Rice Reserve, Singapore can benefit from the regional reserve should any disruptions go longer.

Most food supply disruptions caused by epidemics or natural disasters are likely to be localized. After initial shocks, a country will be able to quickly find alternatives to handle food imports. However, if a large-scale war erupts, the impact can be widespread and prolonged. It is valuable for Singapore to also play an active role to promote and contribute to regional and global peace. Singapore is highly developed economically, and it has high research and development capabilities. Coupled with its strategic location and friendly relationships with many other countries, Singapore can contribute to worthwhile initiatives to

ensure sustained peace in the region and globally. Singapore will be the ultimate beneficiary of a peaceful world (Teng and Escaler 2010).

Overall, Singapore has successfully managed its food security. It continues to improve its strategies, seek new opportunities, and address risks in an increasingly complex environment to sustain a high level of food security. It has shown to the world that a high level of food security does not have to be achieved by having high self-sufficiency. Through effectively and equitably distributing food, diversifying food import sources, having long-term and good partnerships, it is also possible for a country with a poor natural resource endowment to become highly food-secure.

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9

Achieving Food Security in Asia: Cross-Country Experiences and Lessons

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9.1 Introduction

Chapters 4–8 of this book examined the food security practices of some countries in Asia. These countries are different in various aspects, such as political institutions, degree of corruption, population density, per capita arable land, level of income, and climatic conditions. Their levels of food security have also been divergent, high in some, while low in others. In this chapter, we highlight and compare the similarities and differences in their food security practices, and the lessons and experiences drawn from their quests for improved food security.

9.2 Similarities and Differences, Experiences and Lessons

The endowment of natural resources and size of population are not major determinants of food security.

It is a common perception that if a country is short of natural resources or has a high population, its food security is negatively affected. Such a view is believed to be particularly applicable to the most populous countries, such as Bangladesh, the People's Republic of China (PRC), and India. The actual experience of countries in Asia is, however, contrary to this claim.

Resource endowment is closely related to the size of a country's population. Given the availability of natural resources within the boundaries of a nation, the per capita resource availability is inversely related to the size of the country's population. Hence, indicators such as population density and per capita arable land can better reflect a country's resource endowment. Table 9.1 shows that Israel, Japan, the Republic of Korea, and Singapore all have a high population density but low per capita arable land. Yet, their level of food security is high. On the other hand, countries with a lower population density and higher per capita arable land such as the PRC, Indonesia, the Democratic People's Republic of Korea, and Pakistan have lower levels of food security.

It is also claimed that if a country has a large population, then compared to a country with a smaller population, it is more difficult for the former to manage its food demand and supply, thus making it harder to achieve a high level of food security. This myth had already been shattered by the improved food security status in the PRC. In 1974, the PRC's total population was 909 million. By 2014, its population reached 1.364 million, over 455 million more people than in 1974. Yet, compared to 1974, the PRC's food security level today is higher. People can buy whatever food that they want as long as they can afford it. In 1974, the PRC had a lower population but a higher per capita resource endowment. However, food availability was poor at that time, and people could not buy the food that they wanted even if they had money. Clearly, the size of population should not be used as an excuse for a lower level of food security. If this was the case, many countries with smaller populations would have much higher levels of food security.

Economic growth and thus higher consumer income are important for better food security.

It can be argued that the PRC's improved food security is largely due to its fast economic expansion in the past 3 decades and hence its improved consumer income. This is largely true. Table 9.1 indicates that Asian countries with higher levels of food security have higher per capita incomes. Indonesia is a case in point. As shown in Figure 8.6, its economy suffered a major setback due to the 1997 Asian financial crisis. This in turn had a negative impact on its food security. With sustained economic recovery over the past decade, however, its food security has again started improving.

Table 9.1 Level of Food Security and Associated Variables of Selected Asian Countries, 2014

Country	Global Food Security Index (%)	Corruption Perceptions Index (%)	Democracy Index (%)	Per Capita GDP, PPP (2011 constant) ($)	Total Population ('000)	Total Land Area ('000 km²)	Population Density (persons per km²)	Arable Land Out of Total (%)	Total Arable Land Area ('000 km²)	Per Capita Arable Land (ha per capita)
Bangladesh	36.5	25.0	57.8	2,991	158,513	130	1217.7	58.96	77	0.05
PRC	62.2	36.0	30.0	12,609	1,364,270	9,388	145.3	11.28	1,059	0.08
Democratic People's Republic of Korea		8.0	10.8	1,800	25,027	120	207.8	19.52	24	0.09
India	48.6	38.0	79.2	5,565	1,267,402	2,973	426.3	52.54	1,562	0.12
Indonesia	46.6	34.0	69.5	10,099	252,812	1,812	139.6	12.97	235	0.09
Israel	81.0	60.0	76.3	31,180	8,215	22	379.6	13.62	3	0.04
Japan	78.0	76.0	80.8	35,635	127,132	365	348.7	11.65	42	0.03
Pakistan	44.0	29.0	46.4	4,619	185,133	771	240.2	27.48	212	0.11
Singapore	84.8	84.0	60.3	78,958	5,470	0.7	7813.9	0.90	0	0.00
Republic of Korea	73.5	55.0	80.6	33,629	50,424	97	518.0	15.64	15	0.03

GDP = gross domestic product, ha = hectare, PPP = purchasing power parity, PRC = People's Republic of China, km² = square kilometer.

Notes and sources:

Global Food Security Index: the higher the index, the higher the level of food security: EIU (2014).

Corruption Perceptions Index: the higher the index, the lower the level of perceived corruption: Transparency International (2015).

Democracy Index: the higher the index, the higher the level of democracy. Full democracies: 80 to 100, flawed democracies: 60 to 79, hybrid regimes: 40 to 59, and authoritarian regimes: 0 to 39: EIU (2015).

Per capita GDP, population, land area, and proportion of arable land: World Bank (2015).

Higher levels of democracy lead to higher levels of food security.

The relationship between the global food security index (GFSI) and the democracy index, on the one hand, suggests that higher levels of democracy are related to higher levels of food security, for example, in Japan and the Republic of Korea (Table 9.1). On the other hand, a low democracy index is associated with low levels of food security, for example, in the Democratic People's Republic of Korea and Pakistan.[1] However, there are cases where a country's higher level of democracy does not necessarily guarantee a higher level of food security. Similarly, a country's lower level of democracy may not necessarily restrict it from achieving higher levels of food security, such as Singapore, where institutional settings effectively curtail the level of corruption and ensure a decent social security safety net. Hence, apart from democracy, certain institutional aspects also need to be strong to influence a country's food security. One of these is the presence of strong institutions that deter corruption.

Higher degrees of corruption lead to lower levels of food security.

Table 9.1 shows that food security has a strong inverse relationship with a country's corruption. In countries with low degrees of corruption, the levels of food security are higher, such as in Israel, Japan, and Singapore. Otherwise, high degrees of corruption are associated with lower levels of food security, such as in the Democratic People's Republic of Korea and Bangladesh. This suggests that a country's corruption level can significantly affect a country's food security level. If a country has high levels of corruption, its food security is compromised.

Corrupt systems hurt food security in various ways. For example, when there is a lack of or no enforcement of food quality and safety regulations and legislation, low quality and unsafe food can become widespread in the market. Damage to the environment not only compromises the existing level of food security but also that of the future. Corruption leads to leaks and waste in the operation of public food distribution systems and to mismanagement of buffer reserves that undermines a country's food security in case of emergency. The poor suffer the most from the reduced level of food security due to

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[1] The GFSI is not available for the Democratic People's Republic of Korea, but its food security is low as shown in Chapter 6 of this book.

corruption. In corrupt systems, inequality and discrimination against the poor are common, trapping the poor in a vicious circle of poverty and chronic lack of economic access to food.

Inequality and poverty reduce a country's level of food security.

Inequality and poverty directly cause food insecurity among low-income groups through the lack of economic access to food. In Asian countries with low levels of food security, there is widespread inequality and high levels of poverty incidence. Inequality further reinforces poverty. Inequality and poverty are sources of social unrest. When a country suffers from social instability, food security also suffers.

It must be pointed out that although on the surface food insecurity is closely related to poverty, poverty itself, however, is not the fundamental cause of food insecurity. The fundamental causes as noted are serious inequality, corruption, and lack of democracy. The poor have continuously been taken advantage of by those with power and marginalized by corrupt systems, although a few voices defend their interests.

Investment in agriculture is key to improved food security.

Adequate investment in agriculture in general and in research and development (R&D) in particular are crucial to improving a country's food supply and thus promoting food security. Israel, Japan, and the Republic of Korea have benefited from investment in agriculture in their quest for better food security. In the case of Israel, investment in agricultural R&D is claimed to be the major factor in the higher level of food security.

The PRC has also benefited from increased investment in agriculture since the 1990s, in both infrastructure and R&D. This helped improve its agricultural total factor productivity, which in turn helped achieve sustained high grain output. Between 1990 and 2010, total agricultural production grew 4.5% in the PRC and 2.9% in India (ABARES 2014).

In the other countries included in this book with lower levels of food security, investment in agriculture has helped them raise their food output, for example, in Bangladesh and Indonesia. Otherwise, their food security level could have been much lower. However, their investment in agriculture has been insufficient.

How food production is organized has a significant impact on food security.

Since the end of World War II, the countries included in this volume have tried different farm production models. These models have had different, sometimes drastically different, impacts on food security.

- **Producing through cooperatives.** Some countries use cooperatives to help boost agricultural output. For example, in Israel, cooperatives are widely used. Farmers join or exit the cooperatives on a voluntary basis. These cooperatives are practical and effective. The PRC also used cooperatives, which proved effective during 1954–1956 when farmers could join the cooperatives voluntarily. Unfortunately, they were soon transformed into collectivized production.
- **Producing through highly collectivized arrangements.** The PRC started coercing farmers to produce through highly collectivized arrangements in 1957, whereby all farmers were forced to join the commune system in which farm production and many aspects of life were collectivized. The consequences were disastrous, resulting in vastly declined or stagnant food output. The return to traditional family-based production in the early 1980s saved the PRC as far as food supply is concerned. The Democratic People's Republic of Korea also uses a highly collectivized production model. Consequently, the country has been suffering from serious food shortages over the past decades. It has started to move away from such a highly collectivized model, but this process is slow and sometimes retreats. (In the Democratic People's Republic of Korea, the term "agricultural cooperatives" is used, but it actually refers to highly collectivized working units and not cooperatives.)
- **Producing through family- or household-based farming units.** This model has been most widely used. It has also proven to be the most effective in many societies. In the foreseeable future, family-based farming units are likely to dominate agricultural production in many countries.

Food procurement through administrative forces has almost always been a failure.

Several countries have tried to procure food through administrative forces and then distribute it through government channels. None of them succeeded. From 1953 to 1993, farmers in the PRC were forced to deliver

grain under the unified procurement system to the government through imposed quotas at government-set prices. It was one of the strongest disincentives to farmers to produce. The Democratic People's Republic of Korea also uses the same approach to make its farmers deliver grain to the government. The negative impacts on food production are similar to those in the case of the PRC. When food was in short supply after World War II, both Japan and the Republic of Korea forced their farmers to deliver to the government, often at low prices. However, both failed to gain cooperation from farmers. These two countries stopped using this method long ago when they discovered it did not work well, and in the meantime, their food supply has improved. In these countries, when government procurement was in place, black markets became active unless there was a serious crackdown by the government as in the PRC and the Democratic People's Republic of Korea.

The market has an important role in achieving food security.

From the experiences of the countries included in this book, it is clear that the market has an important role in helping a country achieve its food security. Whenever the market was not allowed to function, food shortage problems became further aggravated. Markets in the four more food-secure countries currently are allowed or even encouraged to participate in the operations of their food economy, although they were briefly controlled during food emergencies such as in Israel, Japan, and the Republic of Korea. In the PRC, whenever the market was not allowed to operate before the 1970s, food availability worsened. During several brief occasions when the controls were slightly relaxed, food supply always improved. When the market gradually became deregulated beginning in the the late 1970s, the PRC's food supply continued to improve. This is also the case in the Democratic People's Republic of Korea today, where the government has tolerated the operations of the market to some extent. Many markets have emerged in the country where residents can buy more food at higher prices. Many people have benefited from these markets, and it may become difficult for the government to revert to strict controls over them, although it wishes to do so.

It must be pointed out, however, that while the market is more efficient and effective in food distribution in peacetime, it may not work well during times of food emergencies. Therefore, during normal times, the market should be allowed to function freely. When a food crisis emerges, certain levels of government control can be justified.

Countries have handled food emergencies differently.

After World War II, when there were serious and devastating food shortages, Japan and the Republic of Korea resorted to imports to avoid catastrophic consequences. The PRC and the Democratic People's Republic of Korea, however, often did not import food at times when food was badly needed, leaving people to die (e.g., during the 1958–1962 famine in the PRC and during the mid-1990s famine in the Democratic People's Republic of Korea).

When famines were looming or occurring, the national and state governments of India worked together and acted quickly to bring the situation under control to minimize severe casualties to the citizens. The public was also able to voice their demands to the government to help those in need. In the case of other countries, the handling of famines has often been startlingly different. During the Great Famine in the PRC and famines in the Democratic People's Republic of Korea, the respective governments were often slow or took no action to help those in need. The Great Famine was nationwide and lasted for several years due to the lack of government action. Adding to the misery, those suffering were even deprived of the chance to survive by moving to other regions. Similarly, in the Democratic People's Republic of Korea, residents had few alternatives to resort to for survival.

During emergencies, many countries have used controlled food distribution, such as through food rationing, especially in urban areas. Japan and the Republic of Korea both resorted to rationing during food shortages but lifted the rationing soon after food supply improved. In Israel, during the austerity period, food rationing was used. However, its rations were abundant. Hence, controlled food distribution can be a useful tool in managing food scarcity during emergencies, as demonstrated in many other countries in similar situations such as the United Kingdom during World War II. The PRC and the Democratic People's Republic of Korea, used food rationing in the early 1950s to handle shortages at that time. However, this became part of their food management policy (as the other side of the compulsory food procurement) for decades. (In the PRC, the "unified distribution system" was abolished in 1993; in the Democratic People's Republic of Korea, this practice still exists.)

Countries use different approaches to handle food crisis information.

In some countries, the news of famine occurrences were not allowed to be publicized. During the 1958–1962 Great Famine in the PRC, the media was not allowed to publicize the food crisis, and local cadres

prevented the news from spreading by banning hungry people under their jurisdiction to beg in other areas (Yang 2008; Zhang 2013). The government also tried to hide the news from the international community (Yang 2008). In Indonesia, famines occurred frequently during the 1950s and 1960s with casualties in excess of 100,000, according to available statistics. However, these famines were not reported in the local media because local authorities feared being blamed for poor administration (Van der Eng 2012). Similarly, in the Democratic People's Republic of Korea, the media was not allowed to report famines.

In contrast, famines have been well publicized in India. During several severe food crises, the public was informed of the scope and depth of the famines. The public made use of such news to put pressure on the government to do more to assist those in need, even resorting to public protests. Protests during the Maharashtra Drought were also vividly reported in the media as Drèze and Sen noted, with many accounts of popular protests being reported in the columns of India's popular and influential *Economic and Political Weekly* (Drèze and Sen 1989). Drèze and Sen also attributed the zero death record of the severe Maharashtra Drought to "the affected populations themselves, which pressed their demands in numerous ways—including marches, pickets, and rallies .... As one labourer aptly put it, 'they would let us die if they thought we would not make a noise about it'" (Drèze and Sen 1989: 133).

Countries also handle food crisis prevention differently.

Given the high level of food security they have already achieved, the emphasis of food security management in Israel, Japan, Singapore, and the Republic of Korea today is more about the prevention of food insecurity. One key similarity in their insecurity prevention policies is that the governments take responsibility for ensuring food security, and the right to food of each individual is protected under law. Under this approach, these governments have also innovatively implemented measures to sustain their high levels of food security. In these four countries, there is a designated government agency that is in charge of the maintenance of the country's food security.

Japan's preventive approaches are worth mentioning again. As noted earlier, since the 1970s, the government has been exercising a high level of diligence and a high degree of innovation in devising preventive measures to ensure the country's food security, with the following examples.

- **Helping foreign agricultural development to encourage Japan's own food imports**. Brazil's increased capacity to produce and export soybeans due to the assistance of Japan

International Cooperation Agency notably increased global supply. This in turn significantly eased the upward import price pressure for Japan due to the PRC's emerging large volume imports of soybeans. Following the success of the Cerrado development in Brazil, Japan has begun another agricultural development program in the savanna area of Mozambique based on a tripartite cooperation including Brazil.

- **Inventing models to better understand global food demand–supply conditions**. Understanding and being able to forecast possible changes in global food demand and supply is important when a country has to use imports to manage its food supply and food security. Japan has devoted resources to develop, for the first time, a world food supply–demand model, which has also benefited similar models that were developed later (MAFF 2009).
- **Categorizing food security emergencies to act accordingly**. Food security emergencies have different severities. Handling emergencies without distinguishing the level of severity can be costly and less effective. Japan's categorization of a food security emergency according to the extent of the severity is sensible and valuable for other countries.

In India, famine prevention policies have been in place since its independence. The deployment of such policy measures has gone a long way in reducing mortalities during various famines. The fact that there were no deaths during the 1972 Maharashtra Drought is known for the successful utilization of famine prevention policies.

After the PRC was founded, there were no famine prevention measures in place. When the 1958–1962 Great Famine occurred, there were no measures to deploy. Much progress has been made in the PRC since the 1980s in terms of the preparedness for food emergencies, such as the building up of buffer stocks. However, it is still not clear whether the PRC has a coordinated, deployable, and effective mechanism in place to cope with any food emergencies.

Diversifying food import sources has attracted much attention.

Most countries included in this book rely on imports to ensure domestic food supply. Stable import sources are crucial for them—especially for those with very low food self-sufficiency ratios—to achieve and sustain their food security. These countries have realized and emphasized the

importance of diversifying the sources from which they import food. Some of them have also proactively invested in the food production of exporting countries to increase their sources of imports, e.g., Japan, the Republic of Korea, Singapore, and the PRC.

