



AT A GLANCE
FOOD
INSECURITY
IN ASIA

Why Institutions Matter



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WHY INSTITUTIONS MATTER

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Contents

Boxes, Figures, and Tables	iv
Abbreviations	vi
Executive Summary	vii
1. Introduction	1
1.1 The Large Number of Undernourished in Asia: Disturbing and Unacceptable	1
1.2 Food Security Status between Regions and Countries: Wide Differences	1
1.3 What Are the Factors Responsible for the Differences?	4
1.4 Institutions: What Do We Mean?	5
1.5 The Objective and Structure of the Report	6
2. Quest for Improved Food Security: Country Experiences	9
2.1 Bangladesh	9
2.2 People's Republic of China	15
2.3 India	23
2.4 Indonesia	30
2.5 Israel	34
2.6 Japan	42
2.7 Democratic People's Republic of Korea	50
2.8 Pakistan	55
2.9 Singapore	58
2.10 Republic of Korea	59
3. Achieving Food Security: Country Experiences Compared	71
3.1 Similarities and Differences	71
3.2 Empirical Verifications	77
3.3 Implications	79
3.3.1 Getting the Institutions Right	79
3.3.2 Economic Growth and Sharing Its Proceeds Equitably	79
3.3.3 Other Important Implications	80
4. Looking into the Future: The Role of the PRC and India in Regional and Global Food Security	83
4.1 Food Demand and Supply in the PRC and India: The Current and the Future Scenarios	83
4.2 Scenario Design	89
4.3 Data	94
4.4 Findings	95
4.4.1 Baseline Scenarios	95
4.4.2 Best and Worst Scenarios	98
4.4.3 Changes in the PRC and India's Food Self-Sufficiency Ratios	101
4.4.4 Global and Regional Impact of Changes in the PRC and India's Food Demand and Supply	103
4.4.5 Some Qualifications	104
4.5 Conclusions and Implications	105
5. Conclusions and Recommendations	108

Boxes, Figures, and Tables

Boxes

1.1	Two International Targets for Hunger Reduction	3
1.2	The Global Food Security Index of the Economist Intelligence Unit	3
2.1	Corruption Perceptions Index	9
2.2	Democracy Index	10
2.3	Corruption and Food Security	14
2.4	Food Rationing in Israel	35
2.5	Food Stocks and Food Emergency Management in Israel	38
2.6	Cooperative Communities in Israel's Agriculture: Development and Evolution	39
2.7	Japan's Basic Act and Basic Plans	47
2.8	Japan's Food Security Manual for Emergency Situations	49

Figures

1.1	Asia's Share of the Undernourished in the World Developing Regions, 2014–2016	1
1.2	The Undernourished in Asia: Regional Differences	2
2.1	Self-Sufficiency Ratio of Cereals in Bangladesh, 1961–2013	11
2.2	Population and Food Security of Bangladesh, 1990–2011	12
2.3	Population and Food Security in India, 1990–2011	25
2.4	Average Dietary Energy Supply Adequacy, and Protein and Fat Supply of Indonesia, 1961–2013	30
2.5	Self-Sufficiency Ratios and Import Dependency Ratios of Rice, Maize, and Soybeans in Indonesia, 1961–2013	31
2.6	GDP Growth and the Prevalence of Undernourishment in Indonesia, 1991–2013	33
2.7	Energy, Protein, and Fat Supplies in Israel, 1961–2011	36
2.8	Self-Sufficiency Ratio and Import Dependency Ratio of Major Foods in Israel	37
2.9	Changes in Food Imports, Production, and Consumption in Japan since 1930	44
2.10	Energy, Protein, and Fat Supplies in Japan, 1961–2011	45
2.11	Trends of Soybean in Brazil: Production and Export	46
2.12	Dietary Intake per Capita per Day in the Democratic People's Republic of Korea	51
2.13	Self-Sufficiency Ratio and Import Dependency Ratio of Wheat in Pakistan, 1961–2013	55
2.14	Dietary Intake per Capita per Day in the Republic of Korea	61
2.15	Self-Sufficiency Ratio and Import Dependency Ratio of Major Foods in the Republic of Korea	64
4.1	Food Self-Sufficiency Ratios and Import Dependency Ratios in the People's Republic of China and India, 1961–2013	87
4.2	Food Self-Sufficiency Ratios in the People's Republic of China and India, 2011, 2030, and 2050	101
4.3	Food Self-Sufficiency Ratios under Three Scenarios in the People's Republic of China and India, 2030	102

Tables

1.1	Differences in Regional Food Security Status in Asia	2
1.2	Progress Made in Achieving the World Food Summit and Millennium Development Goal Targets in Selected Asian Countries	4
2.1	Key Indicators of Food Security in Bangladesh	13
2.2	Per Capita Consumption of Major Food Items in the People's Republic of China, 1952–1985	16
2.3	Per Capita Nutrition Intake in the People's Republic of China, 1961–1985	16
2.4	Key Indicators of Food Security in the People's Republic of China	17
2.5	Per Capita Net Availability of Major Foods in India	24
2.6	Annual Per Capita Consumption of Different Commodities in India	24
2.7	Key Indicators of Food Security in India	26
2.8	Estimates of Energy Intake in Rural and Urban All-India	27
2.9	Key Indicators of Food Security in Indonesia	32
2.10	Supply of Macro Nutrients in Israel (per capita per day)	40
2.11	Key Indicators of Food Security in the Democratic People's Republic of Korea	52
2.12	Key Indicators of Food Security in Pakistan	57
2.13	Food Self-Sufficiency Targets in the Republic of Korea	65
3.1	Level of Food Security and Associated Variables of Selected Asian Countries, 2014	72
3.2	Estimation Results of the Food Security Function	79
4.1	Food Demand and Supply in the People's Republic of China and India	84
4.2	Population and GDP Growth in India and the People's Republic of China, Actual and Forecast	90
4.3	Possible Changes in Arable Land Area in Region Groups, 2011–2050	92
4.4	Scenario Assumptions	93
4.5	Region Aggregation	94
4.6	Commodity Aggregation	95
4.7	Change in Food Demand, Supply, and Prices in 2030	96
4.8	Change in Food Trade of the People's Republic of China and India in 2030	96
4.9	Change in Food Demand, Supply, and Prices in 2050	97
4.10	Change in Food Trade of the People's Republic of China and India in 2050	98
4.11	Change in Food Demand, Supply, and Prices in 2030 (Best Scenario, change in percentage points in relation to the 2030 baseline scenario)	99
4.12	Change in Food Trade of the People's Republic of China and India in 2030 (Best Scenario, change in percentage points in relation to the 2030 baseline scenario)	99
4.13	Change in Food Demand, Supply, and Prices in 2030 (Worst Scenario, change in percentage points in relation to the 2030 baseline scenario)	100
4.14	Change in Food Trade in 2030 of the People's Republic of China and India (Worst Scenario, change in percentage points in relation to the 2030 baseline scenario)	101
4.15	Regional Differences of Self-Sufficiency Ratios under Various Scenarios	103
4.16	Prices Change at the Regional Level (in percentage points in relation to the 2030 baseline scenario)	104

Abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ADB	Asian Development Bank
ADER	average dietary energy requirement
ADESA	average dietary energy supply adequacy
AMS	aggregate measurement of support
APTERR	ASEAN Plus Three Emergency Rice Reserve
APQMS	Agricultural Product Quality Management Service
CPI	corruption perceptions index
CPC	Communist Party of China
EIU	Economist Intelligence Unit
FAO	Food and Agriculture Organization
GDP	gross domestic product
GFSI	Global Food Security Index
GTAP	Global Trade Analysis Project
ha	hectare
IDR	import dependency ratio
kCal	kilocalorie
kg	kilogram
km ²	square kilometer
MDG	Millennium Development Goal
mt	million ton (1 ton = 1000 kg)
PDS	public distribution system
PRC	People's Republic of China
PPP	purchasing power parity
R&D	research and development
SSR	self-sufficiency ratio
TFP	total factor productivity
TPDS	targeted public distribution system
TRQ	tariff rate quota
US	United States
WFS	World Food Summit
WTO	World Trade Organization

Executive Summary

While overall food security has improved remarkably in Asia in the past few decades, food insecurity still prevails in many developing countries in the region. According to the Food and Agriculture Organization (FAO) of the United Nations, over 500 million Asians still suffer from hunger. Sound strategies need to be developed and actions undertaken to fight food insecurity in Asia.

In the meantime, there have been success stories in many parts of Asia where food security has been maintained or achieved. Exploring the lessons and experiences behind the success or failure in the quest for food security is clearly important and valuable.

In this report, we postulate that institutional differences between countries are the most *fundamental* determinants of their divergent food security status. More specifically, we will take a comparative approach, focusing on the roles and effects of governmental and economic institutions on food security in the selected countries of Bangladesh, the People's Republic of China (PRC), India, Indonesia, Israel, Japan, the Democratic People's Republic of Korea, Pakistan, Singapore, and the Republic of Korea. These countries share some similarities, but also differ in terms of their institutional settings, natural resource endowments, population size, and the level of economic development.

Our study reveals that Israel, Japan, Singapore, and the Republic of Korea have achieved or maintained food security. The PRC and Indonesia have managed to improve their food security although more remains to be done. But Bangladesh, India, the Democratic People's Republic of Korea, and Pakistan continue to face formidable challenges. Some of the more specific findings are as follows:

- The endowment of natural resources and the size of population are not significant determinants of food security;
- Economic growth and thus higher income is crucial for better food security;
- Higher levels of democracy generally lead to higher levels of food security;
- Higher degrees of corruption lead to lower levels of food security;
- Inequality and poverty reduce a country's level of food security;
- Investment in agriculture holds the key to improved food security;
- How food production is organized affects food security significantly;
- Food procurement through administrative forces has almost always been a failure;
- The market has an important role to play in achieving food security;
- Diversifying food import sources has attracted much attention;
- Regional cooperation is yet to receive more substantial endorsement;
- Reducing food wastage is on the agenda.

The most important implication is that getting the institutions right is fundamental to improving and achieving food security. Good examples include Israel, Japan, Singapore, and the Republic of Korea, as they have achieved or maintained food security due to strong institutional settings such as high levels of democracy, well-functioning judiciary systems, and lower levels of corruption. On the other hand, the level of food security in Bangladesh, the PRC, India, Indonesia, the Democratic People's Republic of Korea, and Pakistan is relatively low—they all have weak institutional arrangements.

Clearly, reforming governmental and economic institutions is essential. It is vital to ensure that governments are accountable to their citizens, their policy processes transparent, and their operations efficient. Economic institutions should be established to enhance and facilitate the role of markets in food production and distribution. Needless to say, effective

and independent judiciary systems are essential to ensure that the governmental and economic institutions function properly and in particular to prevent or minimize corruption.