Investing in the food production of exporting countries is a valuable approach to secure sources of imports. However, such an approach might sometimes cause conflicts between investors and local residents or even induce resistance from locals. In this regard, Japan has moved one step ahead of others in diversifying its food import sources through two innovative measures. The first measure is to provide assistance to other countries to produce more food without the requirement of exporting the produced food to Japan. The second measurement is to encourage the private sector to actively expand into, and become more focused on, the later stages in the food supply chain (away from engaging in farmland purchase or crop production).

The latter approach is an important initiative. Farmers in exporting countries, especially in developed exporting countries like New Zealand and Australia, know how to produce well. Their major challenge is to find markets for their products. Japan's approach to help them diversify their sales destinations with a focus on Asia reduces the tension between locals and investors (avoiding the sensitivity of land acquisition or environmental protection issues due to the lack of local knowledge of requirements). Such an approach is likely to be welcomed by producers in exporting countries. It helps these producers produce and sell more while helping Asian countries gain more supply sources.

Regional cooperation is yet to receive more substantial endorsement.

Economies in today's world are highly integrated, which requires more cross-country cooperation. Most of the countries included in this study have made efforts to engage in regional cooperation to deal with any unexpected disruptions to their food supply. Currently, the Association of Southeast Asian Nations (ASEAN) Plus Three Emergency Rice Reserve is a major initiative in the Asian region. Indonesia, Singapore, the PRC, Japan, and the Republic of Korea are part of the initiative. Whether the initiative is capable of working to expectations is yet to be tested. It is believed that more substantial commitments are needed from member countries to make it a system that member countries can rely upon when in need.

Reducing food waste is on the agenda.

Food waste has been extensive in many countries from post-harvest to the table. Reducing food waste is equivalent to improving food availability or increasing production resources. While there is potential in reducing food waste between post-harvest and prior to the table, the potential of reducing waste at the dinner table is also enormous. In some cultures, food waste on the dinner table can be excessive, such as in the PRC and the Republic of Korea. Some countries have started making efforts to educate consumers on reducing or avoiding food waste. The PRC uses public media for this purpose. The Republic of Korea collects levies for treating food waste. Singapore has started working with stakeholders at various levels of the food supply chain to reduce post-harvest food waste.

9.3 Empirical Verification

The above comparisons and analyses indicate that many forces have affected food security in the countries in various ways. However, some of the forces are more fundamental than the others. For example, it has been widely held that investment in agriculture (including in important infrastructure, R&D, and extension and education) helps a country improve its agricultural total factor productivity and thus contribute to better food security. Then, why do some countries invest more, such as Israel and the Republic of Korea, while others, such as the Democratic People's Republic of Korea and Pakistan, invest insufficiently? It could be argued that, as we proposed in the beginning of this book, primarily and ultimately, institutions do matter. Therefore, adequate investment in agriculture is more likely to take place if a government is held accountable, its operations are transparent and efficient, and the business environment facilitates the market.

On the one hand, there are strong relationships between the GFSI and factors that reflect the quality of a country's institutions, such as the degree of corruption and the level of democracy (Table 9.1). On the other hand, there are no strong connections between the GFSI and resource and population variables. These inferences lend support to the propositions that we raised earlier that a country's food security may be more importantly affected by institutional factors but not affected by factors that are commonly held as important such as resource endowment and size of the population. It would be valuable if we can empirically verify such assertions. Fortunately, data are currently available to carry out such verification.

Based on the preceding argument, we formulate that the level of food security in a country is a function of the degree of corruption, level of democracy, level of income, resource endowment, and population size. That is,

Food Security = f (corruption, democracy, income, resource, population)

Data on the dependent variable of food security, GFSI, are obtained from the Economist Intelligence Unit. A corruption index (CPI) is available from Transparency International. A democracy index (DI) can be obtained from the Economic Intelligence Unit. Per capita gross domestic product (GDP) (PCGDP), per capita arable land (PCLAND), and country population (POP) are obtained or calculated on the basis of the data from the World Bank Open Data maintained by the World Bank. Per capita GDP is used as a measure of income and is converted to international dollars using purchasing power parity rates. Per capita arable land is used as a surrogate of resource endowment. It is calculated by using a country's total arable land area (in hectares) divided by its population.

Since the GFSI only started in 2012, consisting of 109 countries, and most other indicators are available until 2014, we were able to form a 109×3 panel dataset. GFSI, CPI, and DI are in percentages. PCGDP is in international dollars. PCLAND is in hectares. POP is in number of persons.

A linear form of the food security function within the generalized regression framework can be represented as follows:

$$GFSI_{it} = \beta_1 CPI_{it} + \beta_2 DI_{it} + \beta_3 PCGDP_{it} + \beta_4 PCLAND_{it} + \beta_5 POP_{it} + u_i + \varepsilon_{it} \quad (1)$$

where i denotes the i-th individual country and t denotes the t-th time period. Thus, $GFSI_{it}$ represents the t-th observation on the dependent variable for the i-th individual country. Assuming we have T observations on N individuals (country), the indexes will have i =1, 2, ..., N and t = 1,2,....., T. The β's are parameters to be estimated, u_i is the individual heterogeneity, which can be fixed or random, and ε_{it} is a random variable with mean zero and variance σ_ε^2.

CPI is expressed in percentages. If a country's corruption is perceived to be low, it has a high percentage; otherwise, a low percentage. Given this way of expression, CPI is expected to have a positive sign, meaning the lower the degree of corruption, the higher the GFSI. DI is also expressed in percentages. If a country has a high level of democracy,

Table 9.2 Estimation Results

	Coefficient	Z Score	P Value
Constant	0.8280	4.7100	0.000
lnCPI	0.0950	2.9600	0.003
lnDI	0.0886	2.6300	0.009
lnPCGDP	0.2437	24.6400	0.000
LnPCLAND	0.0013	0.1500	0.878
lnPOP	0.0120	1.6600	0.097

Source: Authors' estimation.

it has a high percentage; otherwise, it has a low percentage. DI is expected to have a positive sign. The income variable, PCGDP, is also expected to have a positive sign.

So far in this study, we have pointed out that resource endowment and population size, while important, are not fundamental determinants affecting the level of a country's food security. However, it has often been argued that they are important factors affecting food security. If such views are correct, we would expect that the coefficient of PCLAND (per capita arable land, representing natural resource endowment) would be positive and significant, and the coefficient of POP (total population of a country) would be negative and significant.

Following various tests for any existence of multicollinearity, heterogeneity, and the appropriateness of a fixed effect model and a random effect model, a random effect log–log model was estimated. A log–log model produces elasticities and helps reduce heterogeneity. After initial estimations, a likelihood ratio test is conducted to test for any remaining heterogeneity. Homogeneity was rejected by the likelihood ratio test. Thus, the model was re-estimated to obtain a heteroskedasticity-corrected consistent standard error. The results of the final model estimation are provided in Table 9.2. The R-squared of the model is 0.9255.

The findings from the econometric verification confirm that a country's food security is closely related to its institutional settings: the higher the level of democracy, the higher the level of food security; the lower the degree of corruption, the higher the level of food security. As expected, the level of income has a major bearing on a country's level of food security. When a country's income improves, its food security also improves. On the other hand, our results provide no support to the claims that food security is significantly affected by resource endowment

and population size. Although the per capita arable land variable has a positive sign, it is not statistically significant, suggesting it is not a factor that significantly affects the level of food security. For the size of a country's population, the sign was even contrary to many claims, although it is not statistically significant.

9.4 Summary

In this chapter, we compared the similarities, differences, experiences, and lessons of various Asian countries' efforts in pursuing food security. We also empirically verified whether some factors that are commonly held as important determinants of food security have significant impacts on the level of a country's food security. The findings of these investigations have valuable implications for Asian countries to improve their future food security. Before we draw any conclusions, however, the next two chapters will delve into two other important related areas: (i) how changes in the food demand and supply in the PRC and the Indian Subcontinent could affect their food security and food security regionally and globally, and (ii) what Asian countries can learn from countries on other continents to improve food security.

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PART III

Looking to the Future

10

Changes in Food Demand and Supply in the People's Republic of China and the Subcontinent: Impacts on Global Food Security

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10.1 Introduction

The People's Republic of China (PRC) and the Indian Subcontinent face formidable challenges in the quest for their future food security. On the demand side, their large and increasing population, rising consumer incomes, and growing urbanization will continue to increase total food consumption. In the meantime, changes in dietary patterns associated with rising income and urbanization will lead to increased demand for diverse and high-quality foods. On the supply side, limited and declining agricultural production resources with deteriorating quality, climate variability, and uncertain levels of agricultural investment will place pressure to further increase domestic food production. Hence, how their demand for, and supply of food, will change is important for their own future food security and also in other parts of Asia and globally. This chapter carries out simulations to examine how their food demand and supply may change in the future.

The major objectives of the simulations are to examine, under various scenarios[1], (i) the changes in the PRC and India's food demand and supply; (ii) how such changes will affect food markets in other regions and globally and to what extent; and (iii) the implications of

[1] The purpose of the scenario simulations in this study should not be used to characterize , interpret, or predict official policies or acts.

such changes for food security, regionally and globally by 2030 and 2050. The determination of 2030 is mainly due to a possible major change in the PRC's population: the PRC's total population will continue growing and is expected to reach its peak by the mid- or even early 2030s, after which it is expected to decline. The decline will complicate studies on the PRC's demand for food. It is useful and necessary to simulate the PRC's food demand when the population is expected to decline.

Before we get into details of the simulations, a brief overview of the PRC's and the Subcontinent's current food demand and supply and the key factors that affect their food demand and supply should be beneficial—this is the subject of Section 10.2. Section 10.3 gives details about the scenario design and associated assumptions. Section 10.4 explains the data used. Section 10.5 reports on the findings of the simulations. Finally, Section 10.6 provides conclusions.

10.2 Food Demand and Supply: Current and Future Scenarios

To provide a background to this chapter, this section highlights some key aspects of the current situation of food demand and supply in the PRC and India, and the major forces that are likely to affect their food demand and supply in the future.

Food demand and supply for major food items are summarized in Table 10.1. The per capita consumption of major cereals is comparable in these two countries. On average, the PRC people consume more soybeans than their Indian counterparts, while Indians consume more pulses. However, at the per capita level, the PRC consumes significantly more food of animal origin (except milk) than India. For most animal products, India's consumption is less than one-fifth that of the PRC. In the case of milk, however, India's consumption is 2.5 times of that of the PRC. India also consumes significantly more sugar than the PRC.

Consumption preferences partly explain the differences. Many Indians are vegetarians, although they consume milk and other dairy products. When consuming dairy products, adding sugar is customary in India, which is one reason for the higher sugar consumption. Pulses are a major source of protein for most vegetarian Indian consumers. Despite the differences in preference, it is true that the average consumption level in India is lower than that in the PRC. This indicates that if income levels in India continue improving, then the total food demand could experience some major increases in the future.

Table 10.1 Food Demand and Supply
(3-year average, 2011–2013; '000 tons unless otherwise indicated)

Panel A: The PRC

	Wheat and Products	Rice (milled equivalent)	Barley and Products	Maize and Products	Soybeans	Pulses	Sugar	Beef	Mutton and Goat Meat	Pork	Poultry	Eggs	Milk	Fishery Products
Production	119,972	135,378	1,654	206,467	13,079	4,531	15,644	6,609	4,007	50,813	17,795	28,495	41,337	55,301
Imports	3,607	1,714	2,270	3,413	58,074	957	3,928	169	155	721	509	0	6,006	9,445
Stock variation	1,357	–3,001	0	–9,253	0	0	–326			0			0	56
Exports	643	471	642	412	289	941	1,453	66	5	272	557	105	209	7,544
Total domestic supply	124,294	133,620	3,281	200,215	70,864	4,546	17,794	6,713	4,157	51,261	17,748	28,391	47,134	57,257
Feed	26,373	11,914	25	138,333	7,526	2,295							1,517	8,567
Seed	4,623	4,691	50	1,600	712	269						721		0
Waste	2,987	6,485	191	9,715	784	157						1,425	1,456	
Processing	188	0	2,797	6,381	56,768		8,353			21	2		0	
Other uses	2,874	1,969	9	34,544								484		1,867
Food	87,248	108,560	209	9,642	5,074	1,825	9,450	6,713	4,157	51,240	17,746	25,760	44,160	46,824
Food supply per capita (kilograms)	63.4	78.8	0.2	7.0	3.7	1.3	6.9	4.9	3.0	37.2	12.9	18.7	32.1	34.0
Net imports	2,964	1,243	1,627	3,001	57,785	16	2,475	103	150	449	-48	-105	5797	1901
SSR (%)	97.6	99.1	50.4	98.6	18.5	99.7	86.3	98.5	96.4	99.1	100.3	100.4	87.7	96.7
IDR (%)	2.9	1.3	69.2	1.6	82.0	21.0	21.7	2.5	3.7	1.4	2.9	0.0	12.7	16.5

IDR = import dependent ratios, SSR = self-sufficiency ratio.

continued on next page

Table 10.1 *continued*

Panel B: India

	Wheat and Products	Rice (milled equivalent)	Barley and Products	Maize and Products	Soybeans	Pulses	Sugar	Beef	Mutton and Goat Meat	Pork	Poultry	Eggs	Milk	Fishery Products
Production	91,755	105,586	1,678	22,437	12,943	17,554	33,785	2,557	755	358	2,312	3,652	131,978	7,979
Imports	20	7	20	14	1	3,613	771	0	0	2	0	0	196	50
Stock variation	−4,280	−1,667	0	0	−217		−126					0	0	0
Exports	4,331	8,961	242	4,595	148	264	3,083	1,214	15	0	7	72	1,035	1,037
Total domestic supply	83,163	94,966	1,456	17,856	12,579	20,903	31,347	1,343	741	359	2,304	3,580	131,139	6,992
Feed	1,893	2,112	152	6,734		1,835	286						21,731	272
Seed	3,004	2,164	94	983	693	935						149		
Waste	5,505	3,519	34	2,244	583	690						366	4,688	
Processing	0	366	108	0	10,961		6	0		0				
Other uses				36			2,654						14	409
Food	72,763	86,806	1,068	7,859	342	17,442	28,401	1,343	741	359	2,304	3,067	104,706	6,310
Food supply per capita (kilograms)	58.8	70.2	0.9	6.4	0.3	14.1	23.0	1.1	0.6	0.3	1.9	2.5	84.7	5.1
Net imports	−4,311	−8,954	−222	−4,581	−147	3,349	−2,312	−1,214	−15	1	−7	−72	−839	−987
SSR (%)	104.9	109.3	115.3	125.7	101.1	84.0	107.3	190.4	102.0	99.6	100.3	102.0	100.6	114.1
IDR (%)	0.0	0.0	1.4	0.1	0.0	17.3	2.5	0.0	0.0	0.5	0.0	0.0	0.1	0.7

IDR = import dependent ratios, SSR = self-sufficiency ratio.

Source: FAO (2015).

Currently, food supplies in both the PRC and India are sufficient. The PRC net imports food from the world market, while India net exports. For the three major cereals, i.e., wheat, rice, and maize, in 2013 the PRC's self-sufficiency ratio (SSR) was 98%, while India's was 112%. For meat (beef, mutton and goat, pork, and poultry), the PRC's SSR in 2013 was 99%; India's was 136% due to its larger output but lower consumption.[2]

India's higher food SSR has puzzled many people given that (i) its total food output was much lower than that of the PRC, (ii) its population is similar to the PRC, and (iii) it net exports food. Although the export quantity may be small, it would only make per capita food consumption even lower. The differences in dietary preference may be partially responsible for this.

In 2013 (3-year average of 2012–2014), the number of people undernourished in India was still large (FAO 2014). The effective demand for food by such a low-income population is low. Otherwise, India might have had no need to net export food, and its food SSRs would have been lower. As such, a country's food SSR is useful to gauge a country's overall food demand–supply situation, but it is hardly indicative of a country's food security status.

Historical changes in SSRs and import dependent ratios (IDRs) for major food items in the PRC and India are given in Figure 10.1. India had some major shortages of soybeans in the 1960s and wheat in the 1960s and 1970s. Since the 1980s, SSRs for all major food items has been around 100% or greater, e.g., beef and maize. In recent years, India has also exported rice and, occasionally, barley. In the PRC, there have been some interesting developments in terms of food SSRs. The wheat SSR used to be relatively low compared with other major food items. It remained between 80% and 95% for most of the years until 1997 when it reached 99% for the first time. Since 1997, the wheat SSR fluctuated around 100% (being above 100% during 1997–2013), but by 2013, it again dropped to 96% (chiefly due to increased wheat imports for feed purposes to substitute higher-priced maize in 2013). The decline in the SSRs of soybeans and barley is remarkable. The PRC used to be largely self-sufficient in both of these items, but in 2013, the SSR had dropped to 49% for barley and 16% for soybeans (protection

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[2] The SSR is equal to domestic production divided by the sum of domestic production plus net imports. If a country's net import is negative, i.e., it net exports a product, this product's SSR will be greater than 100%. The import dependent ratio (IDR) is equal to imports divided by the sum of domestic production plus net imports. If a country does not produce a product or produces very little but imports a large quantity for both domestic consumption and for re-exports (after processing), this product's IDR can be greater than 100%. The sum of SSR and IDR does not have to add up to 100.

was removed for these two crops after joining the World Trade Organization in late 2001). For all other major food items, the SSRs have all dropped to below 100% in 2013 (rice, 98.8%; maize, 98.6%; beef, 94.9%; lamb and mutton, 94.1%; pork, 99.0%; and poultry, 99.9%). However, it must be noted that currently the PRC is not short of major cereal crops, i.e., wheat, rice, and maize. Increased imports of these crops in recent years are due to lower world prices but higher prices of domestic products resulting from price support.

How the PRC's and India's food supply and demand will change depends on many factors. Some important factors are elaborated below.

- **Population change.** The PRC's total population will continue to increase until around the early or mid-2030s and is then expected to start declining. Between 2030 and 2050, whether the PRC's population decline will lead to reduced total food demand depends on two major offsetting effects: (i) decline in the demand for food due to a smaller population, and (ii) increase in per capita demand for food due to higher incomes.[3] From now until 2050, India's total population will continue to increase although at a decreasing rate, resulting in a higher total demand for food.
- **Income growth and distribution.** Average consumer incomes will continue to improve in both countries. Nonetheless, the PRC's income level is likely to remain higher than India's. In general, nutritional needs have been largely met for most of the PRC. For the PRC, income improvement is likely to have a greater impact on the composition of food demanded but less on the total quantity of food demanded. In the case of India, improved consumer incomes will lead to higher effective demand, which will initially have a greater impact on the quantity demanded and later an increasing impact on the composition demanded. Income distribution in the meanwhile will also affect the demand for food.
- **Rate of urbanization.** Both countries will experience further progress in urbanization. Urbanization has an important impact on dietary preferences. Increased urbanization will result in increased demand for food (not food grain) and for food of greater diversity and higher quality. Such a change in demand will have an impact on the source of supplies and require improved supply chain management.

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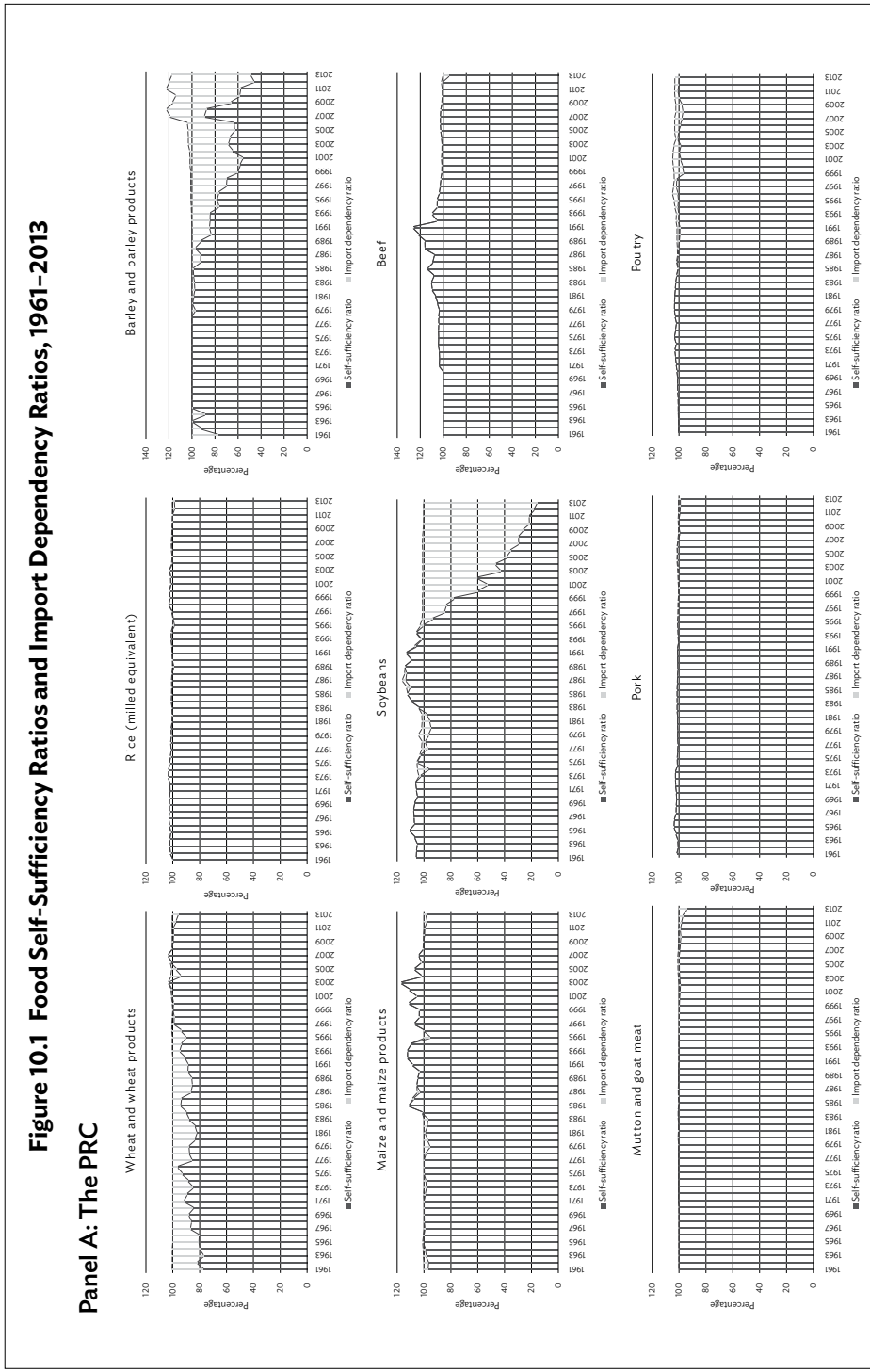
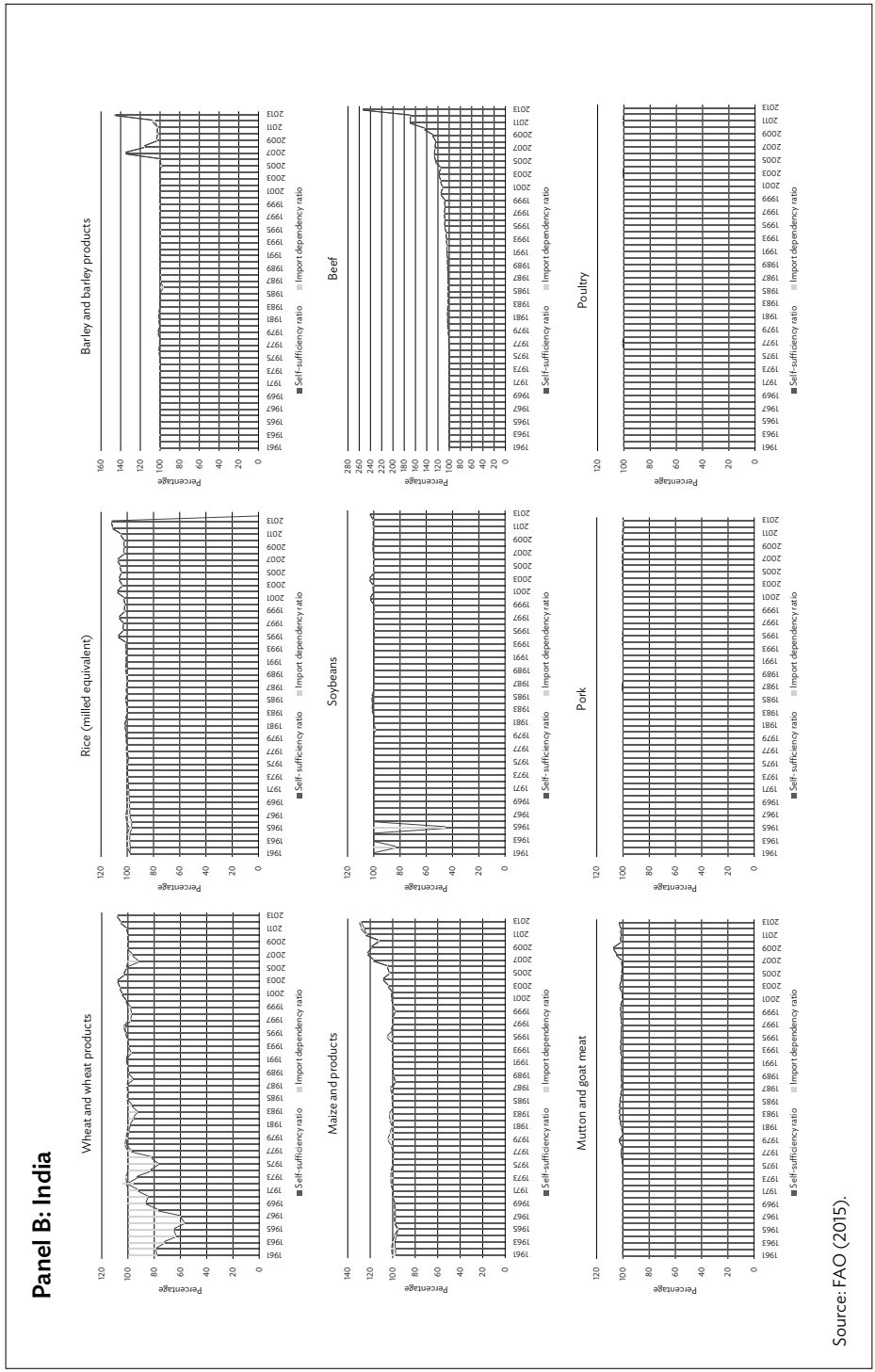
[3] Large-scale population aging in the PRC will impact dietary patterns of this population and hence the composition of food demanded in the future.

Figure 10.1 Food Self-Sufficiency Ratios and Import Dependency Ratios, 1961–2013

Panel A: The PRC





Source: FAO (2015).

- **Protection of natural resources and the environment.** At the per capita level, both countries' production resources are scarce and a large portion of such resources has been overused or has deteriorated due to environmental causes. To reduce or stop environmental effects and to rehabilitate the resources for sustainable use are important for future food security. Ensuring this, however, will have an impact on the current capacity to produce.
- **Climate variations.** How the climate will change locally and globally is hard to predict. Nonetheless, it has become widely accepted that global warming is taking place. Global warming alone can potentially cause many uncertainties for food production in the future. Food production in both countries is subject to challenges resulting from future climate variations.
- **Investment in agriculture.** Investment in agricultural infrastructure and in research and development (R&D) is vital to improving total agricultural productivity. Future food production increase will have to primarily rely on yield improvements resulting from progress in R&D and improvements in agricultural infrastructure. How much each country will invest in agriculture and how they can ensure such investment is most effective will be vital to their food production increase and thus food security.
- **Global trade liberalization.** Both countries will need to use trade to manage their domestic food supply. A freer global trade regime for agricultural products will be conducive to all countries in their management of domestic food supply. On the other hand, pressure from overseas competition will be tougher for farmers in both countries, especially if global prices decline. Farmers of both countries should look for new ways to sustain their livelihood. It is hard to predict how trade liberalization will progress in the near future.
- **Economic growth and industrial adjustments.** When the economies of both countries further grow, the competition for resources between the agricultural sector and other sectors will become more severe. Opportunity costs of agricultural production will increase. The PRC and India will have to deal with the increasing needs of adjusting their macroeconomic structure so that they can best capitalize on the comparative advantages of different industries but, in the meantime, do not unnecessarily disadvantage their agricultural production.

- **Food waste reduction.** There is significant potential for the PRC and India to reduce food waste. Waste reduction is equal to an increase in supply. Food waste can be reduced at the dining stage, especially in the PRC. If the supply chain is better managed, there could be less food waste between post-harvest and prior to the table. Better food processing technologies will also improve food utilization and reduce wastage.

10.3 Scenario Design

10.3.1 Simulation Focus

In addition to the above-mentioned forces, many other factors can also affect food demand and supply. Over a longer time span such as from 2015 to 2050, forces that will impact the PRC's and India's food demand and supply are even more uncertain and complex. In fact, for shorter-term projections (e.g., 10 years), influential forces may change frequently, as reflected in the work of several leading bodies such as the United States Department of Agriculture (USDA 2015), the Organisation for Economic Co-operation and Development and the Food and Agriculture Organization (OECD–FAO 2015), and the Food and Agriculture Policy Research Institute of Iowa State University (FAPRI–ISU 2012). Taking too many forces into consideration in a simulation exercise is difficult. In our study, the key variables included in the simulation of baseline scenarios include population change; availability of key factors of production (i.e., skilled and unskilled labor force, arable land and other natural resources, and capital); global trade reform, including tariff reductions, domestic support, and export subsidies; efficiency change in the agricultural sector such as the use of factors of production; efficiency change in other sectors of the economy; and income growth.

Among these, the more important forces in the PRC and India are population changes, income changes, and possible changes in agricultural productivity.

Population changes. Both countries have huge populations, being the largest and second-largest in the world, accounting for 36.5% of the total world population. Changes in their populations will have important impacts on the demand for food, which in turn may affect their food trade. Population growth prospects in the two countries will, however, differ to a great extent.

The PRC had a high rate of population growth between 1963 and 1974 of over 2% per annum. Family planning policies has caused the

growth rate to decline since 1975. In the first few years of the 2010s, the rate was around 0.5%. If current trends continue, the growth rate will become negative by about the early 2030s. However, the One Child Policy has recently been abolished, and any family is now allowed to have two children. It is yet to be seen how this will affect the population.

India's population growth used to be very high, at a rate of over 2% per annum before the 1990s. Since 1992, it has gradually slowed. Nonetheless, it has still been around 1.3% in the past few years. It is forecast that the growth rate will continue to decline in the decades to come but may remain around 1%.

The population growth rates used in the simulations are based on the rates given in Table 11.2. The forecast rates for 2015–2050 are based on *World Population Prospects: The 2012 Revision* by the Population Division of the United Nations (UN 2013). The annual average growth rate between 2011 (the Global Trade Analysis Project [GTAP] Data Base reference year is 2011) and 2030 is derived by using the 2015–2030 forecast rate and the actual rates of 2010–2014. The simulations in this chapter focus only on changes in the total population. Changes in other aspects related to demography such as aging, changes in family size, and urbanization are not incorporated in the simulation.

Income growth. Income is the most important force affecting food demand. Both countries have experienced impressive fast income growth in the past few decades, which has played a major role in driving up demand for more food with greater diversity and higher quality. The gross domestic product (GDP) growth rate will be used to represent income changes in the simulations. The average annual GDP growth was around 6.5% in India between 2010 and 2014 compared with 8.5% in the PRC over the same period (World Bank 2015; IMF 2015). The PRC's GDP growth is expected to gradually become slower in future years. There is uncertainty in the direction of India's growth in the short run. It could go notably either higher or lower than the current rate, and it is hard to predict when this might happen. However, when the size of the Indian economy further expands, it is generally expected that its growth will slow over the longer term. As noted earlier, income distribution is also important in affecting food demand, i.e., whether the growth is inclusive and poverty alleviating. This aspect is not taken into consideration in the simulation.

Available GDP growth rate forecasts for India and the PRC until 2050 are limited. The long-term forecasts for the PRC's and India's growth rates until 2050 by the Hongkong and Shanghai Banking Corporation (HSBC) (2012), Lu and Cai (for the PRC only, 2014),

and Trading Economics (2015) are given in Table 10.2. Some other organizations also provided forecasts but only for limited years or periods. For example, PricewaterhouseCoopers forecast that by the 2040s, the PRC's GDP growth rate will be around 4% per annum (PWC 2013).[4]

For the simulations, a medium annual GDP growth rate is first worked out for each country for 2015–2030 and 2030–2050 based on the sources as shown in Table 10.2. As in the case of population, the actual rates of 2010–2014 are used in the calculation of the average GDP growth rates for 2011–2030. For the low and high growth rates of GDP for 2011–2030 and 2030–2050, a one-percentage point variation is applied to the medium rates—i.e., for a lower/higher GDP growth, one percentage point is taken away from or added to the medium rate. The use of a one-percentage point is based on our judgment and is arbitrary. In our simulations, GDP growth was treated as an endogenous variable.

Changes in agricultural productivity. Investment in agriculture, especially in R&D, education and extension, and key infrastructure helps raise a country's agricultural productivity. Higher productivity will bring about higher output, increasing food supply in the country. The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) showed that total agricultural production in India grew by 2.9% a year between 1990 and 2010 compared with 4.5% in the PRC over the same period. According to ABARES, difference can be partly attributed to slower productivity growth in India (ABARES 2014a). An improvement in total factor productivity (TFP) is often seen as the real driver of economic growth. Technology growth and efficiency are regarded as the two biggest components of TFP. Increased agricultural investment improves these two components, hence improving agricultural TFP.

According to Fuglie (2012), India's average annual agricultural TFP growth was around 1.6% between 1991 and 2009 compared with 3.5% in the PRC over the same period. Recently, ABARES projected that between 2009 and 2050, the PRC's agricultural TFP growth will average 0.97% a year (ABARES 2014b). For India, it will be 2.7% (ABARES 2014a). The projected agricultural TFP growth by ABARES for both the PRC and India seems to be on the high side.

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[4] Extensive efforts were made to locate various growth forecasts produced by sources in India and the PRC. We were only able to obtain GDP growth rate forecasts for the PRC from two PRC researchers (Lu and Cai 2014) who examined how the changes in population structure could affect future GDP growth.

Table 10.2 Population and GDP Growth in India and the PRC, Actual and Forecast

	2010	2011	2012	2013	2014			
Population Growth: Actual and Forecast								
World Bank								
PRC	0.483	0.479	0.487	0.494	0.506			
India	1.374	1.328	1.286	1.251	1.227			
UN							**2015–2030**	**2030–2050**
India (high)							1.251	0.880
India (medium)							0.939	0.464
India (low)							0.607	0.027
PRC (high)							0.517	0.162
PRC (medium)							0.241	-0.241
PRC (low)							-0.051	-0.652
Economic Growth: Actual and Forecast								
IMF	**2010**	**2011**	**2012**	**2013**	**2014**	**2015F**		
India	10.26	6.64	4.74	5.02	5.63	6.40		
PRC	10.41	9.30	7.65	7.70	7.38	7.10		
World Bank								
India	10.3	6.6	4.7	5	5.6	6.40		
PRC	10.4	9.3	7.7	7.7	7.4	7.10		
OECD								
India	11.1	7.8	4.9	4.7	5.4	6.39		
PRC	10.4	9.3	7.7	7.7	7.3	7.14		
HSBC		**2010–2020**		**2020–2030**		**2030–2040**		**2040–2050**
India		5.7		5.6		5.5		5.2
PRC		6.7		5.5		4.4		4.1
Trading Economics		**2020**		**2030**				**2050**
India		6.8		5.5				4.5
PRC		5.0		3.0				3.33
Lu and Cai	**2011–2015**	**2016–2020**	**2021–2025**	**2026–2030**	**2031–2035**	**2036–2040**	**2041–2045**	**2046–2050**
PRC	7.72	6.58	5.78	5.34	5.16	4.8	4.39	4.04

HSBC = Hongkong and Shanghai Banking Corporation, IMF = International Monetary Fund, OECD = Organisation for Economic Co-operation and Development, PRC = People's Republic of China, UN = United Nations.