While growth is important, growth alone is insufficient to improve a country's food security unless it is inclusive. In addition, social security safety nets should be established and well operated so that all residents have the access to an adequate amount of food.

Less food-secure countries need to take into account the following measures:

- Maintain an adequate level of investments in key agricultural infrastructure and agricultural research and development (R&D), extension, and education;
 - Have a designated government body in charge of food security that coordinates with other departments and in particular deploy necessary resources to handle food emergencies;
 - Handle food emergencies according to their severity;
 - Ensure food security policies to be dynamic to respond to changing circumstances;
 - Engage the private sector in the pursuit of food security, at least during peacetime;
- Pay more attention to reduce food wastage;
 - Assist, where possible, offshore food production to boost the global food supply;
 - Support the establishment and maintenance of harmonious global trading institutions so that trade can be used to strengthen food security in the home country;
 - Protect natural resources and the environment for sustainable production of safe and quality foods.

The crucial importance of sustained adequate investment in agriculture cannot be overemphasized. In the years to come, Asian agriculture has to produce more food with fewer resources to feed its increasing number of people. This can only be achieved through a far-more efficient agriculture sector, where adequate investment in crucial agricultural infrastructure, R&D, extension, and education will help.

In short, despite the impressive progress many Asian countries have made so far, challenges to keep improving food security are substantial. In addition to a large and rising population, limited and declining resources, environmental degradation, and the impact of climate change, the most important challenge lies in reforming institutions to achieve a higher level of food security.

1 Introduction

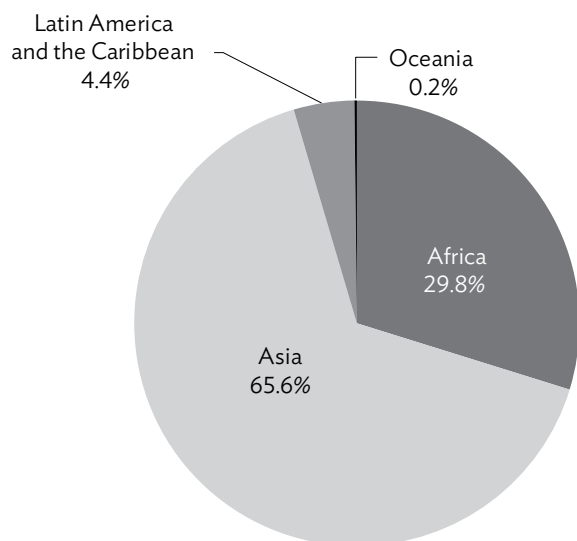
1.1 The Large Number of Undernourished in Asia: Disturbing and Unacceptable

Achieving food security is of huge importance for human development and peace in any nation. However, food insecurity still prevails in many developing countries in Asia. According to the latest State of Food Insecurity in the World report, during 2014–2016, the number of chronically undernourished people in Asia’s developing countries was still as high as 512 million (globally, 780 million chronically undernourished are living in developing countries) (Figure 1.1) (FAO, IFAD, and WFP 2015: 44–47).

As a whole, Asia has made remarkable progress in feeding its huge populations and improving its food security since World War II. However, the still-tenacious food insecurity status of over 500 million hungry people in today’s Asia is disturbing and unacceptable. Strategies need to be developed and measures need to be taken to improve the food security of this large number of underprivileged people.

Sound strategies and actions must be based on insights from cases of success and failure in attaining food security. Although there are still a large number of Asians living with food insecurity, there have been some successes in achieving food security, or in significantly reducing food insecurity, in many parts of Asia. Scrutinizing the forces responsible for the success or failure of Asia’s quest for achieving food security can offer valuable lessons and experiences for countries to learn from each other for improved food security in the future.

Figure 1.1 Asia’s Share of the Undernourished in the World Developing Regions, 2014–2016



Sources: FAO, IFAD, and WFP (2015: 44–47).

1.2 Food Security Status between Regions and Countries: Wide Differences

There have been large differences in the status of food security between regions and countries within Asia. Some regions have improved their food security or have reduced their level of food insecurity with greater success compared with others. Table 1.1 shows that the total number of undernourished in East Asia and Southeast

Table 1.1 Differences in Regional Food Security Status in Asia

	Number of People Undernourished (million)		Proportion of Undernourished in Total Population (%)	
	1990–1992	2014–2016	1990–1992	2014–2016
Caucasus and Central Asia	9.6	5.8	14.1	7.0
East Asia	295.4	145.1	23.2	9.6
South Asia	291.2	281.4	23.9	15.7
Southeast Asia	137.5	60.5	30.6	9.6
West Asia	8.2	18.9	6.4	8.4
Total	741.9	511.7		

Sources: FAO, IFAD, and WFP (2015: 44–47).

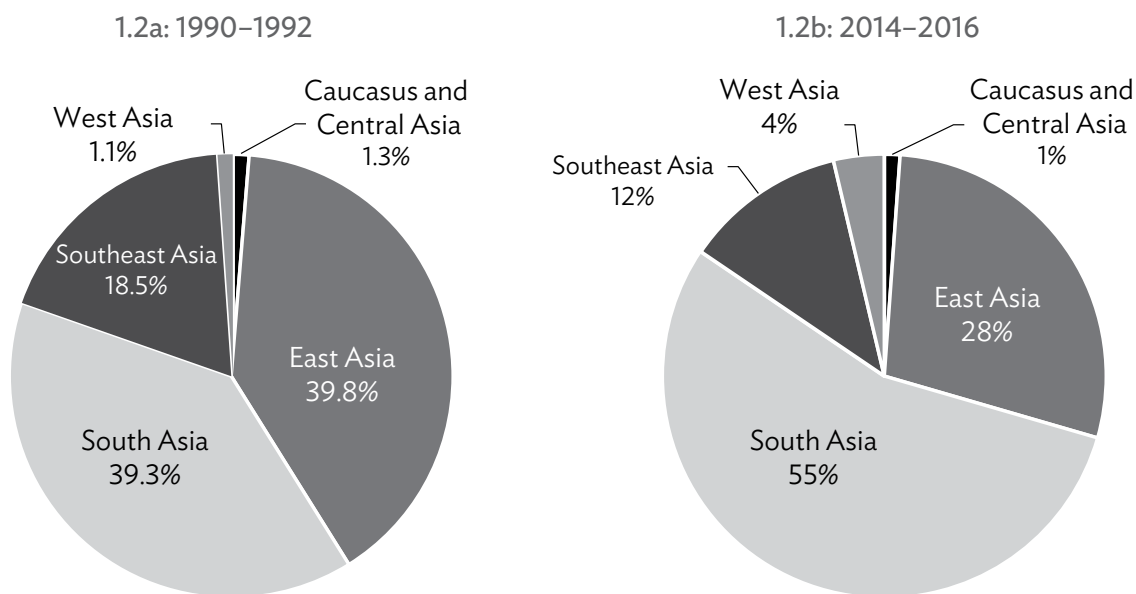
Asia has dropped significantly from 295 million and 138 million in 1990–1992 to 145 million and 61 million in 2014–2016, respectively. In South Asia, however, the

progress has been less impressive, with the number of the undernourished dropping from 291 million in 1990–1992 to 281 million in 2014–2016. In West Asia, the number of the undernourished has actually increased during the same time period, from 8 million to 19 million (Table 1.1).

In terms of their share of the undernourished in Asia’s total, those in the Caucasus and Central Asia remained at 1% between 1990–1992 and 2014–2016, while East Asia and Southeast Asia experienced a major drop from 40% and 19% to 28% and 12%, respectively (Figure 1.2). On the other hand, the share of West Asia increased from 1% to 4%, while that of South Asia increased from 39% to 55%.

Three of the five subregions in Asia—i.e., East Asia, Southeast Asia, and the Caucasus and Central Asia—have made notable progress since 1990 in achieving the two internationally established hunger-reduction targets (Box 1.1). Table 1.1 shows that East Asia and Southeast Asia have achieved both the World Food Summit (WFS) and the Millennium Development Goal 1 (MDG 1) targets, with the Caucasus and Central Asia achieving only the MDG 1 target. While wars, civil unrest, and displacement of refugees have frustrated efforts to

Figure 1.2 The Undernourished in Asia: Regional Differences



Sources: FAO, IFAD, and WFP (2015: 44–47).

Box 1.1 Two International Targets for Hunger Reduction

Two international targets for hunger reduction were agreed upon, and the year 2015 was the end of the monitoring period for them.

The first is the World Food Summit (WFS) goal pledged by representatives of 182 governments at the WFS held in Rome in 1996, “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 1 (MDG 1) hunger target pledged by 189 nations in 2000, 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. MDG 1 includes a target to halve the proportion of people who suffer from hunger between 1990 and 2015.

The Food and Agriculture Organization (FAO) of the United Nations monitored the progress toward achieving the WFS and the MDG 1 hunger targets, using the 3-year period of 1990–1992 as the starting point (FAO, IFAD, and WFP 2015: 9).

Source: Compiled by authors based on FAO, IFAD, and WFP (2015).

reduce hunger in West Asia, the performance in South Asia is less satisfactory. The latter has only reduced the number of undernourished people by 9.8 million (from 291.2 million in 1990 to 281.4 million in 2014), a reduction of only 3.4%, being 46.6% short of the 50% target set by the WFS goal. With regard to the MDG target, the proportion of the undernourished in the total population declined from 23.9% in 1990 to 15.7% in 2014, again short of the target (FAO, IFAD, WFP 2015: 46).

Wide differences also exist at the country level. Some countries, chiefly the developed ones, have achieved very high levels of food security, while others, chiefly the developing ones, have made limited progress. According to the Global Food Security Index (GFSI) prepared by the Economist Intelligence Unit (EIU) (Box 1.2), four Asian countries, i.e., Singapore, Israel, Japan, and the Republic of Korea, have achieved a very high level of

Box 1.2 The Global Food Security Index of the Economist Intelligence Unit

The Economist Intelligence Unit (EIU) designed and constructed the Global Food Security Index (GFSI), which is sponsored by DuPont. The index is published annually with the first one published in 2012.

The GFSI considers the core issues of affordability, availability, and quality and safety across a set of 109 countries. It is a dynamic quantitative and qualitative benchmarking model, constructed from 28 unique indicators, which measures these drivers of food security across both developing and developed countries.

The overall score for the GFSI (on a range of 0–100, where 100 is the most favorable) is calculated from a simple weighted average of the scores of the three categories (i) affordability, (ii) availability, and (iii) quality and safety.

The EIU makes the complete results of each annual model available in an Excel workbook for download. The workbook provides an advanced interactive functionality that facilitates easy and in-depth exploration of the model for users who prefer more expansive access to the data.

A user guide is also available to help users navigate the GFSI model. It provides information on how to access findings from the model, including rankings, scores, raw data, and in-depth and comparative results for each country and indicator.

The GFSI provides a worldwide perspective on which countries are the most and least vulnerable to food insecurity. The indexes can be downloaded from the EIU’s website at <http://foodsecurityindex.eiu.com>.

Source: Compiled by authors based on EIU (2015).

food security, being ranked as the 2nd, 19th, 21st, and 26th, respectively, in 2015. On the other hand, some other countries were ranked very low, e.g., India (68th), Indonesia (74th), Pakistan (77th), and Bangladesh (89th) (EIU 2015: 10).

With reference to achieving the two internationally established hunger targets, the progress made by developing countries in Asia has also varied greatly.

Table 1.2 Progress Made in Achieving the World Food Summit and Millennium Development Goal Targets in Selected Asian Countries

(1)	Number of People Undernourished (million)				Proportion of Undernourished in Total Population (%)			
	1990- 1992 (2)	2014- 2016 (3)	% Change (3)/(2) (4)	Progress toward WFS Target (5)	1990-1992 (6)	2014- 2016 (7)	% Change (7)/(6) (8)	Progress toward MDG Target (9)
PRC	289.0	133.8	-53.7	Achieved	23.9	9.3	-60.9	Achieved
Democratic People's Republic of Korea	4.8	10.5	118.5	Worsened	23.3	41.6	78.4	Worsened
Bangladesh	36.0	26.3	-27.0	Progress	32.8	16.4	-49.9	Almost achieved
India	210.1	194.6	-7.4	Limited progress	23.7	15.2	-36.0	Progress
Pakistan	28.7	41.4	44.2	Worsened	25.1	22.0	-12.4	Limited progress
Indonesia	35.9	19.4	-45.9	Close to achieving	19.7	7.6	-61.6	Achieved

MDG = Millennium Development Goal, PRC = People's Republic of China, WFS = World Food Summit.
Sources: FAO, IFAD, and WFP (2015: 46).

Table 1.2 shows that the People's Republic of China (PRC) has achieved both targets, while the Democratic People's Republic of Korea has failed to achieve either of the two and, in fact, has experienced a worsening of the hunger problem. Indonesia has also made remarkable progress in reducing hunger and has almost achieved both targets. While Bangladesh's progress has also been commendable, that of India and Pakistan has been very limited (Table 1.2).

1.3 What Are the Factors Responsible for the Differences?

Studies on food security are not scarce. Various studies have examined the factors responsible for food security or food insecurity. Gibson (2012) provides a comprehensive review of such key factors. Some commonly cited factors are resource endowments, country and population size, the level of economic

development, and cultural or social differences. However, these factors are unable to explain the differences in the levels of food security attained by these Asian countries.

- **Resource endowments.** Israel, Japan, and the Republic of Korea have limited agricultural resources, while Singapore has even fewer resources. At the national level, none of these countries suffer from food insecurity problems. Ironically, as far as food security is concerned, they top Asian rankings according to the GFSI. In Asia, many countries have much better resource endowments than these countries, but have serious food insecurity problems. Another convincing example that suggests that resource endowment is not a determining factor of a country's level of food security is the drastic change in the PRC's food supply status. The PRC suffered from serious food shortage before the 1980s, but food supply today has been abundant; yet on a per capita basis, the country

has fewer resources today compared with the years before the 1980s.

- **Country and population size.** Both India and the PRC are large countries with large populations. Before the 1980s, the PRC suffered from chronic food shortage. India also experienced serious food shortage. Today, while India still has a large proportion of undernourished people, the PRC's food security has dramatically improved. But before the 1980s, the PRC's population was lower than today, yet it suffered chronically from food shortage. Today, the PRC's population has more than doubled, yet its food supply has become plentiful.
- **The initial economic level.** Many Asian countries suffered as a result of World War II. After the war, the per capita gross domestic product (GDP) of some Asian countries were not hugely different (e.g., in 1950, the Republic of Korea: \$854; the Democratic People's Republic of Korea: \$854; and Indonesia: \$840; in the 1990 international dollar) (Maddison 2015). However, the Republic of Korea improved its economy and subsequently food availability for its people, while the Democratic People's Republic of Korea has been struggling to get an adequate amount of food for its people. Indonesia's food security achievement is also far behind that of the Republic of Korea. In 1976, when the PRC's Cultural Revolution ended, the per capita GDP for the PRC, India, and the Democratic People's Republic of Korea was \$853, \$889, and \$2,841, respectively (Maddison 2015). By the 2010s, the PRC's food security level was much higher than India's. The PRC also provides food aid to the Democratic People's Republic of Korea. Singapore was poor when it started in 1965; yet it now has a secure food supply for its people.
- **Cultural or social differences.** Cultural traditions and social settings can affect food security to some extent; however, again they cannot be deterministic factors. Before the separation in 1945, the Democratic People's Republic of Korea and the 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 south, the number of undernourished people in

the north is still large. The PRC provides another convincing story: before 1980, people suffered chronically from undernourishment; since 1980, food has become readily available. Yet people, culture, and the society are largely the same.

These observations suggest that *many commonly held arguments cannot explain the significant variability in the levels of food security* attained by different Asian countries. Deeper determinants of food security must be found elsewhere. This report postulates that differences in institutions between countries are fundamentally responsible for the differences in their levels of food security.

It is noted that poverty is the root cause of malnutrition, e.g., most micronutrient deficiencies primarily affect the poor and disadvantaged households. Over the past 20 years, the distribution of income has worsened with economic growth in many countries, especially the developing countries, leading to rising inequality and poverty. Income inequality and poverty, if left unchecked, are seeds of social unrest, thus undermining a country's overall food security. However, in many cases, it is the poor quality of institutions in a country that results in poverty and inequality.

1.4 Institutions: What Do We Mean?

"Institutions are systems of established and embedded social rules that structure social interactions" (Hodgson 2006). Five primary institutions are found among all human groups (i) in determining kinship, (ii) in providing for the legitimate use of power, (iii) in regulating the distribution of goods and services, (iv) in transmitting knowledge from one generation to the next, and (v) in regulating our relation to the supernatural (Sociology Guide 2015). These five basic institutions can be referred to as family institutions, political (or governmental) institutions, economic institutions, educational institutions, and religious institutions.

While all these five primary types of institutions may affect the food security of a country, we argue that two in particular—governmental institutions and economic institutions—have the most determining influence over

a country's food security. In this report, we focus on the impact of these two sets of institutions on the food security of the selected countries.

Extending from this general definition of institutions, an economic institution is the set of rules and norms that govern the production and distribution of goods and services in any particular society. Examples include laws governing property rights and commercial transactions, court systems, and policy organizations such as regulatory agencies.

A governmental or political institution represents the set of rules and norms within which governments operate, including such concepts as 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 governmental and economic institutions are most important in affecting a country's food security, we postulate the following propositions:

1. A country achieves a higher level of food security if all the following three conditions are met:
 - (i) The government is elected by the citizens and is accountable to the citizens;
 - (ii) The government policy process is transparent;
 - (iii) The government operations are efficient.

When all three conditions are met, a country is most likely to achieve food security at a higher level. If any one of the conditions is not met, a country is unlikely to achieve food security, although it may be possible to improve some aspects of its food security, e.g., improved food availability.

2. 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 shortage).

Many aspects of a country's economic institutions can affect its level of food security. However, whether the market is allowed to play a major role in coordinating food production and distribution is most important. In countries where the market is allowed to work and

market failures are closely monitored and corrected, food security is likely to be achieved at a higher level.

If all the conditions in these two propositions are met, a country is expected to achieve a high level of food security.

1.5 The Objective and Structure of the Report

This report examines how institutions, in particular governmental and economic institutions, have affected the levels of food security in various Asian countries. It draws policy implications for national governments and international bodies, through improved institutions, to reduce poverty and inequality and thus achieve higher levels of food security nationally and globally. Its specific objectives include:

- investigating whether and how institutions of selected Asian countries have affected their food security status;
- examining the impact of institutional arrangements on poverty and inequality and subsequently on food security; and
- demonstrating how countries can learn from each other in terms of making institutional arrangements conducive to achieving higher levels of food security.

A cross-country comparative approach is used to help verify our research propositions and achieve the research objectives. Representative countries selected in this study include Bangladesh, the PRC, India, Indonesia, Israel, Japan, the Democratic People's Republic of Korea, Pakistan, Singapore, and the Republic of Korea. Findings of individual countries will be synthesized to demonstrate how institutions in major Asian countries affect food security and what lessons and experiences can be drawn from particular countries to help establish institutions that are conducive to improving food security in the future.

The next section looks at the evolving status of food security in the selected Asian countries and the practices they have adopted in their quest to improve food security over the past 6 decades. In the third

section, we compare country experiences; evaluate the influences of various forces on their food security status; and derive important lessons for countries to learn from each other for achieving higher levels of food security. The sheer size of the population and economy of the PRC and India and their potential regarding food production will not only have a significant impact on their future food security, but also that of Asia and

the rest of the world. Hence, the fourth section of this report is devoted to shedding some light on the impact of the PRC and India on global food security in 2030 and 2050 under various scenarios. In the fifth section, we conclude this report with recommendations for national governments and international bodies to achieve higher levels of food security nationally, regionally, and globally.

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2 Quest for Improved Food Security: Country Experiences

2.1 Bangladesh

In 1947, when Pakistan partitioned from India, it consisted of two geographically separate areas to the east and the west of India: East Bengal (and later East Pakistan) and West Pakistan. In 1971, East Pakistan became a sovereign country as the People's Republic of Bangladesh. It has a large population of some 160 million (the eighth largest in the world), but a relatively small area of land (some 130,170 square kilometers [km²]), making it a country with very high population density (1,218 persons per km² in 2014) (CIA, The World Factbook).

Bangladesh's per capita gross domestic product (GDP) is low by international standards. In 2014, it was \$2,991 (at purchasing power parity (PPP), 2011 constant) (World Bank 2015). The major problems facing this country include political instability, poor infrastructure, severe corruption, insufficient power supplies, and slow implementation of economic reforms (CIA, The World Factbook). In 2014, the Corruption Perceptions Index (CPI) for the country was 25% (Box 2.1 provides a brief explanation of the CPI), making it one of the most corrupt countries in the world (Transparency International 2015). Bangladesh is classified as a "hybrid regime" according to the Democracy Index, with an index score of 5.78 (or 57.8%) (EIU 2015) (Box 2.2 explains the Democracy Index in more detail). The overall food security level of Bangladesh has been low at 36.5 out of 100 in 2014 (EIU 2014).