Sources: UN (2013); IMF (2015); World Bank (2015); OECD (2015); HSBC (2012); Trading Economics (2015); Lu and Cai (2014).

In our simulations, the TFP for the two baseline scenarios are determined by what is needed to achieve the pre-set GDP growth. The same TFP improvement is applied to all economic sectors to avoid one sector having an unjustified comparative advantage over the other sectors. For the 2011–2030 baseline scenario, the TFP improvement for the PRC and India is 16.7% and 22.8%, respectively. On a per annum basis, the TFP improvement is approximately 0.9% for the PRC and 1.2% for India.

For the best or worst scenario, only the TFP for the agricultural sector changes by a further 10 percentage points. This means, compared with other sectors, there will be a preferential extra investment or lack of it in the agricultural sector. Hence, for the best scenario, the annual TFP is 1.41% for the PRC and 1.73% for India; for the worst scenario, it is 0.35% and 0.67%, respectively. Hence, the TFP in our simulations is lower than the ABARES estimates, especially for India.

10.3.2 Scenarios to Simulate

Three scenarios are simulated in this study: the baseline scenario, the best (most optimistic), and the worst (most pessimistic). ("The best" and "the worst" are from the perspectives of improving agricultural supplies, not of improving the overall national welfare). The baseline scenario assumes the population and GDP will grow at the medium rate, and the rate of TFP is the one that is needed to achieve the medium rate of GDP growth. Based on the baseline scenario, the two extreme scenarios—the best and the worst—are simulated. For the best scenario, the population will grow at low rates, and the GDP will increase at high rates as suggested in Table 10.2; the agricultural TFP will have extra improvement (10 percentage points extra). For the worst scenario, the opposite is true.

Many other scenarios are also possible. However, simulating more than the above-mentioned three scenarios would generate limited extra value. Any other scenario will be just one of the many possible scenarios between the best and the baseline scenarios or the worst and the baseline scenarios. It is noted that under the best (most optimistic) scenario, the impacts of faster income growth and slower population growth (or population decline) on food demand would offset each other to some extent. In the meantime, food supply would be expected to improve due to favorable technological progress. In balance, food security would improve in general under the best scenario. The worst scenario is the one to avoid. However, it is unlikely that both the PRC and India will fall into the worst scenario at the same time.

As with any simulation work, certain assumptions are essential.[5] One assumption is about possible future changes in the area of arable land, which is the most crucial resource for food production. Based on historical changes in arable land areas in the 2015 World Development Indicators Database (World Bank 2015), possible future changes are assumed for different region groups (Table 10.3). These assumptions are reflected in the simulations by bringing shocks of varying values for the arable land variable.[6]

Similar to the arable land variable, assumptions are also made for other key variables in the simulations. Key assumptions for simulated scenarios are given in Table 10.4. When simulating the best and worst scenarios, all the assumptions for the baseline scenarios for the PRC, India, and all other regions in the world do not change. This helps to isolate and examine the impacts resulting from changes in the economy, population, and agricultural TFP of the PRC and India on food demand and supply under the same broad national and global conditions.

It is noted that in Table 10.4, there are assumptions for the 2030–2050 baseline scenario only. Two major answers we intend to derive from the simulations are (i) whether the trend in 2030–2050 would be vastly different from that in 2011–2030, and (ii) whether the simulation results of the best and worst scenarios would be vastly different from those of the baseline scenario. From long-term perspectives, around 2030 will be the turning point for the PRC's population growth. It will also be most likely that its economy will enter into a period of slower growth. As such, if there are no major disruptions in the PRC's food demand and supply by 2030, threats to its own and global food security will reduce significantly. Our simulations of two time periods, 2011–2030 and 2030–2050, help us to obtain the first answer. The simulations of the best and worst scenarios provide the second answer. For 2030–2050, the likely directions and magnitudes of scenario changes on food demand and supply are not expected to be drastically different from those for 2011–2030. It is unlikely that we would gain any extra valuable information if further simulations of the best and worst scenarios for 2030–2050 were carried out.

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[5] It goes without saying that all of these assumptions and estimates are only the personal views of the chapter authors and may prove accurate wholly or in part. They are posited purely for the academic purpose of scenario simulations and can never be used to characterize , interpret, or predict official policies or acts.

[6] Details about shock values for arable land and all other variables can be obtained from the authors.

Table 10.3 Possible Changes in Arable Land Area by Region or Group, 2011–2050

Region	Region Name	Including	Assumptions[a]
1	PRC	PRC	Total arable land area will decline but at a rate lower than before; the decline will continue at a gradually decreasing rate; will take measures to improve land use efficiency in order to cope with land scarcity.
2	Indian Subcontinent	India	Arable land area will decline; it will decline at a pace slower than the PRC's in the early years of the simulation period (2011–2030); it will decline at a pace greater than the PRC's in the latter years (2030–2050) due to urbanization and industrialization; will take measures to improve land-use efficiency in order to cope with land scarcity.
3	Major East Asian food importers	Japan; Republic of Korea; Singapore; Taipei,China; and Hong Kong, China	Arable land will continue declining at a rate lower than before; over time, the decreasing rate will become lower and lower.
4	Other countries in East Asia, Southeast Asia, and South Asia	Mongolia, ASEAN excluding Singapore, excluding India	Different patterns have existed—some countries' arable land area has increased (e.g., Indonesia and Thailand) but that of others has dropped (e.g., Pakistan). Overall, arable land area in this region will continue increasing but at a decreasing rate.
5	Major food exporters	Australia, New Zealand, Argentina, Brazil, US, and Canada	Brazil's arable land will continue increasing but the US's will decrease. Overall, total area in this region will continue declining but at a decreasing rate.
6	Africa	All African countries	Total arable land area in this region will continue decreasing but at a decreasing rate.
7	Western and Northern Europe	EU25 and countries in Northern Europe	Arable land area in this region will mostly stay the same.
8	Others	All the rest (West Asia, East Europe, and other Latin American countries)	Total arable land area in this region will decrease very slowly and the rate of decline will hardly change.

ASEAN = Association of Southeast Asian Nations, EU = European Union, PRC = People's Republic of China, US = United States.

[a] It goes without saying that all of these assumptions and estimates are only the personal views of the chapter authors and may prove accurate wholly or in part. They are posited purely for the academic purpose of scenario simulations and can never be used to characterize , interpret, or predict official policies or acts.

Sources: Based on GTAP (2015), and information from the World Bank and FAO.

Table 10.4 Scenario Assumptions

Scenario	Assumption
2030 baseline	• Population, labor force, natural resources, and capital increase at varying rates; arable land decreases at varying rates • Multilateral trade negotiations lead to increased global trade; tariffs and domestic supports are reduced by 30% in economically developed regions (major East Asian food importers, Western and Northern Europe, and major food exporters) and by 20% in all other regions; export subsidies are reduced by 50% in all regions (the impacts of growing free trade agreements, bilateral or regional, are too complicated to simulate and are not attempted) • The PRC and India improve their efficiency in the use of arable land, skilled and unskilled labor, and capital (due to institutional reforms or favorable policies) • The PRC and India improve their efficiency in the use of natural resources in their fishery industries • The PRC; India; and other countries in East Asia, Southeast Asia, and South Asia encourage private consumption (policy adjustments as required to manage the macro economy)
2030 best scenario (based on the 2030 baseline scenario)	• Lower population; lower unskilled labor force • Slower decline in arable land due to more effective control • Higher agricultural technical efficiency (favorable policies) • Technical efficiency in nonagricultural sectors also improves
2030 worst scenario (based on the 2030 baseline scenario)	• Higher population; higher unskilled labor force • Faster decline in arable land (increased use for nonagricultural purposes) • Lower agricultural technical efficiency (less favorable policies) • Technical efficiency in nonagricultural sectors also declines
2050 baseline (based on the 2030 baseline scenario)	• Total population in the PRC declines; population increase in India slows • Labor participation rates in the PRC and India hold constant, but the proportion of skilled labor force continues to rise • Arable land declines at a faster rate in other countries in East Asia, Southeast Asia, and South Asia; arable land area remains unchanged in Western and Northern Europe; arable land declines in all other regions but at a slower rate • Capital increase is faster in India and Africa, slower in the PRC, and similar to the rates of 2011–2030 for all other regions • Natural resources increase at a rate similar to that of 2011–2030 • No further trade policy reforms • The PRC and India improve their efficiency in the use of arable land, skilled and unskilled labor, and capital (due to institutional reforms or favorable policies) • The PRC and India improve their efficiency in the use of natural resources in their fishery industries (favorable policies to avoid excessive price rise of fishery products) • The PRC; India; and other countries in East Asia, Southeast Asia, and South Asia encourage private consumption (policy adjustments as required to manage the macro economy)

PRC = People's Republic of China.
Source: Compiled by authors.

10.4 Data

Data are from the GTAP Data Base (GTAP 2015). This database represents the world economy and is utilized by many researchers as a key input into contemporary applied general equilibrium analysis of economic issues of global significance. The latest release of the database features 2004, 2007, and 2011 reference years as well as 140 regions for all 57 GTAP commodities. In our simulations, the reference year is 2011.

The data were first aggregated into region and commodity groups. All countries and regions are placed into regional groups. Any notable changes in the population, income, and TFP in the PRC and India will lead to changes in their domestic food demand–supply equilibriums and also their broad macroeconomic structure. Through trade, such changes will impact the global food market and general economy. The impacts will, however, be different for different countries and/or regions, depending on whether (i) they are net food importers or exporters, (ii) they are affluent or poor, and (iii) and they are geographically close to the PRC and India. Regions such as East Asia, Southeast Asia, and South Asia are likely to be affected by changes in the PRC and India to a greater extent. There have been concerns that increased food imports by the PRC and the Indian Subcontinent may raise world prices. In the long run, the question as to whether they will need to significantly increase their food imports remains not clearly answered. To date, with the exception of soybean imports into the PRC, the share of the PRC's and India's food imports out of the total world trade has been small, with India actually net exporting some cereal foods. If their entry to the world market causes a price hike, the resulting impact on food security is likely to be smaller for a wealthier food-importing country but larger for a poorer food-importing country. To examine the likely different impacts on different countries and/or regions, the world is divided into eight groups (as shown in Table 10.3).

We aggregated the 57 GTAP commodities into 12 groups (Table 10.5). Commodities from agricultural industries are less aggregated and placed into nine groups, enabling us to examine the changes in those major agricultural products. Commodities from all other industries are placed into three groups: mining, manufacturing, and service and others (Table 10.5).

10.5 Findings

10.5.1 Baseline Scenarios

If the economies in the PRC and India grow according to the anticipated trends, household demand for agricultural products will experience a

Table 10.5 Commodity Aggregation

Group	Group Name	Including
1	Rice	Paddy, processed rice
2	Wheat	Wheat
3	Other cereals	Other cereals
4	Vegetables	Vegetables, fruit (fresh and dried)
5	Cash crops	Oil-bearing crops, sugarcane and sugar beet, fiber crops, and other cash crops
6	Animals and animal products	Cattle, sheep, and horses; other animals; wool and silk cocoon; beef, lamb, and horse meat; meats of other animals
7	Milk	Raw milk, processed dairy products
8	Aquatic products	Aquatic products
9	Other processed food of agricultural origin	Vegetable oil, sugar, other processed food, beverages, and tobacco
10	Mining	Forestry, coal, petroleum, natural gas, and other mining activities
11	Manufacturing	Textiles, leather, paper, plastic, steel and iron, refining, chemicals, and all other manufacturing activities
12	Services and others	Transport, trade, financing, and all other services

Source: Based on GTAP (2015).

major increase by 2030 compared with the demand in 2011. Table 10.6 shows that the total consumption of all major food items in 2030 will increase by 50% or even higher.[7] The increase in the consumption of food of higher value, such as animal products, dairy products, and processed food is much faster in both countries. India is also likely to have a faster increase in the consumption of aquatic products (due to its low per capita annual consumption of 5 kilograms [kg] in 2011 compared with the PRC's 34 kg; Table 10.1). On the other hand, in both countries,

[7] A few limitations are noted. The income elasticities of demand for foods in the GTAP Data Base are probably slightly overstated. The elasticities would be high for low-income consumers. However, after consumers' basic food needs are met and when their income continues to increase over time, the income elasticities of demand for most food items would decline. Serious food waste at the consumption stage, especially in the PRC, exists. Policies that discourage such waste can lead to a lower demand for food in the future. Given these limitations, it may be possible that food demand in the longer term could be lower, especially in the PRC.

Table 10.6 Change in Food Demand, Supply, and Prices in 2030 (2011 as the base period)

	PRC			India			World		
	Household Demand (%)	Domestic Supply (%)	Supply Price (%)	Household Demand (%)	Domestic Supply (%)	Supply Price (%)	Total Supply (%)	Export Price (%)	Import Price (%)
Rice	52.3	56.5	28.5	79.2	62.2	–8.1	45.3	–3.2	–15.2
Wheat	52.8	39.7	24.0	74.6	43.8	4.7	45.2	1.9	–4.3
Other cereals	57.5	68.4	43.9	68.1	59.4	39.6	54.7	11.0	–3.7
Vegetables and fruit	46.4	58.0	58.5	66.1	48.1	57.8	48.9	23.7	–1.1
Cash crops	89.2	-6.1	23.7	67.4	53.0	42.8	50.1	12.3	1.1
Animal products	96.8	71.0	15.2	95.6	59.8	9.8	63.4	–16.5	–27.0
Milk	115.5	56.3	–13.5	93.5	82.5	14.6	54.4	–24.8	v29.2
Aquatic products	77.6	72.9	60.6	98.2	91.4	0.7	53.8	41.1	3.0
Other processed foods	96.5	77.8	–12.9	99.4	73.4	–16.4	57.4	–26.6	–28.9

PRC = People's Republic of China.

Source: From simulations using GTAP (2015).

the increase in domestic supply will be lower than that in consumption for most food items. The PRC's ability to produce cash crops (which include soybeans) will also decline.

Constrained by their limited natural resources and the global market environment, the prices of all factors of production except capital will increase in both countries. The price of capital is likely to decrease to some extent on the assumptions that the savings rate will continue being high and that there will be continued high inward foreign direct investment. Among other factors of production, the price of arable land and other natural resources will experience a major increase. In the meantime, the prices of most food items supplied will increase at varying degrees (Table 10.6). At the global level, the total supply of food will increase as well. Changes in world prices of imports and exports are mixed. However, import prices of most food items in the world market will be lower (Table 10.6). Given the higher global supply but lower import price, food import prices for both the PRC and India will also be lower in 2030 (Table 10.7). Table 10.7 also shows that both countries' food imports will increase at a fast pace but exports will drop compared with 2011.

Table 10.7 Changes in Food Trade in 2030 (2011 as the base period)

	PRC			India		
	Import Price (%)	Import Quantity (%)	Export Quantity (%)	Import Price (%)	Import Quantity (%)	Export Quantity (%)
Rice	–10.6	1,284.6	–64.3	–17.6	510.9	46.2
Wheat	0.2	828.0	–78.3	–11.1	904.1	18.4
Other cereals	–2.5	217.0	–21.3	2.6	226.8	25.4
Vegetables and fruit	13.3	356.5	–19.8	7.0	346.0	–28.4
Cash crops	1.4	197.1	8.8	6.9	724.8	–47.6
Animal products	–27.6	1,286.3	–88.1	–26.8	1,106.2	–74.5
Milk	–30.4	714.3	13.1	–29.7	2,277.9	–87.1
Aquatic products	7.8	274.7	–32.3	43.0	62.2	196.1
Other processed foods	–28.7	288.8	7.1	–27.0	237.6	33.8

PRC = People's Republic of China.
Source: From simulations using GTAP (2015).

From 2030 to 2050, it is anticipated that economic growth will become slower in both countries. Major changes in the total population and population structure will also take place. The PRC's total population will start declining. On the other hand, India's total population will probably continue increasing and will overtake the PRC to become the most populous country in the world. By 2050, the PRC's and India's food consumption will have grown compared with the 2030 level but at a slower pace than 2011–2030 (Table 10.8). Overall, the increase in private consumption in India is greater. This is not surprising. In the PRC, basic food needs in terms of quantity will have been largely met. On the other hand, food intake in India has been lower, especially among low- and middle-income consumers, and there is a need to increase their food intake. In addition, India is expected to have a higher total population by 2050, adding to the demand for more food. Moreover, Indians' disposable incomes will also increase, so they can afford more food. Domestic food supply in both countries will also increase and at a rate faster than the increase in consumption for most of the food items.

In the meantime, the price of arable land and other natural resources will continue increasing in both countries, and the price of capital will continue decreasing. Due to a relatively faster increase in the supply of skilled labor, its price will drop. Unskilled labor prices will increase at a very low rate. In balance, due to the faster increase in the prices of arable land and other natural resources, most of the prices of foods domestically supplied will continue rising but at a much smaller rate compared with that during 2011–2030 (Tables 10.6 and 10.8). It is noted that the price of some food items is likely to become lower by 2050, e.g., animal products, dairy products, and processed food for the PRC; rice, dairy products, aquatic products, and processed food for India.

If there are no further world trade reforms, changes in import prices of both countries in 2050 will be similar to world import price changes (in terms of both direction and magnitude) in relation to the 2030 prices (Tables 10.7 and 10.9). Thus, the prices of rice, animal products, milk and dairy products and other food will be lower than those in 2030, while the prices of wheat, other cereals, vegetables and fruit, cash crops, and aquatic products will be higher than those in 2030. Changes in trade volumes will be mixed. For some food items, both imports and exports will increase at varying degrees, while for others, imports may increase (or decrease) and exports may decrease (or increase) (Table 10.9).