Crops produced in Bangladesh include rice, jute, cotton, tea, wheat, sugarcane, potatoes, tobacco, pulses, oilseeds, spices, and fruit. Rice is by far the single most important agricultural product (the output of rice in 2013 was 34.4 million tons (mt) compared with wheat at 1.23 mt and maize at 1.49 mt). It also produces beef, mutton, goat meat, and poultry meat. The output of these meats is small, with each being around 0.2 mt per annum.

Box 2.1 Corruption Perceptions Index

Transparency International, a global movement with a vision of achieving a world free of corruption, which has an international secretariat in Berlin, publishes the Corruption Perceptions Index (CPI) annually since 1995 (all downloadable from its website). The CPI ranks countries and territories based on how corrupt their public sector is perceived to be. The data and methodology used in compiling this index are available at http://www.transparency.org/cpi2014/in_detail#myAnchor2

According to Transparency International, "corruption generally comprises illegal activities, which are deliberately hidden and only come to light through scandals, investigations, or prosecutions. There is no meaningful way to assess absolute levels of corruption in countries or territories on the basis of hard empirical data. ... Capturing perceptions of corruption of those in a position to offer assessments of public sector corruption is the most reliable method of comparing relative corruption levels across countries."

This index is expressed in a range of 0 to 100. The smaller the index (i.e., the closer it is to 0), the more corrupt a country is; the larger the index (i.e., the closer it is to 100), the less corrupt a country is. For example, the CPI for Singapore in 2014 was 84 (ranked 7 out of 175 countries), implying it is "very clean." For Bangladesh, this index was 25 in 2014 (ranked 145 out of 175 countries), indicating it is very corrupt. The most corrupt countries are the Democratic People's Republic of Korea and Somalia, both with a CPI of 8 in 2014 (with the former ranked the second last and the latter the last out of 175 countries). The least-corrupt country in 2014 was Denmark with a CPI of 92, and it ranked first out of 175 countries (Transparency International 2015).

Source: Compiled by authors based on Transparency International (2015).

Box 2.2 Democracy Index

According to the Economist Intelligence Unit (EIU), there is no consensus on how to define democracy (EIU 2014: 34). Nonetheless, it is generally agreed that, at a minimum, the fundamental features of a democracy include a government based on majority rule and the consent of the governed, the existence of free and fair elections, the protection of minority rights, and respect for basic human rights. Democracy presupposes equality before the law, due process, and political pluralism.

The EIU emphasizes that free and fair elections and civil liberties are necessary conditions for a democracy, but they are unlikely to be sufficient for a full and consolidated democracy if unaccompanied by transparent and at least a minimally efficient government, sufficient political participation, and a supportive democratic political culture.

The democracy index compiled by the EIU is based on the ratings for 60 indicators grouped into five categories: (i) electoral process and pluralism, (ii) civil liberties, (iii) the functioning of government, (iv) political participation, and (v) political culture. Each category has a rating on a 0 to 10 scale. The overall index of democracy, also on a scale of 0 to 10, is the simple average of the five category indexes.

Based on the democracy index scores, the EIU classifies each country as one of four types of regimes (i) full democracy (scores of 8–10), (ii) flawed democracy (scores of 6–7.9), (iii) hybrid regime (scores of 4–5.9), and (iv) authoritarian regime (scores below 4). The EIU (2014: 38–39) gives the following description for each regime:

- **Full democracy:** Under this regime, a country's basic political freedoms and civil liberties are not only respected but also tend to be underpinned by a political culture conducive to the flourishing of democracy. The functioning of the government is satisfactory. Media are independent and diverse. There is an effective system of checks and balances. The judiciary is independent and judicial decisions are enforced.
- **Flawed democracy:** A country has free and fair elections and even if there are problems (such as infringements on media freedom), basic civil liberties tend to be respected. However, there are significant weaknesses in other aspects of the democracy, including problems in governance, an underdeveloped political culture, and low levels of political participation.
- **Hybrid regime:** Elections have substantial irregularities that often prevent them from being both free and fair. Government pressure on opposition parties and candidates may be common. Serious weaknesses are more prevalent compared with flawed democracies, e.g., in political culture, functioning of the government, and political participation. Corruption tends to be widespread and the rule of law is weak. Civil society is also weak. Typically, there is harassment of and pressure on journalists, and the judiciary is not independent.
- **Authoritarian regime:** State political pluralism is absent or heavily circumscribed in these countries and many are outright dictatorships. Some formal institutions of democracy may exist, but these have little substance. Elections, if they do occur, are not free and fair. There is disregard for abuses and infringements of civil liberties. Media are typically state-owned or controlled by groups connected to the ruling regime. There is repression of criticism of the government and pervasive censorship. There is no independent judiciary.

The democracy index provides a snapshot of the state of democracy worldwide, which includes 165 independent states and two territories. It was first produced for 2006 and then updated for 2008 and 2010. Since 2011, it has been updated annually. The indexes and other related documents are available for download from the EIU's website at https://www.eiu.com/public/topical_report.aspx?campaignid=Democracy0115. In this study, the democracy index has been expressed in percentile terms by multiplying the original score by a factor of 10, with higher values corresponding to higher levels of democracy.

Another index, the World Governance Indicators (WGI), is more comprehensive but largely similar to the democracy index. It is compiled by the WGI project of the World Bank. According to the WGI project, "governance consists of the traditions and institutions by which authority in a country is exercised. This includes the process by which governments are selected, monitored, and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them" (World Bank, WGI (2015)).

Box 2.2 continued

The WGI reports on the following six broad dimensions of governance (i) voice and accountability, (ii) political stability and absence of violence, (iii) government effectiveness, (iv) regulatory quality, (v) rule of law, and (vi) control of corruption. A definition of each of the six dimensions and a list of the individual indicators on which each aggregate indicator is based can be found at <http://info.worldbank.org/governance/wgi/index.aspx#doc>. More details about the methodology used in compiling the WGI can also be found at this same site. The estimate of governance ranges from -2.5 to 2.5 with higher values corresponding to better governance. The WGI project also ranks the governance performance among all countries in percentile terms, ranging from 0 (lowest rank) to 100 (highest rank).

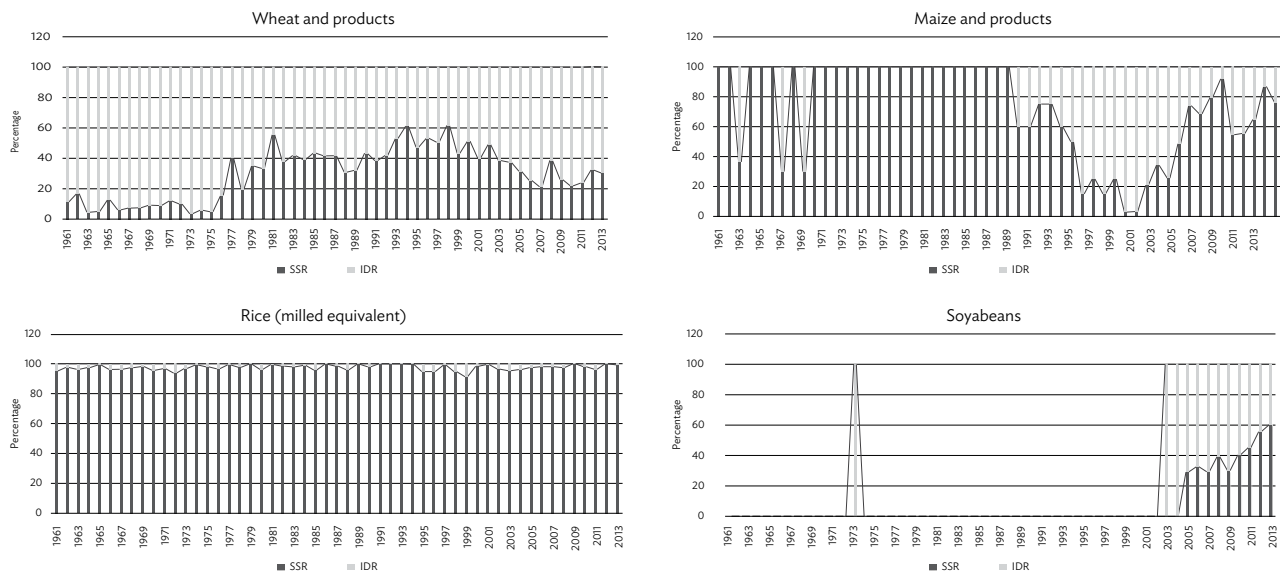
Source: Compiled by authors based on EIU (2015) and World Bank WGI (2015).

Rice is the staple food for Bangladeshis. Fish, meat, milk, eggs, and pulses are the major sources of protein. The output of pulses at 0.25 mt per annum is very low, and its consumption relies heavily on imports (net imports being roughly 0.8 mt per annum). The total consumption of pulses, at some 1 mt per annum (production plus imports) is low given the size of the total population and its significance as a major source of

protein for many vegetarians in the country (FAO 2015a).

For most food crops, Bangladesh has a relatively low level of food self-sufficiency except in the case of rice. The self-sufficiency ratio (SSR) for rice is about 99%.¹ For wheat, maize, and soybean, the SSRs are 27%, 68%, and 46%, respectively (Figure 2.1). The

Figure 2.1 Self-Sufficiency Ratio of Cereals in Bangladesh, 1961–2013

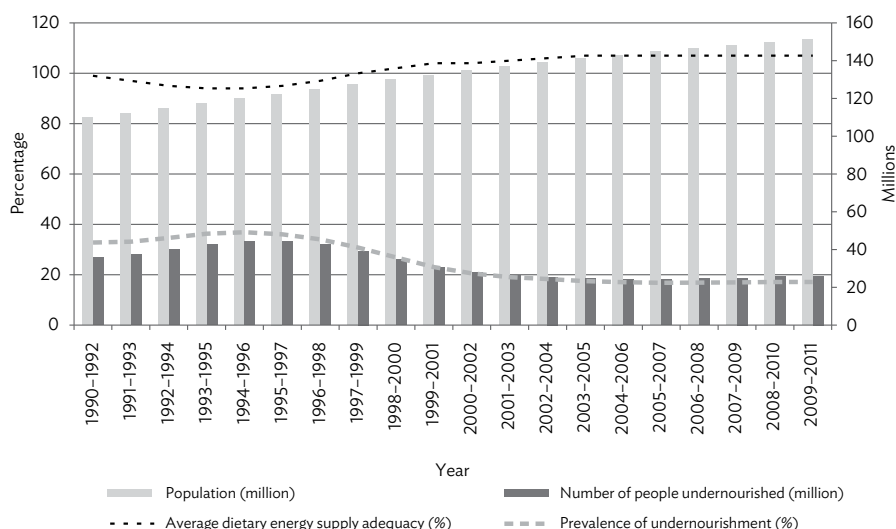


IDR = import dependency ratio, SSR = self-sufficiency ratio.

Source: Food and Agriculture Organization of the United Nations. FAOSTAT. Food Balance Sheets. <http://www.fao.org/faostat/en/#data/FBS> (accessed 15 May 2015).

¹ 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 is a net exporter of a product, this product's SSR will be greater than 100%. Import dependency 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 (FAO 2015a).

Figure 2.2 Population and Food Security of Bangladesh, 1990–2011



Sources: Food and Agriculture Organization of the United Nations. FAOSTAT. Food Security Indicators. <http://www.fao.org/faostat/en/#data> and World Bank. World Bank Open Data. <http://data.worldbank.org/> (accessed 25 October 2015).

SSRs for beef, mutton and goat meat, and poultry meat have been around 100% in the past few decades. The import dependency ratio (IDR) for these meat items is minimal. Without significant imports, the meat intake by Bangladesh is very low given that its total output was only 0.6 mt per annum.

Although Bangladesh is short of natural resources and has low SSRs for most food crops, it has managed to improve its average dietary energy supply adequacy (ADESA) in the past 2 decades since the mid-1990s (Figure 2.2).² According to Ninno, Dorosh, and Smith (2003), favorable agricultural investment policies enabled a long-term expansion in the winter season rice crop (*boro*), which has reduced the country's dependence on the flood-susceptible monsoon season rice crop (*aman*). Further, investments in marketing infrastructure and promotion of private-sector trade, including liberalizing rice and wheat imports in the early 1990s, have also helped develop more efficient and competitive food grain markets that can respond quickly to any impending production shortfalls.

Figure 2.2 shows that the prevalence of undernourishment has dropped steadily since the mid-1990s. This decline was, however, not sufficient to meet the two international hunger reduction targets. For the World Food Summit (WFS) goal, Bangladesh only managed to reduce the number of people undernourished from 36 million in 1990–1992 to 26.3 million in 2014–2016, a reduction of 27%, being 23% short of the target (Box 1.1). For the Millennium Development Goal 1 (MDG 1), the reduction of 49.9% in the proportion of undernourished in the total population nearly met the target (FAO, IFAD, and WFP 2015: 46).

Overall, the level of food security in Bangladesh is still very low and unstable. In terms of the Global Food Security Index (GFSI), Bangladesh's food security level has not shown steady improvement and has sometimes even moved backward. Many other key food security indicators by the Food and Agriculture Organization (FAO) in Table 2.1 also indicate a low level of food security. The level of protein and fat intake by Bangladeshis has been low and is below the desired level (Table 2.1). Domestic

² ADESA expresses the dietary energy supply as a percentage of the average dietary energy requirement (ADER).

Table 2.1 Key Indicators of Food Security in Bangladesh (5-year average)

	1990– 1994	1995– 1999	2000– 2004	2005– 2009	2010– 2014
Dietary energy supply (kCal per capita per day)	2,057	2,171	2,345	2,407	2,456
Average protein supply (g per capita per day)	44.0	46.6	51.4	53.8	NA
Average fat supply (g per capita per day)	19.8	25.8	26.4	28.6	NA
Average dietary energy requirement (kCal per capita per 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 (millions)	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
Percentage of children under 5 years of age affected by wasting (%)	16.4	16.4	13.2	14.1	12.7
Percentage of children under 5 years of age who are stunted (%)	71.4	63.8	52.0	46.0	41.7
Percentage of 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 = kilocalorie, NA = not available, PPP = purchasing power parity.

Source: Based on Food and Agriculture Organization of the United Nations. FAOSTAT. Food Security Indicators. <http://www.fao.org/faostat/en/#data> (accessed 26 August 2015).

food price volatility in Bangladesh is relatively high. The rates of wasting, stunting, and underweight for children under 5 years of age are still worryingly high, although significant progress has been made to reduce them (Table 2.1). The rate of anemia among pregnant women in the early 2010s was still over 48% (FAO, 2015b). For children under 5 years of age, this rate is as high as 56%.

Root Causes of Bangladesh's Low Level of Food Security

High level of poverty incidence. There is enough food for people in the country to consume—the ADESA has been over 100% since the early 2000s. Yet, there are high levels of wasting, stunting, and underweight for children under 5 years of age, and there is a high prevalence of anemia among pregnant women and children under 5 years of age. These facts suggest that the poor do not have sufficient economic access to the required amount of food.

Both the proportion and the number of people living under poverty in the total population are still very high in Bangladesh despite notable reductions in the past several years. In 2000, the poverty headcount ratio at national poverty lines (% of population) was 48.9. It dropped to 40 in 2005 and to 31.5 in 2010. The corresponding numbers were 64.2, 57.2, and 47.8 million, respectively (World Bank 2015). These proportions and numbers are based on an income of \$1.25 per day per adult.

A 2014 report by the Asian Development Bank (ADB), *Poverty in Asia: A Deeper Look*, however, argues that the use of the \$1.25 poverty line is no longer adequate for Asia considering the rapid economic growth in the past few decades and the associated rising cost of living. It estimated and proposed an Asia-specific poverty line of \$1.51 per person per day.

Using this Asia-specific poverty line of \$1.51 per person per day, Bangladesh's population under poverty would

be 64.5% for 2005, 61.2% for 2008, and 58.0% for 2010, with the corresponding numbers being 90.63, 89.06, and 86.24 million, respectively (ADB 2014: 11). Various other studies have also pointed out that poverty is one of the major causes for food insecurity in Bangladesh (for example, Smith, Obeid, and Jensen, 2000; Hossain, Naher, and Shahabuddin 2005; McIntyre et al. 2011).

High level of corruption. The CPI of 25% in 2014 suggests that corruption is very severe in Bangladesh (Transparency International 2015). Corruption causes misuse or misallocation of resources and an inequitable distribution of the benefits accruing from economic growth. If corruption is not seriously curtailed, speeding

up economic growth and alleviating income inequality will be difficult. This, in turn, would retard achievement of a higher level of food security for the country (Box 2.3).

Political instability. The FAO publishes an index of “political stability and absence of violence.” It 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. This index can be negative or positive. If positive, it suggests political stability and the absence of violence; the larger the positive number, the more politically stable and

Box 2.3 Corruption and Food Security

Corruption, which is the abuse of entrusted power for private gain, is the cancer of any society. It causes serious damage to a society in many ways. According to Transparency International (2015), the damage corruption causes to a society can be political, economic, social, and environmental.

- Politically, corruption is a major obstacle to democracy and the rule of law. In a less democratic or nondemocratic system, offices and institutions do not lose their legitimacy when they are misused for private advantage. Corrupt individuals have the desire to do everything possible to erect obstacles to democracy.
- Economically, corruption depletes national wealth. Corrupt politicians allocate scarce public resources to projects considering more how such projects will benefit them rather than how such projects will benefit communities. Corruption also hinders the development of fair market structures and distorts competition.
- Socially, corruption corrodes the social fabric of society. It undermines people’s trust in the political system, its institutions, and its leadership. There is also the danger that the public may get corrupted, which will not only lower social moral standards, but also make it more difficult to tackle corruption in the future.
- Environment degradation is also closely linked to corrupt systems. The lack of, or nonenforcement of, environmental regulations and legislation often leads to precious natural resources being carelessly exploited and entire ecological systems being ravaged. From mining to logging and pollutant discharging, companies pay bribes in return for damaging the environment.

Most people, if not all, suffer from corruption. As far as food security is concerned, corrupt systems hurt food security in various ways. For example, corruption can impact food availability through distortions and inefficiencies in the use of resources, as well as bottleneck inefficiencies in food distribution (EIU 2014: 47), such as in the Democratic People’s Republic of Korea. When there is a lack of, or nonenforcement of, food quality and safety regulations and legislation, low quality and unsafe foods become widespread in the market (such as in the People’s Republic of China [PRC] and India). Damages to the environment compromise food security, both present and future (such as in Bangladesh, the PRC, and India). Corruption leads to leaks and wastage in the operations of the public food distribution systems (as in India) and to mismanagement of buffer reserves that seriously undermines a country’s food security in case of an emergency (as in the PRC).

Many people suffer from the reduced level of food security due to corruption. However, those who suffer the most are the powerless poverty-stricken people. In corrupt systems, inequality and discrimination against the poor are common, which mires them in a vicious circle of poverty and chronic lack of economic access to food.

Source: Compiled by authors based on EIU (2014) and Transparency International (2015).

peaceful the country. Of the indexes published by the FAO, the smallest is close to -3.5 (e.g., Somalia) and the largest is close to $+2$ (e.g., Greenland). For Bangladesh, this index was -1.4 in the early 2010s, indicating political instability and presence of violence and a negative impact on Bangladesh's level of food security (Table 2.1).

Various other factors may also affect Bangladesh's food security such as the frequent occurrence of natural disasters (e.g., 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 chemical fertilizers and pesticides, ground water 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, *The World Factbook*). However, these factors cannot be held as fundamental to Bangladesh's lack of food security. These problems are just symptoms of the lack of political will to fix them rather than root causes for the country's food insecurity.

Major Challenges to Handle

Bangladesh has to deal with the root causes of food insecurity. The root cause is the lack of good governance, which in turn results in severe corruption. Ensuring good governance and curtailing corruption are vital to further expanding its economy, reducing economic inequalities and the widespread poverty, and, hence, improving the country's food security. Fixing the poor governance and the resultant severe corruption must be given top priority by the Government of Bangladesh and the public.

Other major challenges that Bangladesh has to deal with include the following:

- (1) further efforts to coordinate its population growth to match its economic and environmental capacity;
- (2) preparedness for potential damage to its food production capacity caused by climate change;
- (3) ensuring that investment in agriculture is maintained at an adequate level for continued improvements in agricultural productivity;
- (4) increased efforts to fight against the widespread inequality and poverty;
- (5) innovatively addressing landownership problems (over half of the rural households are considered to be functionally landless with an area being

less than 0.2 hectares (ha), which is insufficient to fulfill basic subsistence needs); and

- (6) fostering an economic, social, and political environment that provides adequate incentives to farmers for food production.

2.2 People's Republic of China

In 1949, when the civil war came to an end with the Communist Party of China (CPC) defeating the Kuomintang, the CPC established the People's Republic of China (PRC). The PRC has a land area of 9.6 million km². In 2014, its population was 1,364 million. Its per capita GDP (at PPP) reached \$12,609 (2011 constant) following fast economic expansion since the late 1970s. Currently, major problems facing the country include severe corruption, environmental pollution and degradation, and large and increasing income inequalities. In 2014, the CPI was 36%, suggesting a very high level of corruption in the PRC. The PRC has a democracy index of 30 out of 100 and is classified as an "authoritarian regime," which is the category that has the lowest level of democracy (EIU 2015: 8) (Box 2.2). Its overall food security level has been improving in recent years. The GFSI stood at 62.2 in 2014 (EIU 2014: 13).