Table 10.8 Change in Food Demand, Supply, and Prices in 2050 (2030 as the base period)

	PRC			India			World		
	Household Demand (%)	Domestic Supply (%)	Supply Price (%)	Household Demand (%)	Domestic Supply (%)	Supply Price (%)	Total Supply (%)	Export Price (%)	Import Price (%)
Rice	15.0	28.7	2.0	36.9	44.4	-21.0	35.8	-7.6	-12.4
Wheat	13.2	22.1	10.1	28.7	30.0	17.6	34.9	22.9	24.0
Other cereals	10.7	38.2	23.2	26.4	26.1	32.1	41.3	38.2	26.1
Vegetables and fruit	10.7	30.7	24.6	25.0	31.0	42.4	37.2	36.9	21.8
Cash crops	17.8	53.0	22.4	24.1	45.7	48.7	39.5	35.7	26.6
Animal products	32.8	31.8	-6.0	40.2	42.1	1.3	47.5	-12.8	-15.9
Milk	39.4	36.1	-21.6	44.3	42.8	-12.6	46.5	-19.3	-20.8
Aquatic products	28.0	29.5	5.7	44.5	47.9	-14.1	33.9	60.4	24.2
Other processed foods	31.2	34.4	-15.7	41.2	42.1	-13.1	44.4	-17.1	-18.8

PRC = People's Republic of China.

Source: From simulations using GTAP (2015).

Table 10.9 Changes in Food Trade in 2050 (2030 as the base period)

	PRC			India		
	Import Price (%)	Import Quantity (%)	Export Quantity (%)	Import Price (%)	Import Quantity (%)	Export Quantity (%)
Rice	–9.8	89.7	–29.7	–12.1	–3.7	206.8
Wheat	25.7	–18.6	355.5	27.6	–10.1	160.6
Other cereals	25.9	27.8	52.6	40.9	16.5	35.4
Vegetables and fruit	26.1	32.5	74.4	34.6	40.6	16.1
Cash crops	25.5	43.0	109.4	30.2	148.7	–32.4
Animal products	–15.3	100.9	–37.1	-17.6	176.2	–57.6
Milk	–18.9	22.6	85.5	–21.3	107.0	–17.2
Aquatic products	20.1	9.5	57.7	51.5	–29.3	322.8
Other processed foods	–18.4	42.3	29.7	–17.7	58.4	24.3

PRC = People's Republic of China.
Source: From simulations using GTAP (2015).

10.5.2 Best and Worst Scenarios

The significance of conducting this simulation exercise is to see how changes in population, income, and agricultural TFP might affect food demand and supply in the PRC and India, which is relevant for deriving valuable policy implications. This section provides the results of the best and worst scenarios—both are in relation to the 2030 baseline scenario. For the best scenario, the population grows at a lower rate, but the GDP grows at a higher rate. Agricultural TFP has 10 percentage point extra growth compared to other economic sectors—agriculture receives extra preferential investment. Under the best scenario, the private consumption of all foods in both countries will be at a higher level compared to the 2030 baseline level (Table 10.10). The increase in the consumption of higher-valued foods is at a slightly faster pace. The domestic supply of all food is increasing in India, with higher-valued food increasing at a faster rate. The supply of land-intensive

Table 10.10 Change in Food Demand, Supply, and Prices in 2030
(best scenario, change in percentage points in relation to the 2030 baseline scenario)

	PRC			India			World		
	Household Demand	Domestic Supply	Supply Price	Household Demand	Domestic Supply	Supply Price	Total Supply	Export Price	Import Price
Rice	7.9	-5.3	-7.3	8.9	3.2	-1.3	-1.2	-5.2	-4.8
Wheat	8.5	-3.9	-10.0	10.1	1.7	-8.3	-1.3	-7.3	-6.3
Other cereals	8.5	-6.7	-13.4	9.9	7.9	-6.9	-1.7	-8.3	-6.4
Vegetables and fruit	8.4	-1.2	-9.5	9.8	7.2	-6.2	0.0	-7.5	-6.1
Cash crops	12.3	-6.4	-6.5	10.3	2.9	-9.0	-0.6	-7.1	-6.5
Animal products	15.0	5.5	-6.3	14.1	6.6	-5.4	1.4	-5.8	-5.6
Milk	15.1	9.6	-6.7	12.8	10.9	0.3	2.4	-4.5	-5.3
Aquatic products	17.6	5.4	-13.2	11.2	9.0	7.5	2.6	-9.4	-6.6
Other processed foods	14.1	6.9	-11.5	13.2	12.9	-8.9	1.6	-7.1	-5.5

PRC = People's Republic of China.
Source: From simulations using GTAP (2015).

food is decreasing in the PRC, while the supply of those of higher value is increasing. Domestic supply prices decline for all food except two for India (milk and aquatic products at 0.3 and 7.5 percentage points higher, respectively). Globally, both import and export prices of all food items will decline. The changes in total supply are modest (Table 10.10).

The improved agricultural TFP leads to greater domestic supply. The need to import declines and the ability to export increases. Consequently, all import prices for both countries will be lower than those in the baseline scenario, by about 5.0 to 6.5 percentage points (Table 10.11). There are mixed changes in the quantity imported or exported. For the PRC, all imports except milk will decline, while all exports except cash crops will increase. For India, export increase for other processed food will be faster than import increase. For wheat and cash crops, imports will decline by about 7 percentage points, while their exports will increase by about 14 percentage points compared with the

Table 10.11 Changes in Food Trade, 2030 (best scenario, change in percentage points in relation to the 2030 baseline scenario)

	PRC			India		
	Import Price (%)	Import Quantity (%)	Export Quantity (%)	Import Price (%)	Import Quantity (%)	Export Quantity (%)
Rice	–4.9	–7.6	12.9	–5.3	23.0	–19.1
Wheat	–6.6	–17.9	42.0	–6.2	–7.4	15.2
Other cereals	–6.4	–9.2	19.8	–6.5	7.8	–0.3
Vegetables and fruit	–6.2	–9.8	10.5	–6.4	7.7	–2.5
Cash crops	–6.6	–6.7	–0.6	–6.3	-6.6	13.4
Animal products	–5.7	–4.0	5.9	–5.7	10.3	-0.8
Milk	–5.6	7.2	19.8	–5.4	37.2	–34.5
Aquatic products	–6.4	–4.4	18.2	–6.6	30.8	–28.0
Other processed foods	–5.3	–8.0	27.3	–5.1	3.8	13.1

PRC = People's Republic of China.

Source: From simulations using GTAP (2015).

baseline. For all other food items, imports will increase and exports will decrease. Higher economic growth and thus higher per capita income will translate into higher demand for these food items in India.

Under a pessimistic or worst scenario, the population grows at a higher rate, but the GDP grows at a low rate. Agricultural TFP grows by 10 percentage points lower compared with other industries—agriculture receives less investment. If this scenario occurs, domestic private consumption of all food will decline in both countries compared with the 2030 baseline level (Table 10.12). The decline will be in the range of 10 to 17 percentage points for the PRC and 10 to 5 percentage points for India. The consumption of higher-valued food will have a slightly greater decline in both countries.

Slower improvements in agricultural TFP will result in lower supply. Domestic supply of all foods will decline with the exceptions of rice (4.7 percentage points higher) and other cereals (7 percentage points higher) for the PRC. The reduction in food supply caused by lower TFP growth will be partially offset by the lower demand for food due to lower income (as well as the lower demand for intermediate goods such as cereal crops for feed purposes). In the meantime, some resources used to produce food of high-income elasticities are likely to be spared in producing essential crops such as cereals. In balance, overall domestic food supply could decline, causing domestic supply prices to increase for all foods except aquatic products for India. Under this worst scenario, both import and export prices of all food items will increase. Global total supply will generally decrease (Table 10.12). The decline in global food supply could be the result of the following two forces: (i) direct effect—reduction in the PRC and India's supply of land-intensive food crops; and (ii) indirect effect—reduction in the PRC and India's import demand for food of higher value such as meat, hence the reduced supply of this food from the exporting countries.

In both countries, the import prices of all food items will increase by 5–8 percentage points compared with the baseline scenario (Table 10.13). For the PRC, the quantity imported will increase, while the quantity exported will decrease. With lower TFP growth, overall supply decreases. Increase in food demand due to slower population decrease (the PRC) or faster population increase (India) will be partially offset by a decrease in food demand as a result of slower income increase. Within food items, the demand for food of higher income elasticities produced domestically may decline more than the decline in their supply, leading to an improvement in the trade balance. For food of lower income elasticities produced domestically, the opposite is true. In balance, domestic food availability deteriorates, resulting in increased imports but reduced exports.

Table 10.12 Change in Food Demand, Supply, and Prices in 2030
(worst scenario, change in percentage points in relation to the 2030 baseline scenario)

	PRC			India			World		
	Household Demand	Domestic Supply	Supply Price	Household Demand	Domestic Supply	Supply Price	Total Supply	Export Price	Import Price
Rice	-10.4	4.7	14.1	-10.2	-4.2	2.9	1.3	7.6	4.8
Wheat	-11.3	-0.3	19.4	-11.3	-4.1	11.5	0.9	10.2	7.2
Other cereals	-11.0	7.0	29.7	-11.1	-9.3	10.3	2.3	13.7	7.5
Vegetables and fruit	-11.4	-0.9	21.0	-11.0	-8.8	9.6	-0.5	12.5	7.1
Cash crops	-14.1	-1.9	12.5	-11.5	-5.2	13.3	0.4	9.2	7.6
Animal products	-16.9	-8.8	11.2	-14.8	-7.8	8.1	-1.8	7.3	5.2
Milk	-16.7	-14.4	11.1	-13.5	-11.9	0.1	-2.5	4.5	4.6
Aquatic products	-17.3	-7.2	12.9	-11.7	-9.4	-9.8	-3.4	9.6	6.6
Other processed foods	-16.2	-9.7	19.7	-14.1	-15.2	13.7	-2.1	8.6	5.1

PRC = People's Republic of China.
Source: From simulations using GTAP (2015).

Table 10.13 Changes in Food Trade, 2030 (worst scenario, change in percentage points in relation to the 2030 baseline scenario)

	PRC			India		
	Import Price (%)	Import Quantity (%)	Export Quantity (%)	Import Price (%)	Import Quantity (%)	Export Quantity (%)
Rice	4.9	29.9	–35.2	5.1	–13.7	14.9
Wheat	7.9	50.6	–61.4	6.8	16.2	–22.0
Other cereals	7.8	23.4	–35.3	7.6	–6.9	–1.9
Vegetables and fruit	7.9	26.3	–28.4	7.8	–6.1	0.5
Cash crops	8.0	12.0	–19.5	7.3	11.6	–20.9
Animal products	5.5	18.4	–32.0	5.5	–4.0	–16.0
Milk	5.3	1.9	–37.8	4.8	–25.6	42.0
Aquatic products	6.3	0.6	–13.2	7.0	–27.5	46.2
Other processed foods	4.9	19.2	–38.7	4.8	0.3	–23.5

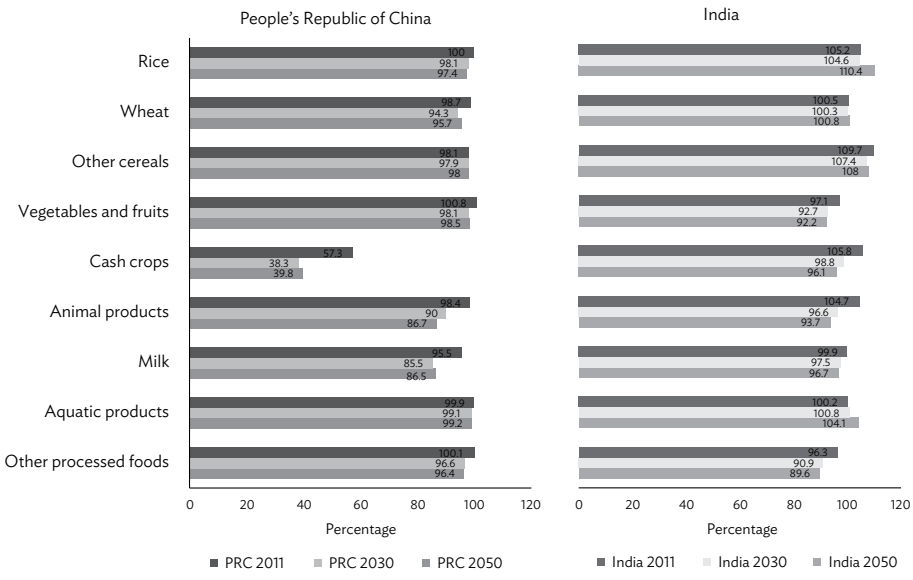
PRC = People's Republic of China.
Source: From simulations using GTAP (2015).

The changes in the quantity imported or exported in India might not have the same character as the PRC's. There could be an increase in the imports as well as exports of food commodities, except in the case of animal products in which both imports and exports will fall. The imports of commodities such as wheat, cash crops, and processed food will increase but their exports will decrease. The exports of commodities such as rice, other cereals, vegetables and fruit, milk, and aquatic products will increase but their imports will decrease.

10.5.3 Changes in the Food Self-Sufficiency Ratios

Under the 2030 baseline scenario, both countries' food imports will increase (and at a fast pace) but exports might drop in 2030 (Table 10.7). This increase in imports but decrease in exports will lead to a decline in the SSR for all food items in both countries (except aquatic products for India whose SSR registers a 0.6% increase) (Figure 10.2). The decline in the SSRs is different for different food. For animal products, the decline

Figure 10.2 Food Self-Sufficiency Ratios in 2011, 2030, and 2050



PRC = People's Republic of China.
Source: From simulations using GTAP (2015).

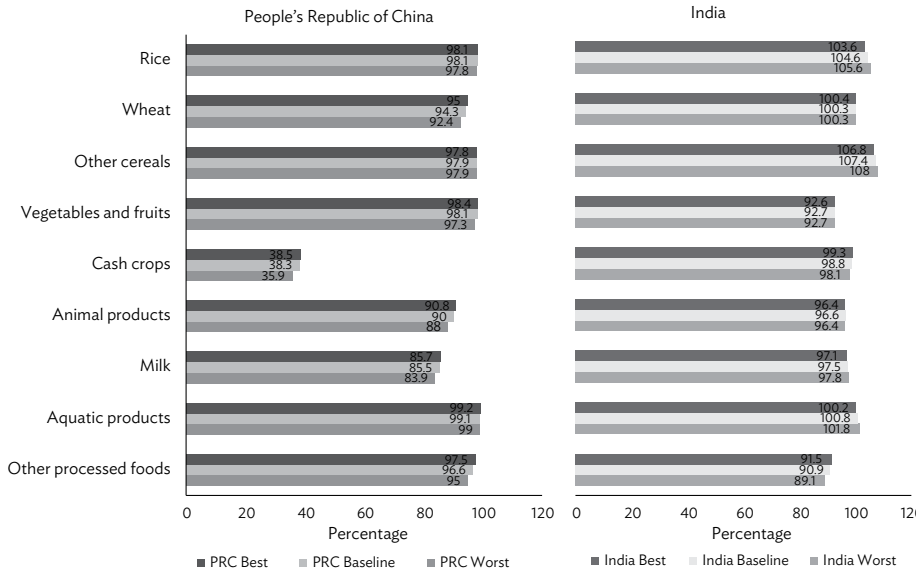
is over 8% for both countries. The PRC will experience a major drop in the SSR for cash crops as well (19%) due to the continued large imports of soybeans. (It is to be noted that some nonfood cash crops such as cotton are also included in the "cash crops" group.) India's SSR for cash crops might also have a major drop (7%) due to the need to import pulses. The decline in the SSR of dairy products for the PRC is also significant (10%) by 2030. Although the imports of some food items (e.g., rice and other cereals for the PRC; rice and wheat for India) will increase at a fast rate, the decline in their SSRs is relatively small. This is due to their very large domestic production but relatively small quantity of imports in 2011.

By 2050, although the SSRs for some food items (e.g., rice, animal products, and other foods for the PRC; vegetables and fruit, cash crops, animal products, milk, and other foods for India) will further decrease, the SSRs for a majority of these food groups will increase to a small extent (in the case of rice in India, the SSR will increase by almost 6%) (Figure 10.2). In general, the drop in the SSRs is small. However, it is useful to note that in both countries, the relatively larger drop in the SSR

is for animal products, around 3%, compared with 2030. The supply of animal products is likely to become a major challenge for both the PRC and India in the future. For the PRC, there is the added challenge of supplying dairy products to its citizens.

If a best scenario occurs, the SSRs for all food items in the PRC (except for other cereals whose SSR will drop by 0.1 percentage point and rice for which there will be no change) will improve by a varying extent between 0.1 and 0.9 percentage points (Figure 10.3). However, if a worst scenario emerges, the SSRs for all food items (except for other cereals whose SSR will remain unchanged) will deteriorate by a varying extent between 0.1 and 2.4 percentage points. For India, in both the best and worst scenarios, the deviations in the SSRs from the 2030 baseline scenario show no clear pattern. Promisingly, in any of the scenarios, India should be able to achieve self-sufficiency for rice, wheat, other cereals, and aquatic products. For other food items, the change in the SSRs is small, although it may be said that the SSRs tend to be lower under the worst scenario, especially the SSR for other processed food that will have a relatively larger drop (Figure 10.3).

Figure 10.3 Food Self-Sufficiency Ratios in 2030 under Three Scenarios



PRC = People's Republic of China.
Source: From simulations using GTAP (2015).

10.5.4 Global and Regional Impacts

Our results show that under either the best or worst scenarios, there will be some major changes in food demand and supply in the PRC and India. Such changes will impact the global market, which in turn will affect the markets in other countries or regions through the changes in prices in the global market. Under a best scenario, the global supply may change to a small extent (either increase or decrease by a margin between 1 and 2 percentage points). The global import prices, however, will all drop by a margin of around 6 percentage points compared with the baseline scenario. If a worst scenario occurs, again total global supply will vary by a small margin, but import prices will increase by around 5–8 percentage points. As such, changes in the PRC and India's food demand and supply are unlikely to cause major concerns for global food security as far as food supply is concerned. Indeed, if these two countries are able to effectively control their population but achieve a higher growth in GDP and agricultural investment, then their efforts will help improve global food security. It is, however, noted that the decline in world food prices resulting from increased global supply will affect countries differently. Generally, exporters will have reduced export income, while importers can expect to save on their imports.