When the CPC came to power in 1949, the new government faced many challenges caused by numerous wars with foreigners as well as domestic civil wars. Many people were starving. The most urgent challenge was to ensure adequate food supply to feed the massive population, which stood at 552 million in 1950. Unfortunately, measures to boost food supply were less than successful for many decades. As shown in Table 2.2, the PRC faced chronically severe shortage of food supply between the early 1950s and the late 1970s. Out of the limited foods available, grain was the major source of nutrition. The intake of most other foods was very low (Table 2.2). By 1978, the per capita consumption of most foods was still below the level seen in 1952.

Data confirm that, by the end of the 1970s, the intake of energy, protein, and fat by the people of the PRC was still below the daily requirements for average adults to perform average-strength work (Table 2.3). According to the FAO, the Average Dietary Energy Requirement (ADER) for the PRC is 2,350 kilocalorie (kCal) per capita per day. The FAO's data in Table 2.3 shows that in no

Table 2.2 Per Capita Consumption of Major Food Items in the People's Republic of China, 1952–1985 (kg)

Year	Grains	Vegetable Oil	Pork	Beef and Mutton	Poultry Meat	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.

Source: State Statistical Bureau. 1986. China Statistics Yearbook 1986. Beijing: China Statistical Press. pp. 687–688.

single year before 1980 was this requirement met. Intakes of both protein and fat were below requirements.

Since the late 1970s, the PRC's food availability has gradually improved. Key indicators of food security for the PRC in Table 2.4 show that its improvements in food

security in the past 3 decades have been impressive. The supply of dietary energy, protein, and fat has become more than adequate. By 2015, it had met both the international hunger reduction targets. For the WFS goal, the PRC reduced the number of people undernourished from 289 million in 1990–1992 to 133.8 million

Table 2.3 Per Capita Nutrition Intake in the People's Republic of China, 1961–1985

	Energy (kCal per capita per day)			Protein (g per capita per day)			Fat (g per capita per 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

continued on next page

Table 2.3 *continued*

	Energy (kCal per capita per day)			Protein (g per capita per day)			Fat (g per capita per day)		
	Total	Vegetal Products	Animal Products	Total	Vegetal Products	Animal Products	Total	Vegetal Products	Animal Products
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
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

g = gram, FAO = Food and Agriculture Organization of the United Nations, kCal = kilocalorie, PRC = People's Republic of China.
Source: FAO. FAOSTAT. Food Balance Sheets. <http://www.fao.org/faostat/en/#data/FBS> (accessed 2 September 2015).

Table 2.4 Key Indicators of Food Security in the People's Republic of China (5-year average)

	1990– 1994	1995– 1999	2000– 2004	2005– 2009	2010– 2014
Dietary energy supply (kCal per capita per day)	2,561	2,760	2,847	2,967	3,114
Average protein supply (g per capita per day)	70.2	80.4	85.2	91.2	NA
Average fat supply (g per capita per day)	60.0	70.8	79.4	89.4	NA
Average dietary energy requirement (kCal per capita per day)	2,345	2,391	2,439	2,459	2,451
Average dietary energy supply adequacy (%)	109.2	115.2	116.8	120.6	127.0
Prevalence of undernourishment (%)	22.8	17.1	15.8	14.0	10.4
Number of people undernourished (millions)	281.5	221.6	211.3	192.0	147.6
Political stability and absence of violence (index)	NA	-0.3	-0.4	-0.5	-0.6
Domestic food price volatility (index)	NA	NA	10.3	11.6	9.5
Percentage of children under 5 years of age affected by wasting (%)	4.1	3.7	2.8	3.0	2.3
Percentage of children under 5 years of age who are stunted (%)	35.2	25.5	19.8	12.7	9.4
Percentage of children under 5 years of age who are underweight (%)	13.4	8.8	7.1	4.7	3.4
GDP per capita (in PPP) (constant 2011 international \$)	1,990	3,093	4,440	7,219	10,632

g = gram, GDP = gross domestic product, kCal = kilocalorie, NA = not available, PPP = purchasing power parity, PRC = People's Republic of China.
Source: Based on Food and Agriculture Organization of the United Nations. FAOSTAT. Food Security Indicators. <http://www.fao.org/faostat/en/#data> (accessed 26 August 2015).

in 2014–2016, a reduction of 53.7%, and 3.7% above the target. For the MDG 1 goal, the reduction is by 60.9%, again above the target (from 23.9% in 1990–1992 to 9.3% in 2014–2016) (FAO, IFAD, and WFP 2015: 46). The rates of wasting, stunting, and underweight for children under 5 years of age have also dropped significantly (Table 2.4).

These trends indicate that the PRC's food security has experienced two vastly distinct periods since its establishment. Before the 1980s, food availability was poor and citizens were undernourished far and wide. Since the 1980s, food availability has been ample and cases of extreme starvation are rare. Factors responsible for the lack of the PRC's food security before the 1980s and the improvements thereafter are elaborated in the following section.

Major Factors that Caused Food Insecurity before the 1980s

Collectivization. Forced collectivization is one of the major factors responsible for the PRC's food shortage. During 1950–1952, the new government carried out a nationwide land reform campaign. It confiscated lands from landowners without compensation, often violently, and then redistributed them to those with little or no land. This resulted in all farmers having land, but the size of the area was very small. The small-scale household-based farming operations led some farmers to form mutual-aid groups to help each other (1953–1954), which the government encouraged. But soon farmers were pushed by the government to join cooperatives: initially preliminary (1955–1956) and then advanced (1957). In 1958, all farmers were compelled to be part of the people's communes, losing the land they were given earlier. By then, all farm production activities had become highly collectivized. Under collectivized farming arrangements, individuals had no incentive to work hard because their rewards were not connected to their efforts. This reduced food output. Some researchers have pointed out the extreme negative impact of collectivization on food output (e.g., Lin 1987; Lin 1992). As soon as collectivization was abandoned in the early 1980s, the PRC's food output increased significantly.

Totalitarian system. By 1958, the PRC had become a highly planned economy through two major campaigns (i) the establishment of the people's communes and (ii) the so-called 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). Through the highly planned economy, the totalitarian government monopolized all production resources, controlling the production, circulation, and distribution of all goods and services. Resource monopolization by the government and the strictly planned economy destroyed the incentives for individual producers, leading to severe shortages in the supply of virtually all essential goods and services and, of course, food products (Yang 2008: 1066–1067).

The totalitarian system was the fundamental reason why the Great Famine occurred in 1958–1962 during which over 30 million people, chiefly rural, died of hunger (Becker 1996; Yang 2008; Dikötter 2010). The firm control of the rural areas through the people's communes entailed many absurd courses of action, such as inflating grain output by rural cadres and forcing farmers to produce iron and steel. The unified grain procurement system, which was brought into effect in 1953, enabled the government, through the collaboration of rural cadres of the people's communes, to over-procure grains from farmers, leaving farmers with insufficient food for their own consumption. The establishment of many public dining halls under the people's communes in 1958 also allowed the rural cadres to completely control individual access to food (Liu 2010).

Lack of error-correcting mechanisms. Because of the wide and strict control of all aspects of life under the totalitarian regime, it became virtually impossible for anyone, either within or outside the party and the bureaucratic system, to comment on or criticize any action of the CPC government without severe ramifications. The media also had no freedom either to report on what was going on in the country. So, when food shortages became widespread in the late 1950s and the famine emerged, there was little or no information transmission upward to the government. Without a mechanism by which the government could be informed of the consequences of its ill-perceived policies, many wrong or unsuitable policies remained unchecked, causing serious damage to not only agricultural production but also the entire economy (Yang 2008: 1083–1085). Since the 1980s, especially after the advent of the internet and its wide adoption, which has made communication much easier, there have been some

improvements from the government's side to pay heed to opinions of the broader community and in particular of 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 and not elected by the citizens. They have strong incentives to please their superiors, but little incentive to serve the citizens under their jurisdiction. Because they were not held accountable to the citizens, their rewards and promotions all largely rested upon whether they kept their superiors happy. If their superiors did not want to hear negative news, they would not report such news. Instead, they would report, or fabricate, whatever their superiors wanted to hear. During the Great Leap Forward and the Great Famine, these people shamelessly inflated grain output, forced and tortured farmers to surrender their grains to the government, ruthlessly controlled the hungry farmers, and prevented them from begging in other areas for survival. They were also prepared to carry out whatever their superiors asked even though they knew those policies could only lead to disaster (Xu 1998; Ouyang 2007; Sha 2007; Qiu 2010; Liu 2013; and Xu 2013).

Lack of economic management capabilities. Many officials in the CPC government between 1950 and 1980 were from a group of military generals or officers from the People's Liberation Army. They may have been good at fighting a battle, but had very little knowledge of or expertise on how to manage a country's economy, let alone a large one like the PRC's. Yet, the new government was neither keen to use those who were capable of running the economy nor did it allow them to help the government in managing the economy. Instead, they were executed or silenced through various political campaigns (Dikötter 2013). During the 1950–1951 campaign of suppressing counter-revolutionists, the new government executed many bureaucrats who had once worked under the Kuomintang government (Dikötter 2013: 84–102). During the 1957 anti-rightist campaign, the CPC suppressed many talented intellectuals who wanted to help the CPC in managing the country's economy better (Dikötter 2013: 275–295). The Cultural Revolution further curbed any criticism, wrecking the already very fragile economy to collapse. Since the early 1980s, there have been improvements in the government's economic management capabilities: The

country has gradually opened up to the rest of the world and the subsequent international exchanges have helped the PRC introduce various types of know-how regarding economic management. There is, however, still a lack of formal mechanisms through which the formulation and implementation of government policies can seek feedback from the broader community.

Major Factors that have Boosted Food Security since the 1980s

Reverting to household-based farming. Reverting to household-based farming in the early 1980s was most fundamental to and instrumental in bringing about improvements in the PRC's food security and that of the society at large. Family-based farming rapidly boosted the output of the PRC's food and other agricultural produce. Not only did the increased output enable many people in the PRC to have more food to eat and have warmer clothes, but it also generated foreign exchange that was then used to import essential inputs for developing the country's other industries. Family-based farming remains the most appropriate farming model for the PRC in today's environment, although how it will evolve in the future is yet to be seen.

Reintroducing market-based 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 clearly demonstrated that highly centralized planning is ineffective and inefficient. The market mechanism can work much better in coordinating the allocation of resources than the centrally planned approach. The reintroduction and functioning of the market-based mechanism has encouraged further increase in food output as well as its diversity.

Reopening the doors 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 a 3-decade 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 the country's students to study in universities overseas, and attraction of foreign investment 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 foods to meet the growing demand of the country's more affluent consumers. This helps the PRC make better use of its comparative advantage in gaining greater benefits from trade as well as overcoming domestic resource shortages. 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, which the country is short of by a huge margin. Let us take soybean as an example. Soybean imports account for the majority of the PRC's grain imports (being over 80%). The net imports in 2013 were 63 mt. The yield of soybean in the PRC in recent years has been roughly 1.85 tons per ha. Hence, soybean imports alone saved the PRC over 34 million ha of arable land or, in other words, helped the country expand its arable land by over 34 million ha. Without trade, the PRC's food availability and variety would not have been as comfortable as it is today.

Government emphasis on ensuring food supply. Since the 1980s, the PRC government has paid increasing attention to ensuring that an adequate amount of food is available to the country's huge population. Such an emphasis is reflected in the development of various policies aimed at improving food supply and the increasing amount of resources allocated toward this purpose. However, not all policy efforts can be regarded as successful. Some perhaps did not help make proper use of the country's comparative advantages, while a few were harmful to the sustainable use of resources or even counterproductive. One phenomenon related to the government's management of food supply is that often when the supply becomes a little more comfortable than usual, complacency sets in; on the other hand, when the supply is a bit tight, even if it is perceived as such or misjudged, over-anxiety dominates. The government also tends to become overly worried if a public person, such as Lester Brown, comments on the PRC's food supply. In 1995, Brown's *Who Will Feed (the People's Republic of) China? Wake-Up Call for a Small Planet* was published, which resulted in enormous panic within the government, followed by a reignited emphasis on increasing the PRC's domestic food production. Nonetheless, government efforts have been instrumental in garnering much attention from the broader society for improving food supply in the country.

Policy efforts for improved food security. Apart from permitting farmers to revert to family-based farming and allowing markets to work in the economy, various 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 the PRC's 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;
- investing to build or expand existing rural infrastructure such as roads, irrigation facilities, electricity networks, mobile phone coverage, and internet access;
- investing in agricultural research and development;
- shifting from food subsidy to income subsidy for low-income consumers; and
- making use of world food markets.

The government of the PRC has also gradually started developing a longer-term vision for a more secure food supply for the country. This is reflected in the conceptualization of three major documents aimed at securing food supply (i) the first medium- and long-term national grain security plan (2008–2020) issued by the government in 2008 (Government of the PRC 2008); (ii) a national plan for beef and lamb production (2013–2020) developed in 2013 (Government of the PRC 2013); and (iii) the culmination of the government's efforts in boosting the country's food security to date, which is probably 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 (Chapter 5, Article 36) (Government of the PRC 2015).

The development of a Grains Act by the Government of the PRC is a significant move in the right direction and should be celebrated. The preliminary draft of the proposed Grains Act was made public in February 2012 to solicit comments and suggestions. In November 2014, a revised version of the act was published to seek further comments and suggestions. The draft act has set various standards or targets for the PRC to follow in the management of its food economy. It has not yet (as of February 2016) been officially promulgated. When promulgated, its implementation would require careful scrutiny.

Currently, food supply in the PRC is plentiful. However, according to food security evaluation frameworks, such as those of the Rome-based agencies, food supply is only one aspect of food security, and food abundance is not equivalent to food security. While the PRC's food supply has been abundant, its weakness lies in several other aspects of its food security, three of which are (i) the lack of food safety and food quality; (ii) environmental pollution and degradation, which undermine food production sustainability; and (iii) the large and increasing income inequalities, which affect social stability.

Because of these and various other weaknesses, the PRC has not been able to achieve a higher level of food security as measured by the GFSI—it was 62.2% in 2014. To further improve its food security, the PRC has to overcome various major challenges and obstacles.

Current Challenges

Securing sustainable food supply. Food supply in the distant future (i.e., beyond 2050) is unlikely a major issue for the PRC due to the foreseen population decline (see Part 4 of this report). For the present and the medium term, however, securing sufficient food supply for the huge population is still an enormous challenge. The PRC will have to rely on imports in the next couple of decades while trying hard to produce as much as possible domestically so long as its comparative advantages permit. The PRC is keen to attain a high level of self-sufficiency in food production. This will be achievable only if the country can manage to effectively preserve its food production resources (in terms of both quantity and quality) and continue investing at an adequate level to boost agricultural productivity. Net food imports to the PRC will continue increasing in the medium future.

Eliminating unsafe foods. Having food to eat is important, but so is having safe and quality food to eat. Currently, the PRC's widespread and heavily polluted water, soil, and air have made it difficult to produce safe and high-quality foods. 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 available resources are able to produce safe and good quality foods in the future. It is a huge challenge for the PRC authorities to be able to

provide safe foods for their citizens anytime soon for the following reasons:

- (i) The country's quality and safety surveillance system is highly corrupt. The current governmental institutions engender corruption. Without substantial reforms of 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;
- (ii) It will take a long time, if ever, for those producers, processors, and retailers who deliberately pollute foods to put an end to their unethical practices. There is little hope that these people will raise their ethical standards anytime soon by exercising their conscience;
- (iii) Even if these 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 foods for a long time to come. Despite the difficulties, efforts still need to be made to reduce and ultimately eliminate unsafe foods.

Narrowing income inequalities. 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. In the PRC, the large and increasing income gap has become a major cause of concern for social stability. It is crucial for the country to quickly address the alarming income disparity problem. Unfortunately, effectively increasing the income of the low-income residents, especially in rural areas, and reducing the income gap are 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 over the government or have deep political connections have always tried to block the reforms. If such blockages cannot be removed, income disparities will only widen 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. In the PRC, food waste is enormous between post-harvest and prior to consumption, and at the consumption stage. Food

wasted at the consumption stage alone would be sufficient to feed a large number of people each year (Wang 2010). Education is the key to significantly reducing food waste. Recent efforts by public media in the PRC to educate residents to avoid wasting food are very welcome. Many younger people, especially those who were born after the 1980s, have little understanding of the miseries caused by food shortages in the past. Many of them do not know that during 1958–1962, there was a Great Famine in the PRC. They have little sense about the importance of saving food. These young people should be educated systematically so that they realize that wasting food is a disgrace. While every person is entitled to having food, no one has the right to waste food.

Food waste at the consumption stage using public money or for bribing government officials is also a serious issue. While the recent anticorruption campaign has greatly deterred this kind of consumption, reforms are needed to establish necessary institutional arrangements so that the use of public money becomes accountable and acts of bribery are deterred. 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 for managing a country's food security. The PRC has a reserve stock of at least 100 million tons (Yinsha 2005). This is comparable to or even higher than the level suggested by the FAO (18% of annual consumption). However, the actual level of grain reserves is kept secret because grain reserve information is of strategic significance due to the large population of the country.

Even though the PRC's reserve is about 100 million tons or even higher, people in the country are still often concerned about their grain security. Two reasons explain this paradox. One is that some greedy and corrupt individuals who manage the grain reserves abuse the system for private gains. They take advantage of the public and the government's concern over grain security and coerce the government to have more grains in the reserve so that there is greater room for them to manipulate the reserves for personal gains (China Business News 2008; Zhou 2010). The other is that no one is probably sure about the actual level of the reserves

due to the manipulations of these greedy and corrupt individuals (Moli 2008; Wang 2008; Zhang 2008). Therefore, having "more" in the reserve would probably be safer.

Bringing transparency to grain reserve management in the PRC can make the operations more efficient and effective. It will help (i) eliminate rent seeking, (ii) reduce the reserve quantity and thus lead to huge financial savings, and (iii) manage the PRC's food security by making better use of the world market. (Transparency in the PRC's reserve management can help producers and traders from both the PRC and the rest of the world to adjust their production and business activities in response to changes in the PRC's reserve levels, hence reducing fluctuations caused by speculation. This would also help other countries to manage their food security, thus contributing to global food security.)

Publicizing the level of grain reserves and bringing transparency to its grain reserve management requires changes in the PRC's 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 greedy individuals who hijack the system for private gain. The recently proposed draft of the PRC's first Grains Act specified that the government would carry out the compilation of statistics on (i) grain production, trade and consumption, and the demand–supply balance, (ii) monitoring and early warning, and (iii) information dissemination. It is, however, 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 truly achieve food security, the challenges mentioned above have to be dealt with. To handle these challenges successfully, however, further innovative reforms are called for in various aspects of the current institutions.

Earlier discussions have frequently indicated that the lack of accountability of government 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 the country's efforts in achieving a higher level of food security. Changes would have to be made to ensure

that governments and their officials at various levels are accountable to the people under their jurisdiction, which would in turn help curtail corruption.

Ensuring that the policy making process is transparent is essential for ensuring that governments and their 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 in the PRC, such as economic and cultural, for improved food security in the future.

Further improvements can also be made to the current economic institutions to strengthen the PRC's food security. One important reform that needs to be carried out is the clarification of land-related property rights. Currently, the size of farms is too small, which restricts grain output. If the farms' scale is increased, farmers can produce more grains and earn higher incomes (Zhan et al. 2012). To increase farm size, the current land tenure arrangement has to be changed to make land consolidation possible and easier. This requires courage on the part of the PRC government to find innovative ways to reform the current land tenure system.

Reforms to social and cultural settings are also necessary. 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 removing the obstacles erected by some interest groups. It also requires the country's broader society to promote a sense of justice and fairness. The financially better-off citizens should demand and support the government in implementing fairer income distribution policies to improve social stability. Having a balanced nutrition intake and healthful eating should also receive policy attention.

2.3 India

India gained independence in August 1947 from British rule. It is the seventh-largest country by area, with almost 3 million km². In 2014, its population was about 1.26 billion, with a per capita GDP (at PPP) of \$5,565

(2011 constant) (World Bank 2015). It is the second-most populous country after the PRC, and is expected to exceed in population by about 2030 to become the world's largest country by population.

It is the world's largest democracy with a democracy index of 79.2% (EIU 2014). This is very close to the "full democracy" categorization of the Economist Intelligence Unit (EIU), although it marginally falls into the "flawed democracy" category. Its overall food security level has been low with the GFSI being 48.6 in 2014 (EIU 2014). Widespread income inequality and poverty, corruption, and poor infrastructure are some of the major problems India has to deal with. In 2014, the CPI for India was 38% (Transparency International 2015).

Before independence, food security in India was almost entirely left to chance and was largely at the mercy of the weather. Severe famines were common and frequent. Soon after becoming an independent nation, a Foodgrains Policy Commission examined the food policy in 1947, submitting its report in April 1948. This commission was followed by a number of other commissions that examined India's food policy from time to time.