At the regional level, changes in the PRC's and India's food demand and supply will have some, but varying, impacts on food-secure and food-insecure regions. Our discussion here focuses on the three food less-secure regions: Region 4, other countries in East Asia, Southeast Asia, and South Asia (excluding the PRC, India, major East Asian food importers, and West Asia); Region 6, all African countries; and Region 8, all others (West Asia, East Europe, and other Latin American countries) (see Table 10.5 for information about region groups).

In general, SSRs for various food items tend to deteriorate over time in these three regions (Table 10.14). Countries in Region 4 will have higher SSRs for rice, vegetables and fruit, aquatic products, and processed food. This region's SSR for wheat is low and declining. For milk and dairy products, its SSR is likely to improve. For the other three items (other cereals, cash crops, and animal products), the SSRs will further decline. In African countries, the SSRs are declining. By 2050, only vegetables and fruit, animal products, and aquatic products will have comfortable SSRs. The SSRs for rice, wheat, and milk will become even lower by 2050. For countries in Region 8, their SSRs by 2030 may actually improve compared with the 2011 level (except for aquatic products). By 2050, the SSRs of all the three regions are likely to decline compared with those in 2030. However, based on the simulations, neither best nor worst scenarios in the PRC and India may cause any major deterioration as far as SSRs are

Table 10.14 Regional Differences of Self-Sufficiency Ratios under Various Scenarios (%)

	2011 Actual	2030 Baseline	2050 Baseline	Best Scenario	Worst Scenario
Region 4: Other Countries in Asia					
Rice	104.0	107.7	108.9	107.4	108.4
Wheat	59.3	47.1	50.9	47.0	47.3
Other cereals	81.3	79.6	78.8	79.5	79.7
Vegetables and fruit	100.8	102.7	99.8	101.7	105.2
Cash crops	91.7	77.8	77.9	77.1	78.6
Animal products	98.5	91.8	91.4	91.4	92.3
Milk	90.9	92.9	113.4	92.1	94.2
Aquatic products	102.2	100.9	99.5	101.0	100.8
Other processed food	110.6	120.0	116.5	118.5	122.5
Region 6: All African Countries					
Rice	80.8	68.7	63.1	69.3	68.2
Wheat	47.2	39.1	34.8	39.1	39.6
Other cereals	93.2	92.6	91.1	92.6	92.7
Vegetables and fruit	104.0	104.2	98.7	104.4	104.2
Cash crops	115.4	122.3	94.7	121.7	124.2
Animal products	96.6	96.4	102.6	96.4	96.5
Milk	85.8	75.1	59.3	75.7	74.2
Aquatic products	101.7	99.4	98.6	99.4	99.3
Other processed food	83.5	83.1	74.7	83.5	82.7
Region 8: All Others					
Rice	77.6	78.0	74.3	78.7	77.3
Wheat	91.1	95.7	93.6	95.7	96.1
Other cereals	80.0	82.5	82.4	82.4	82.6
Vegetables and fruit	103.1	112.6	110.1	112.5	113.1
Cash crops	98.2	108.8	97.4	108.7	109.6
Animal products	92.5	94.4	96.0	94.4	94.5
Milk	95.1	95.2	96.5	95.2	94.9
Aquatic products	100.3	98.7	93.2	99.0	98.3
Other processed food	94.0	104.6	106.4	104.5	104.6

Source: From simulations using GTAP (2015).

concerned for all three regions (Table 10.14). It can be seen that the SSRs in the columns of "Best" and "Worst" are the same as those in the 2030 baseline column, with only a few exceptions.

Although the SSRs are less affected, the presence of the best or worst scenario does affect food security in these three regions through food prices (Table 10.15). If the worst scenario occurs in the PRC and India, the import prices of food in these three regions will increase between 5 and 8 percentage points compared with the baseline prices. This in turn will lead to higher domestic supply prices, which

Table 10.15 Price Changes at the Regional Level (in percentage points in relation to the 2030 baseline scenario)

	Best Scenario		Worst Scenario	
	Change in Import Price	Change in Domestic Supply Price	Change in Import Price	Change in Domestic Supply Price
Region 4: Other Countries in Asia				
Rice	–4.8	–5.0	4.9	5.3
Wheat	–6.5	–6.3	7.9	7.6
Other cereals	–6.7	–6.5	8.7	8.4
Vegetables and fruit	–7.0	–6.6	10.5	9.2
Cash crops	–6.6	–6.2	8.2	7.7
Animal products	–5.6	–4.7	5.4	4.5
Milk	–5.5	–3.8	5.0	2.5
Aquatic products	–5.5	–6.5	4.6	7.2
Other processed food	–5.8	–5.0	5.8	4.7
Region 6: All African Countries				
Rice	–4.9	–5.8	4.9	5.9
Wheat	–6.2	–6.3	6.9	6.8
Other cereals	–6.4	–6.6	7.5	7.2
Vegetables and fruit	–6.1	–6.5	6.8	7.2
Cash crops	–6.2	–6.5	7.0	7.3
Animal products	–5.6	–5.8	5.4	5.6
Milk	–5.4	–6.2	4.9	6.2
Aquatic products	–6.7	–10.2	6.7	12.2
Other processed foods	–5.6	–6.1	5.4	6.1

continued on next page

Table 10.15 *continued*

	Best Scenario		Worst Scenario	
	Change in Import Price	Change in Domestic Supply Price	Change in Import Price	Change in Domestic Supply Price
Region 8: All Others				
Rice	–4.5	–5.5	4.6	5.7
Wheat	–6.4	–6.4	7.4	7.3
Other cereals	–6.4	–6.4	7.5	7.3
Vegetables and fruit	–5.9	–6.3	6.6	7.3
Cash crops	–6.4	–6.6	7.5	7.8
Animal products	–5.6	–5.6	5.4	5.6
Milk	–5.5	–5.5	5.1	5.4
Aquatic products	–6.5	–8.6	6.5	9.6
Other processed food	–5.5	–5.6	5.1	5.6

Source: From simulations using GTAP (2015).

will increase between 6 and 9 percentage points for most food items (Table 10.15). On the other hand, a best scenario will result in lower food import prices (by 5–9 percentage points) and lower domestic food supply prices (by 4–9 percentage points). This suggests that food security in food less-secure countries will be affected by changes in population, income, and agricultural investment in the PRC and India. If the PRC and India continue to successfully control their population, improve their economy, and increase their investment in agriculture, this will help the poorer and food-insecure countries improve their food security.

10.5.5 Some Qualifications

In the authors' opinion, the simulation results for India could possibly be overly optimistic. This is reflected by the high SSRs, especially for cereals in the baseline scenarios (Figure 10.2). It has been speculated that India's demand for food will increase over time and that its ability to continue meeting the rising demand might decline, leading to lower SSRs for most food items including cereals. The higher SSRs derived from the simulations are perhaps the results of underestimated demand but overestimated supply.

Reasons for this optimism can be multiple. The most fundamental reason lies in the representativeness of the reference year data and some key parameters in the GTAP Data Base. Other things being equal, if the SSRs in the reference year are higher, they will generally be higher in the reporting year. The same applies to any other variable. In the case of India, its SSRs were high in the reference year of 2011 (Figure 10.2). This could have also resulted in higher SSRs for some food items in the reporting years 2030 and 2050 (e.g., rice and aquatic products, and to a smaller extent, wheat and other cereals).

It would have been expected that the SSRs, especially for cereals and other land-intensive products, would reduce over time for India like in the PRC. When India's economy further improves, it might be anticipated that the comparative advantage of agricultural production may further decline, and resources may be drawn away from agricultural production. If noncereal crops earn a higher return, cereal production resources can also get diverted.

Of course, whether such resource diversion will definitely lead to lower cereal production and thus lower SSR critically depends on the improvement in agricultural TFP. If the output increase from the improvement in TFP were insufficient to compensate the output decrease due to resource loss, cereal output would decrease. As such, it would be expected that under the worst scenario, the cereal output may decrease, leading to lower SSRs for cereal products. Contrary to the expectations, the SSRs for rice and aquatic products and, to a smaller extent, other cereals went up. This suggests that there may be deficiencies in the modeling or other issues that we are yet to understand. Therefore, the inferences that can be drawn from the India results remain speculative and subject to further investigation.

The price elasticities of supply in the GTAP Data Base affect the changes in supply. These parameters are compiled by using data and information from various sources. Any lack of precision in reflecting the reality of a specific country may lead to some large differences. Reiterating these parameters is beyond the possibility of this study.

On the demand side, the price and income elasticities of demand in the GTAP model will affect the changes in demand. For a low-income population, when income improves, demand for some food items is likely to increase. Therefore, the limitation resulting from the lack of account of poverty alleviation in the simulations will lead to an underestimation of the foods demanded.

When consumer income increases, another change that occurs is the composition of food demanded, for example, the demand for animal products is likely to increase. Our simulation results suggest this is the case. In the meantime, the increased demand for animal products has

also resulted in an increased domestic supply of animal products. This implies an increased demand for feed, including cereal feed. However, feed is an intermediary product. The quantity demanded of feed is subject to the input–output coefficients used in the GTAP model and as well the cross-elasticities of demand. Due to the lack of data and other resources, we did not investigate this aspect of demand in further detail.

Clearly, the data of the reference year and some key parameters in the GTAP model may have been insufficiently representative, which could have distorted the simulation results to some extent. However, overall, the results are largely as anticipated with a few exceptions (which warrant further investigation). As far as the major purpose of this simulation exercise is concerned, the results are strongly indicative that low investment in agriculture will result in reduced food output, increased imports, and higher supply prices; high investment in agriculture will lead to increased food output, reduced imports, and lower supply prices, hence improving the country's food security.

10.6 Conclusions and Implications

Given their enormous population, how the PRC 's and India's demand for and supply of foods may change in the future is important not only for their own future food security but also for food security in other parts of Asia and globally. This chapter painted a broad picture about how their food demand and supply may change by 2030 and 2050 through simulations of key scenarios using the GTAP Data Base.

The simulation results of baseline scenarios suggest that food consumption in the PRC and India will continue to increase until 2050, with India's increasing at a faster pace. Their domestic supply will also increase at a rate that is comparable to, or slightly lower than, that of consumption. As a result, both countries might need to import more food; domestic food prices will also be higher. However, they will still be able to maintain a relatively high rate of self-sufficiency for most staple foods. Basically, for all cereals, their SSRs can be maintained comfortably at 95% or even higher, especially in India. This indicates that as far as the staple food supply is concerned, these two countries have the capacity to largely meet the domestic demand by 2050.

In the best or the worst scenario, the impact on food supply in the two countries would exhibit quite different patterns. In the case of India, the impact will be mixed. It will have a lower import price but may import more of some food items if the best scenario is predominant. If the worst scenario prevails, its imports of most food items may decline, although it would have to pay a higher import price. For the PRC, if the best scenario were prevalent, then its food supply situation would improve. It would

need to import less at lower prices, and domestic prices would also fall. Alternatively, if the worst scenario prevails, it would import more of all food items at higher prices, leading to higher domestic prices.

As such, it is crucial for the PRC to avoid the occurrence of the worst scenario or conditions close to it. It is worth mentioning that the PRC has a very high IDR for cash crops. It has also become increasingly reliant on world markets for the supply of animal products and dairy products. Although the decline in the total population in the PRC may help reduce the demand for food, thus alleviating the pressure, this will not happen until the early or mid-2030s. In this context, it is critical for the PRC to strategically position itself to be able to balance food demand and supply before the 2030s. To achieve this, according to our simulation results, continued and adequate investment in agricultural R&D, extension and education, and infrastructure can be effective. It is also important to continue improving consumer income.

India's SSRs for all food items is higher than those of the PRC's. Unlike the PRC, the challenges will remain for India, due to its still fast-growing population and the need to improve the nutrition intake. From a longer-term perspective, it could be helpful for India to adequately invest in agriculture, control population growth, and improve consumer incomes. Further successful reduction in the scale of poverty would lead to a fast increase in total food demand; hence India's food SSRs will not be as high as the results simulated in this chapter.

The PRC and India could benefit from improved food supply and thus a higher level of food security if they make efforts to attain the best scenario or conditions close to the best scenario. Their efforts will also help improve global food security and, in particular, will be most beneficial to the poorer and food less-secure countries to improve their food security. In this regard, international cooperation to help the PRC and India attain the best scenario would also be valuable. As expected, improved food security in the PRC and India ultimately improves food security elsewhere.

Finally, we note that the main objective of our simulation work is to provide broad indications about how the PRC's and India's food demand and supply might change and thus impact their food security and global food security. Although deficiencies inherent in the GTAP model have affected the results to some extent and require some caveats, the overall results are significant. They can be used to infer the likely direction and extent of change under different scenarios over a period of time, although they should not be interpreted as the precise projection of what may happen at a specific time.

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11

Toward Achieving Food Security in Asia: What Can Asia Learn from the Global Experience?

Jock R. Anderson

11.1 Introduction

Asia arguably has the most experience around the globe in the "business" of food security (in terms of the most potential indicators such as the number of past victims of food insecurity, number of people brought into relative food security, and volumes of public resources directed at achieving food security over recent decades). An obvious first question then is "Why look beyond Asia?" but the experience of others might bring insight to the global assessment of which this chapter is a small part.

This chapter acknowledges the semantic issues surrounding food (in)security, largely addressed in Chapter 2. Famines around the world, including in Asia in the past century but with intriguing European cases mostly in earlier centuries, have long plagued humanity. For brevity in this chapter, the broad literature review is also acknowledged, especially the insightful analyses of authors such as Sen (1981); Ravallion (1987); Drèze and Sen (1991); Dasgupta (1993); Field (1993); von Braun, Teklu, and Webb (1999); and von Braun, Vargas Hill, and Pandya-Lorch (2009). Such analyses are critical to a wider understanding of food insecurity, especially in its most extreme forms. For the present chapter, the emphasis is on more recent cases of food insecurity, particularly since 1950, and the roles played by various types of institutions (government, economic, and knowledge) in dealing with this problem.

11.2 Lessons and Experience in Improving Food Security beyond Asia

There are several themes under which experience can be distilled. The relevant literature is extensive, but is well distilled from diverse perspectives by many contemporary authors, including notably Paarlberg (2002, 2013), Runge et al. (2003), Leathers and Foster (2009), Pinstrup-Andersen and Watson (2011), Conway (2012), Barrett (2013), and Naylor (2014).

Fan, Pandya-Lorch, and Yosef (2014: 6) recently observed:

> As we look ahead to a future of continuing and even increasing shocks, we face an urgent need to predict shocks, prepare for them, and devise strategies for ensuring *resilient* agricultural and livelihood systems, institutions, and policies—at the community, national, and global levels (emphasis added).

The cogent lessons from around the world reviewed in this chapter, including those of concerned international agencies, is intended to assist policy making in Asia.

Pinstrup-Andersen (2014) argued that understanding how and why governments responded to rapidly rising food prices around 2008 is important to enhance the existing knowledge of the political economy of food price policies and to assist governments in policy making as they confront future food price fluctuations. A key lesson from many parts of the world is that it is helpful to have a policy on dealing with emerging food insecurity firmly in place before a crisis arrives, something more easily said than done, given the potential political challenges of sorting out the interplay of roles between public bodies among government institutions and private entities among economic institutions. Even having a proper government in place can be a challenge, as in Bangladesh in 2007–2008 (Raihan 2013). Beyond Asia, Zambia provides a representative finding (Chapoto 2013: 2):

> [The] government, in collaboration with other relevant stakeholders, should develop a "standard" strategy on how to deal with future food and price crises before they happen. An effective early warning system is required to trigger the response strategy, with all players playing their part.

11.2.1 Avoidance

The first and foremost challenge is avoiding food insecurity crises through activities supported by governments and international financial institutions (IFIs). Timmer (2010: 8) advised:

(i) maintaining a stable global effort on agricultural research and advisory services, especially on short-run supply responses and production flexibility;
(ii) expanding and improving management of local buffer stocks, including some degree of international coordination;
(iii) improving world trade stabilizers through macroeconomic coordination;
(iv) reducing volatility of global price signals through more stable exchange rates, possibly to include use of a new reserve currency;
(v) thickening global trading markets by reducing trade barriers; and
(vi) build analytical and advisory capacity in food policy analysis.

The circumstances of food security around the world are as diverse in rural areas as the agricultural and environmental situations that prevail. The Green Revolution of Asia, through improved availability of staple foods, saw great reductions in food insecurity (Anderson, Herdt, and Scobie 1988; Spielman and Pandya-Lorch 2009; Pingali 2012), whereas the absence of such a revolution in Sub-Saharan Africa means that many smallholders still face precarious conditions. Conway (2014) described the food security situation faced by one particular (albeit fictitious) Kenyan smallholder, Mrs. Namarunda. She faces the multiple challenges of land insecurity, resource scarcity, natural variability in her environment, and dubious access to many services including agricultural knowledge and credit, which add up to a highly food-insecure situation. The resolution of her challenges, such as through a more effective provision of agricultural services, as argued convincingly by Conway, would constitute a major advance in working toward greater food security in Mrs. Namarunda's world and among smallholder farmers everywhere.

The IFIs, such as the Asian Development Bank, have a strong record in assisting with agricultural services that have a proven past performance in contributing to food availability, through support at the national, regional, and global levels for agricultural research, and a deep if not always strong record in supporting national agricultural advisory services (Purcell and Anderson 1997; World Bank 2007). However, such support has been waning, particularly in terms of national

budget support for national public agricultural research in developing countries (Beintema et al. 2012), with the major exceptions being Brazil (see, for example, Correa and Schmidt 2014) and, in Asia, the People's Republic of China (PRC) and to a lesser extent, India. Fortunately, with support from the IFIs and other donors such as the Bill and Melinda Gates Foundation, international agencies (particularly the Consultative Group on International Agricultural Research [CGIAR], and others such as the World Vegetable Center and regional programs (especially in Sub-Saharan Africa) have been increasingly supporting national efforts to help complement them and fill gaps in national agricultural research programs. These knowledge-generating and disseminating institutions do matter, but as Alston and Pardey (2014) observed, not enough is being done. It is timely for the IFIs and the donor community to reassess the extent and nature of support for research and extension investment with a view to staving off the food-insecurity consequences of persistent underinvestment in productivity-enhancing innovations that should be driving future growth in productivity, and thus increase the supply of food at diminished cost (Lynam et al. 2016). Looking beyond Brazil, the PRC, and India, the case of Israel illustrates how effectively investment in agricultural research has paid off in terms of heightened food security (Chapter 7 of this volume).

Managing the buffer stocks of major food staples has entered the IFI work programs in different ways over time. During the 1970s, attention was given to commodity stabilization schemes (Hazell and Scandizzo 1975; Reutlinger 1976), culminating in the opus work of Newbery and Stiglitz (1981). Attention persisted into the 1990s (Claessens and Duncan 1993). What had seemed a good idea in principle has proved too expensive and difficult in practice to warrant public intervention via operating stockpiles of commodities. Findings have reconfirmed this in more recent analytic work conducted in the context of the post-2008 food insecurity crises (Wright 2009; World Bank 2012a). Many early IFI agricultural operations were focused on developing the institutional structure and related infrastructure (World Bank 1986; Meerman 1997). In more recent times, the emphasis has moved from public systems to supporting private agribusiness development to assist markets to play their natural role in stabilizing prices (Larson, Anderson, and Varangis 2004), and the International Finance Corporation has taken an increasing share of this aspect of the business of the World Bank. The important point is that economic institutions play an essential role in fostering food security.

IFI policy lending, especially in times of financial and fiscal crises, has been extensive in contributing to macroeconomic stabilization for trade stabilizers, and International Monetary Fund programs more so

than the banks in price volatility. The IFIs have cooperated with United Nations agencies (especially the General Agreement on Tariffs and Trade and subsequently the World Trade Organization) in contributing to the important gains in reducing trade barriers (Blandford 2015), as well as through their own extensive analytical and advisory work on identifying and reducing barriers to trade, as summarized in Anderson (2009, 2010, 2013). These dimensions related to trade policy represent aspects of the interplay between government and economic institutions that support the effective functioning of markets as well as relevant interventions when markets fail to deliver effective food security.

Trade policy adjustment, for instance, was an important part of the Nigerian response to the 2008 food price crisis (Olomola 2013). To cushion the effects of the crisis in the short term, the government released grain from its reserves, ordered the importation of 500,000 tons of rice to be sold at subsidized prices, and suspended tariffs on rice imports. These policy measures reversed the trend of rising food prices within 6 months and generated awareness about the nutritional importance of major food staples including cassava, which led to changes in the demand for food commodities. This policy mix arguably stimulated increased financing for commercial agriculture.

Many of the mentioned reductions in trade barriers contribute to the IFIs' support for analytical capacity, particularly in building analytical and advisory capacity in food policy analysis. This is done in many IFI cells such as the World Bank's Development Economics Research Group and its Global Agriculture Practice, as well as being supported in parts of the CGIAR, especially the International Food Policy Research Institute (IFPRI) with its many partnerships involving analysts in many developing countries. In hindsight, the analytic study on food price risk conducted in 2005 (World Bank 2006) could be considered timely. The rapid production of the World Bank's framework document in 2008 (World Bank 2008) can also be considered significant. The many analytical works on food risk issues produced since can be considered as a reasonable response to the call of the World Bank (2006: 68) for "The Bank needs to revamp its analytical work in this critical area..." The World Bank works include central documents (e.g., World Bank 2012b, 2013a) and several reports of regional assessments. Relevant work beyond the IFIs includes the ongoing annual preparation by the Food and Agriculture Organization of (FAO) of *The State of Food Insecurity in the World* (FAO, IFAD, and WFP, 2013, 2014). (IFAD is the UN's International Fund for Agricultural Development). There are also major thrusts in IFPRI in partnership with others, such as the preparation of the Global Hunger Index (IFPRI 2013), and a parallel effort in preparing the Global Food Security Index sponsored by DuPont (EIU 2014), and

diverse studies in academe (Pardey et al. 2014; Chavas, Hummels, and Wright 2015). Beyond such indexing of food security situations from an international perspective, recognition should be made of substantive efforts by government institutions at the national level, such as those for Japan and the Republic of Korea, summarized in Chapters 5 and 6 of this volume.

In short, there has been much international effort, especially by the IFIs, that assists in diverse ways through government institutions to avoid food insecurity problems as manifested in food-price crises, although for some forms of intervention, perhaps it is "too little, too late" (Pardey, Alston, and Piggott 2006). Crises still happen, so it is logical to turn next to how the world and its concerned agencies can recognize when a crisis is emerging.

11.2.2 Recognition

At its core, food insecurity is a problem faced by individuals, and their households and communities, and eventually a concern for regional, national, and international authorities working through their institutions. For insecurity recognition to happen in a timely and useful manner, effective governance mechanisms (especially institutional arrangements for listening to individual and community concerns) must be in place (Birner 2009a, 2009b). Such mechanisms and arrangements are context specific but can be deficient in areas prone to conflict. Improved institutional arrangements have, for instance, been identified in both East and West Africa. Calderone, Headey, and Maystadt (2014) argued that institutional reforms might be the most effective way to decrease long-term vulnerability in the Horn of Africa where pastoralist groups have historically been marginalized in high-level decision making. Efforts to empower them in national decision-making processes could significantly alter what has been an unfortunate situation. They observed that such efforts have already met with some success in eastern Africa, particularly in Kenya. Turner et al. (2012) reached similar conclusions for countries in West Africa.

Food insecurity crises of all types are not given to precise definition, although most observers share the perception of a problem of great significance. Producers and consumers of food are aware of the considerable inherent variability in production of food staples (Anderson and Hazell 1989), and most were aware of the sharp surges in prices for major staple grains in 2007, especially in the first half of 2008. Food-focused civil unrest in several countries in 2008 ensured that the topic was on the international action agenda. In the IFIs, for instance, the World Bank's quickly delivered response was the production of a

framework document (World Bank 2008) for the Global Food Crisis Response Program (GFRP) and its rapid implementation (World Bank 2012b). In terms of formal recognition, the launch of the GFRP could be categorized as an ad hoc process driven by diverse clients and concerned responders. Presumably, in awareness of this unpracticed process (given the decades since the prior major food crisis of the 1970s), steps have been taken to sharpen the tools for recognition.

At the international level, there are many agencies including the FAO and the World Food Programme (WFP) (which monitors the FAO Food Price Index and also participates in its assembly of the Global Information and Early Warning System on Food and Agriculture [FAO–GIEWS], which was introduced in the context of the food insecurity crises of the early 1970s). Others include development agencies such as the United States Agency for International Development (USAID) and counterparts in other Organisation for Economic Co-operation and Development (OECD) countries, but this chapter focuses on the IFIs. A clear message from the early World Bank GFRP experience is the strong country specificity of food crises. The primary institutional innovation in the World Bank is the establishment of the Food Price Watch (FPW), which produces a quarterly perspective on food prices (World Bank 2010). (The unit is seeking to refine the identification of food insecurity crises.) The website informs about potential crises, and given the context specificity of such crises, it tracks particular country situations where there seems most cause for alarm, based on many sources, including the FAO–GIEWS.

Several donor agencies and the World Bank have also been active in advancing the functionality of the Group of 20 (G20) 2009 initiative of the Agricultural Market Information System, the secretariat of which is housed in the FAO. It is yet to be seen how helpful this initiative will be in future food insecurity crisis recognition and intervention, but in principle, having more well-assembled and reliable information should assist the IFIs and their country and donor partners to create earlier and better crisis-response plans.

Since timing is important, it is pertinent to ask how well the FPW information can signal early indications of an emerging food-price crisis, and indeed the FPW team has recently addressed this (Cuesta, Htenas, and Tiwari 2014). The framework identifies the recent food crises of 2008, 2011, and 2012. This team, in applying the framework, compared several measures based on movements of the World Bank's monthly Global Food Price Index (FOPI). Several measures worked well in the limited historical validation including one based on the FOPI increasing over 5 successive months to a cumulative extent of 15%. However, the best in terms of being a timely global trigger was an alert when the

FOPI exceeded +3 standard deviations (SDs) from the historical trend (with SD computed from detrended data 1960–2000). More complex triggers were developed and tested for indicating country-specific vulnerability, and these seem promising as practical alerts. Improved indicators can be developed in ongoing analyses by the FPW team and others, but any such system of alerts will need to draw on country-based local observation and interpretation to assist IFIs and other analysts in deciding on potential interventions. In the meantime, considerable progress is being made on the recognition front.

11.2.3 Response

However a food insecurity situation is recognized, what must follow quickly is a response that is appropriate and effective. Several of the country studies in this volume describe how rich countries (such as Japan and the Republic of Korea), emerging countries (such as the PRC), and less rich countries have responded by managing stocks and distribution mechanisms and trade arrangements. Unfortunately, on too many occasions, these responses include implementing export bans, which inevitably cause additional problems for their traditional and potential trading partners (Martin and Anderson 2011). For the countries examined in this study, examples come most significantly from India, with export bans on wheat and "common" rice during the perceived crises of 2007–2011 (Ganguly and Gulati 2013a, 2013b), and for the PRC on all food grains in 2008 (Tian and Zhou 2011; Huang, Yang, and Rozelle 2013).

For an IFI, once a food price spike crisis has been recognized, perhaps through specific requests from clients, it must set about determining the nature of the potential crisis in the particular country (or perhaps just a region of a country). Following Timmer (2010), a good starting point is to determine if food is available in the country at prices close to normal. If so, Timmer suggested using trade policy adjustments to limit the transmission of world prices to the domestic situation. If domestic food supplies are low, he further suggested assessing whether food can be imported quickly to make up the shortfall. If this is not possible, it will be necessary for the country to cope with the shortages through rationing and making special provisions for the poor and those most vulnerable to malnutrition, so they can acquire sufficient food. If it is possible to import food in a timely manner, progress will depend on a variety of institutional capacities apart from the logistical setup to manage imports. The investments needed cover infrastructure such as ports and transport systems, and also, most importantly, skilled human capital for policy making and management (see Falcon 2014 on BULOG,

the Indonesian logistics agency, and related institutions in the now largely food-secure Indonesia). The need is for countries to strive to develop capacities at all levels of administration. Indonesia, for instance, still has much to do at the local and municipal levels where capacity in addressing food insecurity is still highly limited and limiting (FAO, IFAD, and WFP 2014). Government institutions matter at all levels.

Most notably, what is required on the institutional side is the availability of safety-net arrangements and the ability of these arrangements to deal with the anticipated scale of support to enable those who need to be protected in coping with the higher prices of food. In spite of past efforts through IFI initiatives such as the World Bank's Social Protection Network, few countries enjoy the strengths of the Brazilian safety net scheme of "Zero Hunger" (Graziano 2009; Graziano, Del Grossi, and Franca 2011) and the successor programs including the National Food and Nutrition Security Plan. The institutional setup in Brazil provides an example of political will to tackle food insecurity (and extreme poverty) and the complex arrangements for interagency cooperation that are required at all levels of government to achieve success in overcoming food insecurity (FAO, IFAD, and WFP 2014). Extant arrangements vary around the world, being designed to address the particular food insecurity (and other) risks faced in specific countries. For a succinct overview of arrangements in Ethiopia and El Salvador, for instance, see World Bank (2013c).

Many countries do have effective arrangements, and it will be a matter of critical assessment as to whether external assistance would be necessary to scale up arrangements to meet the dimensions of a now anticipated emerging crisis, especially in relatively remote and/or rural areas. Additional actions required to enable the safety-net arrangements to function effectively will likely involve trade policy adjustments to reduce extant barriers (e.g., reducing tariffs and taxes) and acquiring access to additional financial resources (perhaps through the IFIs) to face increasing imports at high prices in spiking markets. The diversity of trade policy responses invoked by many countries has been summarized by the FAO. Conceivably, the IFIs might also be helpful in policy dialogue with exporting countries (such as both the PRC and India among the countries represented in this study) in discouraging "beggar-thy-neighbor" export restrictions in times of spiking food prices (Martin and Anderson 2011; Tian and Zhou 2011; Anderson 2013).

In those cases where the safety-net arrangements are inadequate or non-existent, a country has a challenge. It may need external assistance to be able to subsidize imports to boost local supplies and keep domestic food price increases as small as feasible. It will seek whatever access it has to international food aid supplies. It may also call

on external assistance to set up emergency feeding programs managed by government institutions, especially for vulnerable children. As can be seen from the experience with the GFRP emergency operations, the World Bank has the capacity to provide assistance in such situations, notwithstanding some of the concerns expressed by the Independent Evaluation Group (IEG) (IEG 2013) about aspects of its rapid-response processes and the departure in practice of some of the implemented interventions from the framework document (World Bank 2008).

Indeed, the IEG (2013) acknowledged that in learning from the GFRP experience, food-price (and other food insecurity) emergency responses have now been mainstreamed through the International Development Association (IDA) Crisis Response Window and the IDA Immediate Response Mechanism. Going forward, these innovations will provide the basis for World Bank emergency assistance through the IDA. The International Bank for Reconstruction and Development (IBRD) Exposure Management Framework allows the World Bank to respond quickly in IBRD countries should emergencies arise, including through catastrophe deferred draw-down options and rapid post-disaster contingent financing components in operations. It is clear that the IFIs' regular lending programs in agriculture and food-related social protection have evolved to accommodate the desire of clients to deal with the new normal of uncertain and seemingly higher-than normal international food prices. Generically, these can be seen as mechanisms for international knowledge management institutions being of assistance to national government institutions in more effectively dealing with food insecurity.

The strongest critical IEG evaluation concerned the World Bank allegedly proceeding with food emergency operations without appropriately resourced administrative arrangements (IEG 2013). Some of these constraints concerning the IDA have been addressed through the above-mentioned arrangements. Others highlighted by IEG related to "staffing, analytic effort and resources for portfolio management." These are important considerations and will be among those being addressed in the recently reorganized World Bank, not only in the Agriculture Global Practice but also the Social Protection and Labor Practice. In the meantime, the issues and commitment to agricultural development and food security are dealt with strategically in many ways in the IFIs, such as the World Bank in its recent agriculture action plans (World Bank 2013c). In the concerned international agencies, there is heightened interest in assisting countries in their risk management arrangements in the agricultural sector (Hardaker et al. 2015), including, for example, novel insurance instruments such as rainfall and other index insurance (Ceballos and Robles 2014). Other examples are crop and revenue

insurance measures within contemporary agricultural intervention in the United States (Rausser and de Gorter 2013).

11.2.4 Monitoring

There is a need for effective monitoring of food insecurity, and there are many mechanisms in place, among the WFP, the FAO, the G20, and even in the IFIs such as the World Bank, not to mention many national watchdogs. As an example of a committed strong IFI position, IEG (2013) highlighted the need for due diligence concerning monitoring and evaluation (M&E) in future food-price-related operations and pointed to the need for all project designers to comply with the World Bank guidelines (2013b). Indeed, for instance, the preparation of the GAFSP featured the development of a compliant M&E system for its operations. At the national level, Brazil again provides a good example of effective food security M&E arrangements (FAO, IFAD, and WFP 2014). For countries with a more constraining financing capacity, it is a challenging administrative question as to what is the optimal allocation of scarce resources to devote to M&E, and in the absence of relevant guidelines, policy analysts must rely on subjective assessments. Such food insecurity M&E arrangements are the mechanisms for government institutions to track the effectiveness of programs with a view to timely corrective intervention as needs are identified.

11.2.5 Evaluation

Critical evaluation of operations related to dealing with food emergencies is a vital step in the project cycle. Self-evaluation is addressed in the M&E schemes being put in place. Independent evaluation will also be important, which is why the IFIs and increasingly national government institutions have their own independent evaluation units, such as Japan (see Chapter 5). Accountability concerns are important to both donors and governments in driving the investment in evaluation but perhaps even more important are those relating to learning. In short, only by careful and independent study of how well arrangements put in place work can future interventions be better planned in the pursuit of greater effectiveness. Again, what share of the always scarce resources might best be devoted to evaluation is a challenging question, but about 1% of total investment costs would align with the normal intensity of evaluation used in the IFIs and would likely represent more effort than has typically been the case in national and regional food security operations. Humanitarian concerns drive donors to significant investments in evaluation (Ashdown 2011).

Critical observation of interventions around the world post-2007 has catalyzed widespread interest in resilience building and in what a resilience framework implies for better understanding of the causes and consequences of acute vulnerability to natural and man-made disasters. Barrett and Headey (2014) proposed that the development community invest in a new multi-country system of sentinel sites to undertake long-term, high-frequency measurement and analysis of individual, household, and community resilience in the world's most vulnerable regions—a challenge that will be expensive to design and execute, let alone fund. However, they offered several cost-cutting approaches to make such an enterprise feasible as well as imperative. They concluded that (only) "such a cooperative commitment to high-frequency, long-term monitoring and evaluation can provide a crucial scientific evidence base for diagnosing and resolving the most troubling problems of hunger, poverty, and malnutrition and of building sustainable resilience."

11.3 What Can Asia Learn?

Asian countries need to reach out to the relevant international systems for information and evaluative data on the effectiveness of relevant food-security enhancing interventions. This is just one aspect, but an important one, of being conscientious members of the international community. The UN has many bodies concerned with food security. These include FAO, WFP, IFAD, based in Rome, and the Office for the Coordination of Humanitarian Affairs, whose mandate was expanded in recent decades to include the coordination of humanitarian response, policy development, and humanitarian advocacy. Under the UN umbrella is the important platform constituted as the Committee on World Food Security, hosted by the FAO and the Rome-based UN agencies. Policy makers in Asia should be attentive to the processes and products of the Committee on World Food Security as a means of accessing information on the lessons of experience around the world such as is reported annually in the State of Food Insecurity (SOFI). Policy makers should sustain their commitment to implement the Right to Food Guidelines and strive for the realization of the right to adequate food for everybody. That right is derived from the International Covenant on Economic, Social and Cultural Rights.

Studying the evaluated experience of diverse countries around the world, from Brazil to Haiti, will help identify potential innovations in determining improved national policies and practices, such as described in Part 3 of the SOFI 2014. Asian countries can learn from each other as well. Some Asian countries have successful experiences

in improving their food security, as has been revealed in the earlier chapters of this volume. Such experiences should help many other countries, not only in Asia but also elsewhere, to improve their food security.

A concept that has been receiving accelerating attention in recent policy dialogue concerning food insecurity is resilience. To quote one analyst influenced by the Ethiopian Productive Safety Net Programme:

> Resilience focuses attention on the idea that short-term shocks are malign not just because of their immediate effects but also because of their adverse long-term consequences. This idea is especially important in the context of addressing chronic undernutrition, given the compelling body of evidence showing that not only do shocks and stressors such as civil war and drought have immediate effects on preschool children's nutritional status but that these effects persist into adulthood. In turn, this idea takes us to a final implication of a resilience lens on development. Children in households with greater resilience are likely to be better nourished and better schooled; in turn, as adults, these children will likely be more resilient to the shocks and stressors they face. A resilience lens gives especial importance to human capital formation (health, schooling, nutrition) as a means of building sustainable resilience; it creates a virtuous circle of development (Hoddinott 2014: 25).

11.4 Other Key Issues Asia Needs to Address to Achieve Better Food Security

In contemporary societies, where overt conflict has been contained, the major issues are: (i) for countries that depend largely on domestic food production for food availability, to sustain the growth of productivity through stable investment in R&D and infrastructure and its maintenance as has been done well in the PRC and to a significant extent in India, and (ii) to invest in reliable and effective social protection schemes where these are not already in place. Apart from the obvious virtue of avoiding destabilizing conflict, these are the key issues identified and elaborated in sections 11.2 and 11.3.

To quote from the recent considered judgment of the major international authorities, by extracting the final two key messages of SOFI 2014:

> Sustained political commitment at the highest level is a prerequisite for hunger eradication. It entails placing food security and nutrition at the top of the political agenda and creating an enabling environment for improving food security and nutrition through adequate investments, better policies, legal frameworks, stakeholder participation and a strong evidence base. Institutional reforms are also needed to promote and sustain progress. Regions as well as countries have strengthened their political commitment to food security and nutrition.
>
> Hunger reduction requires an integrated approach, which would include: public and private investments to raise agricultural productivity; better access to inputs, land, services, technologies and markets; measures to promote rural development; social protection for the most vulnerable, including strengthening their resilience to conflicts and natural disasters; and specific nutrition programmes, especially to address micronutrient deficiencies in mothers and children under five (FAO, IFAD, and WFP 2014: 2).

This important theme of Resilience for Food and Nutrition Security was addressed at a May 2014 international conference in Addis Ababa (Fan, Pandya-Lorch, and Yosef 2014). There is still much to learn about the political economy of food security policy and its analysis, but recent donor efforts are adding to an improved understanding in this domain (Resnick 2015).

A further timely overview is provided by Timmer:

> In countries that have managed to confront and cope with the challenges of food insecurity over the past two centuries, markets have done the heavy lifting. Markets serve as the arena for allocating society's scarce resources to meet the virtually unlimited needs and desires of consumers: no other mechanism can efficiently signal fluctuations in scarcity and abundance, the cost of labor, or the value of commodities. But markets fail at tasks that society regards as important; thus, governments have had to intervene to stabilize the economic environment and provide essential public goods, such as transportation and communications networks, agricultural research and development, and access to quality health and educational facilities. Ending hunger requires that each society find the right balance of market forces

> and government interventions [through well-articulated negotiation between government and economic institutions] to drive a process of economic growth that reaches the poor and ensures that food supplies are readily, and reliably, available and accessible to even the poorest households. But locating that balance has been a major challenge for many countries, and seems to be getting more difficult as the global economy becomes more integrated and less stable. *Food Security and Scarcity* explains what forms those challenges take in the long run and short term and at the global, national, and household levels (Timmer 2014: back cover).

11.5 Conclusions

Based on the global experience since 1950, Asia seemingly has more to teach than to learn from the rest of the world that institutions matter. Food security has greatly improved over these recent decades in Asia, however, with the continuing large numbers of undernourished people, especially in South Asia (FAO, IFAD, and WFP 2014), there is much yet to be done to adequately address the issue of food insecurity. Asian countries need to assess their national situations, formulate the most appropriate policies, and make the necessary investments. Some of the necessary investments will take time to deliver the needed fruit, such as better-performing national agricultural research systems. Others such as improved national extension systems can deliver more quickly. Yet others, such as improved transport facilities and irrigation systems also take time to be implemented and to become effective in delivering greater food security. Across all the domains of potential intervention, the most critical elements relate to governance (Birner 2009a, 2009b) and are often problematic. Early rather than later action is clearly better. The IFIs and others can be helpful in this, and for Asia in particular, the Asian Development Bank can do much to help national and regional governments and economic institutions do better to achieve much-needed enhanced food security.

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12

Conclusions and Implications

Zhang-Yue Zhou and Guanghua Wan

12.1 Introduction

In this book, we investigated the food security practices of selected countries in Asia. The main purpose of this study was to discover why some countries have higher levels and others have lower levels of food security, and how countries in Asia can learn from each other to further improve their food security in the future. In this final chapter, Section 12.2 provides a summary of major findings. In Section 12.3, we draw some implications for policy and for future research. A brief account of how food security may evolve in the near future in Asia is offered in Section 12.4.

12.2 Summary and Conclusions

Comparing country experiences has revealed that there are some common factors that affect food security, although in different ways. Some of these factors contribute to improving food security, while others deter a country's food security. There are also factors that do not have a significant impact on a country's food security.

Factors that facilitate a higher level of food security include

- responsible governments with accountable officials, efficient operations, and transparent policy processes;
- institutional arrangements that promote sustained economic development and equitable income distribution and redistribution;
- institutions that deter corruption;
- laws and regulations that enable the market to function well; and
- adequate levels of investment in agricultural key infrastructure and agricultural research, development, extension, and education.

Factors that impede a country's food security include

- Forced collective farming,
- Compulsory delivery of food from farmers to the government,
- Absence of a market or a heavily controlled market,
- High incidence of poverty and severe income inequalities,
- Inadequate use of trade by a country, and
- Disharmonious international trade institutions that disturb trade.

Factors that do not have deterministic impacts on food security include:

- size of a country's population,
- availability of food production resources,
- cultural traditions, and
- weather conditions.

The presence of those factors that impede food security negatively affect a country's food security. The presence of those factors that contribute to improving food security help a country improve its food security. Among these contributing factors, strong government and economic institutions are the most fundamental.

A country can achieve a higher level of food security if

- the government of the country is held accountable to its people;
- it accepts that ensuring the food security of its citizens is its responsibility;
- its operations are transparent and efficient;
- corruption is effectively curbed; and
- markets are allowed to function more freely and food producers are offered financial rewards that are comparable to people working in other industries.

Countries in Asia with low levels of food security need to first look into how they are governed, not how economically poor they are or how short of resources they are. They need to pay attention to the most fundamental forces that affect food security: get their institutions right, and foster strong institutions in their country. Their governments need to accept that ensuring food security is their responsibility. The right to secure food intake by every individual should be written in, and protected by, law.

12.3 Implications

Valuable implications can be drawn from the cross-country comparisons and analyses. The most important implication based on the findings of this book is that countries have to get their institutions right if they wish to achieve a high level of food security for their people. On the one hand, Israel, Japan, the Republic of Korea, and Singapore have all achieved high levels of food security, and they all have strong institutional settings, with high levels of democracy, strong judiciary systems, and low levels of corruption. On the other hand, the levels of food security in Bangladesh, the People's Republic of China (PRC), Indonesia, the Democratic People's Republic of Korea, and Pakistan are low, and they all have weaker institutional arrangements, as reflected by the high levels of corruption.

12.3.1 Policy Implications

Getting the Institutions Right

For countries with low levels of food security, it is essential to reform their governments and economic institutions. Government institutions are established to ensure that governments are accountable to their citizens, their policy processes are transparent, and their operations are efficient. Economic institutions are set up to protect and facilitate markets to play a major role in coordinating food production and distribution. Strong, effective, and independent judiciary systems are present to ensure that government and economic institutions are strong and that corruption is low.

Partial achievements of these institutional fundamentals may help a country improve its food security to some extent but may not help achieve a higher level of food security. The PRC's efforts at reforming its economic institutions have helped the country improve its food availability enormously. However, the lack of reforms in government institutions has prevented the country from achieving a higher level of food security.

Growing the Economy and Sharing the Proceeds of the Growth Equitably

Countries with low income levels and low food security levels need to grow their economies diligently and share the benefits resulting from economic growth among all the citizens equitably. There are no grounds for these countries to claim that their low level of food security is due to their low level of income. In the first instance, these countries have

failed in growing their economies. The economies of all the selected countries in this book have suffered from wars (the PRC, Indonesia, Japan, the Democratic People's Republic of Korea, the Republic of Korea, and Pakistan) or had a low starting point when their countries were established (Bangladesh, Israel, and Singapore). However, some countries' economies have expanded impressively, while others have grown limitedly.

Examining the causes of faster or slower economic growth is beyond the scope of this book. Nonetheless, numerous studies have demonstrated that institutional arrangements conducive to economic growth are essential. Hence, again, these low-income countries need to get their institutions right to enable their economic growth.

Higher economic growth alone is not sufficient to improve a country's food security at the national level in general and at the household and individual level in particular. Proceeds from faster economic growth need to be shared among all citizens equitably. Social security safety nets should be established and operated efficiently so that all residents have access to adequate amounts of food for healthy living and productive activities.

Other Important Implications

Investments in agriculture. Maintaining an adequate level of investment in key agricultural infrastructure and agricultural research and development (R&D), extension, and education is crucial for a country to improve its food security. Food output expansion chiefly comes from improvements in agricultural total factor productivity, which in turn relies on improvements in a country's key infrastructure, advancements in R&D, and the level of agricultural extension and education. Returns from investments in agricultural R&D are very high. Hence, there is no justification for a government not to maintain an adequate level of investment in agriculture if it really wishes to improve the country's food security.

A designated government body in charge of food security. Having a designated body in charge of a country's food security is important during both peacetime and food emergencies. In peacetime, such an agency would be charged with responsibilities of routine management of a country's food security matters, including taking measures to avoid food insecurity crises and recognizing potential or emerging problems and crises. During crises, this body would take a leading role in responding to emergencies appropriately and effectively. It would have the authority to seek the cooperation of other departments and deploy necessary resources to handle emergencies.

Handling food emergencies according to their severity. This approach used in Israel and Japan holds valuable lessons for other countries to follow. In these two countries, resources to cope with food emergencies have already been appointed. Some are at the immediate disposal of a designated government agency, while others are ordinary resources that exist in society but can be easily mobilized at times of need. The level of emergency determines the deployment of such resources. This approach of food emergency handling by distinguishing the level of severity is cost-effective. Otherwise, resources can be easily wasted, for example, using resources to manage a country's food security while there is no crisis.

Dynamic food security policies. Food demand and supply situations and the forces affecting them often change, sometimes abruptly. Policies to manage a country's food security need to be modified to suit the situation. Japan's Basic Plan for Food, Agriculture and Rural Areas, which is guided by its 1999 Food, Agriculture and Rural Areas Basic Act and is updated every 5 years, is a good example from which other Asian countries can learn. To ensure that a country's food security management is dynamic, there is a need to build analytical and advisory capacities in food policy analysis.

Role of the private sector. The private sector can play an important role in complementing the achievement of a higher level of food security in a country, at least during peacetime. Its operations in the market can spare public resources for deployment in other needed areas. Rather than worrying about the potential destruction caused by private operations, what is needed is to establish essential regulatory frameworks under which the private sector can work in harmony with public efforts in improving the country's food security and under which unwanted activities are forbidden or penalized. This requires the presence of strong institutions in the country, especially strong government and economic institutions.

Investing in overseas food production and exporting. Where circumstances permit, food-importing countries should proactively seek opportunities to produce more food in other countries. Such commercial investment helps the investing country's food security as a result of increased global food supply, no matter whether the food is exported back to the home country. Another beneficial investment is to help exporting countries to export. Again, the exported food does not have to go to the investing country but can be exported to any country. Japan has been leading in these fronts.

Contributing to world peace. Most countries in Asia, especially in East Asia and Southeast Asia, will increasingly rely on imports to maintain their domestic food supplies. As such, stable food

imports will become more important. Such import stability can be best protected by world peace. In this regard, making contributions to long-term world peace would be most rewarding. An individual country's or joint efforts to dissolve any forces that may cause regional or global unrests should receive serious attention from Asian countries.

Supporting harmonious global trading institutions. Even in a peaceful world, trade barriers exist, and trade disruptions occur (e.g., the 1973 embargo on United States soybean exports to Japan, and the widespread food export bans during the 2007–2008 food price crisis). For countries that depend heavily on imports to manage their food security, any such disruption can significantly derail their food security strategies (e.g., turning to higher self-sufficiency, which is costly and not good for any country in the long run). Hence, it would be most beneficial for Asian countries to contribute to the establishment and maintenance of harmonious global trading institutions, through which trade disruptions can be minimized.

Reducing food waste. In all countries, either developed or developing, there is a huge potential to reduce food waste at all stages from post-harvest to the table. New technologies should be developed to reduce waste between post-harvest and cooking. Consumers need to be educated to reduce food waste at all stages of purchasing, storing, cooking, and eating.

Safeguarding food safety and quality. In recent decades, on the one hand, soil, water, and air pollution have been widespread and serious in many fast-growing economies, which has posed significant challenges to producing quality and safe food in many countries. On the other hand, the demand for better quality and safer food by consumers in such fast-growing economies is increasing. Governments in Asia need to pay due attention to the provision of quality and safe foods to their citizens, which is an important part of achieving a high level of food security.

12.3.2 Implications for Future Research

Emerging issues for attaining food security differ between developed and developing countries and between different countries. Future food security research needs to take into consideration the circumstances peculiar to individual countries. However, country-specific circumstances should not be used as excuses for deterring the adoption of measures that have been proven to be effective in improving food security.

For developed countries with a comfortable level of food security, research efforts need to be focused on (i) how to secure a stable and

reliable food supply to sustain the high level of food security, and (ii) how to reveal and measure food insecurity at the household and individual levels and develop countermeasures to combat such insecurity at the micro level.

Issues that require research efforts for improving food security in less food-secure developing countries are more complex and challenging. As has been emphasized elsewhere in this book, researchers should first look into the fundamental causes of why the level of food security in a country has not been higher. There are valuable experiences from other countries that have been proven effective in improving food security. Then, it is up to researchers to explore why such experiences cannot be adopted in the less food-secure countries. Studies that explore how to remove the obstacles that prevent the adoption of proven experiences and other effective policies would be most valuable to the less food-secure countries.

It is unlikely that certain fundamental problems of the less food-secure countries can be rectified in a short time period although efforts are needed to make continuous improvements. Studies that examine urgent issues affecting present food security levels should be routinely carried out. For countries with low levels of food security, boosting and ensuring a stable food supply is the most pressing issue. For some transition economies where food availability has become adequate, more efforts need to be devoted to studying the economics of a safe and quality food supply. For both these two groups of countries, food insecurity at the household and individual levels should also receive close attention.

Research is also needed to address how less food-secure countries can better learn from the more food-secure countries about food security management approaches. Aspects that deserve particular attention include the role of the private sector in achieving food security, handling food emergencies according to the level of severity, and the practice of a highly coordinated approach to manage food security within a country, e.g., through a dedicated government body with due authority to solicit cooperation from other government bodies.

12.4 Looking Ahead

In the foreseeable future, family-based small-scale farming is likely to dominate in agricultural production in many Asian countries. Small-scale operations often suffer from lower technical and economic efficiencies although they may have better allocative efficiency. Family-based farming, however, does not have to be small in its operations. This is an important area that deserves attention

from national governments in Asia. It would be wise for them to develop plans to further improve their agricultural productivity and to help less efficient farmers to exit farming so that remaining farms can expand their operation scales.

Stressing the importance of small farms in achieving a country's food security is a fantasy. Overstating the role of small-scale farming in a country's quest for a higher level of food security is, at best, maintaining the status quo; at worst, it would mean leading the country toward worse food insecurity. If farmers are not helped in exiting farming rapidly enough, farm operations will only become smaller over time. The absence of policies to help farmers exit reflects either the lack of understanding of the limitations of small-scale farming or the intention to deliberately keep many small farms for easy rule.

Having fewer farmers working the land, of course, should not be misunderstood to mean neglecting agriculture or doing away with farming. What is required is a more efficient agricultural sector that can produce more food with less labor and various other resources, such as the agricultural sector in Israel. The great success achieved in Israel demonstrates enormous hope and potential for food output to expand in many Asian countries.

However, for many less food-secure developing countries to develop more efficient agriculture requires reforms to their current institutional arrangements. Without such reforms, it is not possible for their farmers, their agricultural sector, and their rural areas to be equitably treated within their society. In the absence of reforms, resources cannot be equitably deployed to foster an efficient agriculture. Unfortunately, the reality is that in many such countries, those that have the power to make changes, including both politicians and the better-off public (whose food intake has been rarely an issue), are beneficiaries of the current institutional arrangements. Many of them have little motivation to carry out reforms. Hence, it is unlikely that substantial institutional reforms will be carried out any time soon in these countries.

As such, countries in Asia with high levels of food security today will continue improving their food security. Countries with low levels of food security will continue living with low levels of food security, unless the beneficiaries in these countries are willing to support reforms to their current institutions, especially the government and economic institutions.

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Food Insecurity in Asia

Why Institutions Matter

Achieving food security is of utter importance in any nation. However, food insecurity still exists in many developing countries, with Asia home to almost 65% of the world's undernourished. This calls for urgent action.

Studies that examine differences in food security performance among Asian countries are sparse. This book fills this gap by providing cross-country comparative perspectives on food security improvements. Such a study can be valuable for Asian countries to learn from each other. Country studies included in this book are Bangladesh, the People's Republic of China, Indonesia, Israel, Japan, the Democratic People's Republic of Korea, the Republic of Korea, Pakistan, and Singapore. These countries share similarities but also differ in terms of their institutional settings, natural resource endowments, population size, and level of economic development. This study concludes that institutional differences are the most fundamental determinants of divergent food security status.

This book will be useful reading for anyone who is interested in food security of individual Asian nations and Asia as a whole, including officials of national governments and international bodies, researchers, and university students.

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