Concerned about the growing gap between the rates of growth of population and food production and its potential consequences, the British launched a vigorous "grow more food" campaign in 1943 in response to the wartime food shortages. It was continued by the Government of India from 1947 to 1951 but was not fully successful, and India had to continue importing food. Measures were initiated to stimulate food grain production, including land reforms, irrigation facilities, fertilizer production, strengthening of research, and the organization of a national farm extension service. Around the early 1960s, India's government adopted the United States (US) land-grant university model of agricultural research, under which agricultural universities were gradually set up in most states. This entailed linking research with extension and taking the research from the laboratories to the farms through an extension network linked with the university. In 1961, the government launched the Intensive Agriculture District Programme to enhance productivity in the irrigated areas. The aim was to introduce improved seeds along with a package of agronomic practices to take advantage of the available irrigation. The program had considerable impact but did not live up to expectations, mainly because it did not

have an adequate technological boost to deliver due to a lack of high-yielding varieties of crops.

In the mid-1960s, a Green Revolution took place in India. Capitalizing on resources of international agricultural research and development (R&D) institutions, such as the International Maize and Wheat Improvement Center in Mexico and the International Rice Research Institute in the Philippines, new high-yielding varieties of wheat and rice were made available to the farming community. This significantly boosted India's total food output. Accompanying this was the significant improvement in per capita food grain availability from 149 kilogram (kg) in 1966 to 186 kg in 1991 (Table 2.5).

Since 1991, major economic reforms have been carried out, moving away from a regime of centralized control. The reforms have substantially improved the overall economy and raised per capita income. This, along with the

Table 2.5 Per Capita Net Availability of Major Foods in India (kg per annum)

Years	Rice	Wheat	Other Cereals	Cereals	Pulses	Total Food Grains
1951	58.0	24.0	40.0	122.0	22.1	144.1
1956	68.7	22.5	40.7	131.9	25.7	157.6
1961	73.4	28.9	43.6	145.9	25.2	171.1
1966	59.1	34.8	37.5	131.4	17.6	149.0
1971	70.3	37.8	44.3	152.4	18.7	171.1
1976	68.5	29.1	39.2	136.8	18.5	155.3
1981	72.2	47.3	32.8	152.3	13.7	166.0
1986	77.4	55.1	25.8	158.3	16.0	174.3
1991	80.9	60.0	29.2	171.0	15.2	186.2
1996	74.6	64.3	22.6	161.5	12	173.5
2001	69.5	49.6	20.5	141.0	10.9	151.9
2006	72.3	56.3	22.1	150.7	11.8	162.5
2011	66.3	59.7	23.9	149.9	15.7	165.6
2012	69.4	57.7	21.9	149.0	15.2	164.2

kg = kilogram.

Note: Net availability of food grains is estimated to be gross production (-) seed, feed, and wastage (-) exports (+) imports (+/-) change in stocks.

Source: Government of India (2015).

acceleration in urbanization, has brought about changes in the composition of foods consumed by the people of India. The consumption of food grains started to decrease, while that of edible oils, fruits and vegetables, and foods of animal origin began to increase (Table 2.6). The food-producing industries have also responded accordingly by increasing the output of foods that have rising demand, e.g., meats, especially chicken, meat, and eggs.

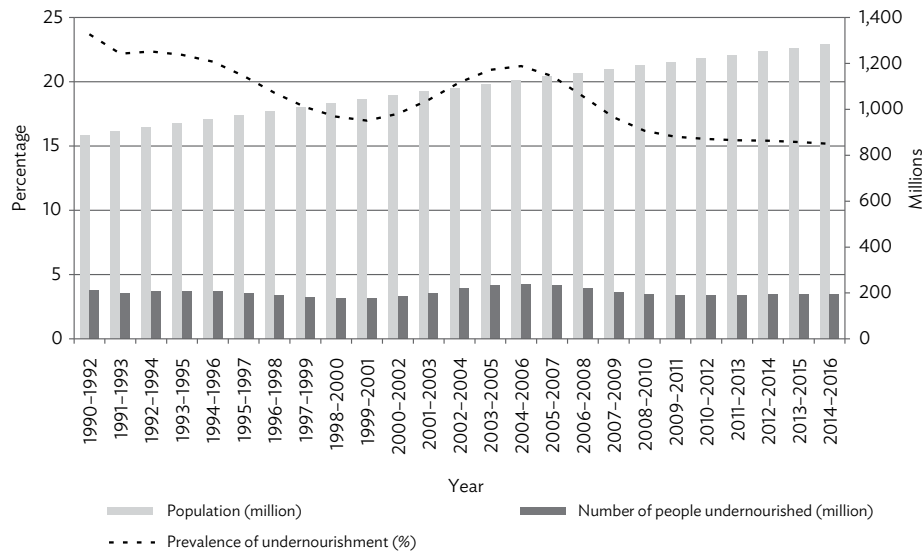
Table 2.6 Annual Per Capita Consumption of Different Commodities in India (kg/liter/no.)

	Rural/ Urban	1993– 1994	1999– 2000	2004– 2005	2009– 2010
Rice	Rural	82.61	80.18	77.62	74.7
	Urban	62.42	62.05	57.31	56.64
Wheat	Rural	52.56	54.14	50.98	53.03
	Urban	54.02	54.14	53.05	52.82
Coarse cereals	Rural	27.86	20.44	18.86	10.34
	Urban	12.53	10.59	10.59	4.6
All cereals	Rural	163.03	154.76	147.46	138.08
	Urban	128.97	126.78	120.94	114.05
Pulses and pulse products	Rural	9.25	10.22	8.64	7.92
	Urban	10.46	12.17	9.98	9.6
Total food grains	Rural	172.28	164.98	156.1	146
	Urban	139.43	138.95	130.92	123.65
Edible oils	Rural	4.5	6.08	5.84	7.74
	Urban	6.81	8.76	8.03	9.95
Vegetables	Rural	32.97	40.15	35.53	49.14
	Urban	35.41	42.46	38.57	50.11
Milk	Rural	47.94	46.11	47.09	50.09
	Urban	59.5	62.05	62.17	65.19
Eggs	Rural	7.79	13.26	12.29	21.08
	Urban	18.01	25.06	20.93	32.53
Fish	Rural	2.19	2.56	2.45	3.27
	Urban	2.43	2.68	2.51	2.9
Meat	Rural	0.97	1.34	1.18	2.07
	Urban	1.71	1.95	1.88	3.3

kg = kilogram.

Source: Government of India, Ministry of Statistics and Programme Implementation, National Sample Survey Office, various years. Reports of 50th, 55th, 61st, and 66th Rounds. http://mospi.nic.in/Mospi_New/site/inner.aspx?status=3&menu_id=31 (accessed January–March 2015).

Figure 2.3 Population and Food Security in India, 1990–2011



g = gram.

Source: Food and Agriculture Organization of the United Nations. FAOSTAT. Food Security Indicators. <http://www.fao.org/faostat/en/#data> (accessed 25 October 2015).

India has clearly made substantial progress from frequent famines and food shortages to achieving a comfortable food demand–supply situation at the aggregate level. Two important landmarks in India’s food policy development were the setting up of the Food Corporation of India and the Commission for Agricultural Cost & Prices (formerly Agriculture Prices Commission) in 1965. The other two major food policy instruments are the public distribution system (PDS) and buffer stocking and widely operational stockholding. Together with various other policy tools, India has largely avoided famines, even during severe adverse weather conditions. The devastating drought of 1987, rated as the most severe of the 20th century, affected nearly 155 million ha. However, there were no starvation and hunger deaths (Sharma 2008).

From the late 1960s, despite the continuous growth in population, the per capita availability of food grains had continuously improved as a result of higher growth in food production. India’s food self-sufficiency rate has also improved significantly. During parts of the 1960s and the 1970s, its food self-sufficiency was low and import

dependence substantial. Since then, food self-sufficiency gradually improved, and by the 1990s, India achieved self-sufficiency. In the 2000s, India is generally showing a self-sufficiency ratio of over 100%. On occasion, India has also been a net exporter of food.

Although the progress in improving food availability at the aggregate level has been notable, there is more to be done to improve India’s food security, particularly for low-income groups. As shown in Figure 2.3, the prevalence of undernourishment in India in 2015 was still very high. The decline in the level of undernourishment during 1990–1992 and 2014–2016 was way off the two international hunger reduction targets. For the WFS goal, India only managed to reduce the number of people undernourished from 210.1 million in 1990–1992 to 194.6 million in 2014–2016, a reduction of a mere 7.4% and short of the target by 42.6%. For the MDG 1 goal, the reduction by 36% is 14% short of the target (from 23.7% in 1990–1992 to 15.2% in 2014–2016) (FAO, IFAD, WFP 2015: 46). It is noted that the reduction in the level of the prevalence of undernourishment has also been unsmooth (Figure 2.3).

Other key food security indicators by the FAO in Table 2.7 also suggest the overall low level of food security in India. Both the fat and protein supply is low. The rates of wasting, stunting, and underweight for children under 5 years of age are high, and the progress in reducing these has been minimal. The rate of anemia among pregnant women has been consistently over 50% during 1990 and 2011 with little progress (FAO 2015b). For children under 5 years of age, this rate decreased from 75% in 1990 to 59% in 2011, still worryingly high.

In India, those who suffer from food insecurity are low- and middle-income people, especially the low-income group. As can be seen in Table 2.8, the energy intake below the ADER (2,226 kCal per capita per day in 2000–2004) has been as high as 60% of the total population (even higher in some years). On the other hand, India has been a net food exporter in recent years. This clearly indicates that many people in India do not have sufficient economic means to access the food they need.

To strengthen the country's capability for improving its overall food security and also deal with food insecurity of the large population of the poor, the Parliament of India passed a National Food Security Act in 2013. This act is

expected “to provide for food and nutritional security in human life cycle approach, by ensuring access to adequate quantity of quality food at affordable prices to people to live a life with dignity.” It provides for coverage of up to 75% of the rural population and up to 50% of the urban population for receiving subsidized food grains under the targeted public distribution system (TPDS), thus covering about two-thirds of the population. The act also has a special focus on nutritional support to women, children, and the poorest of the poor.

Despite some controversies and criticisms, the move toward promulgating such an act is highly commendable. Through this act, it has been made clear that the government has the responsibility to ensure food security of the people in India. However, whether the public distribution system (PDS) or the TPDS is capable of, and adequate in, addressing India's food security in a much-changed environment is questionable. Similarly, whether further investment in this system is financially worthwhile is debatable and needs to be investigated. Resources could be more beneficially deployed if they are devoted to more innovative approaches to address India's low level of food security and its root causes.

Table 2.7 Key Indicators of Food Security in India (5-year average)

	1990– 1994	1995– 1999	2000– 2004	2005– 2009	2010– 2014
Dietary energy supply (kCal per capita per day)	2,298	2,366	2,292	2,400	2,455
Average protein supply (g per capita per day)	55.8	56.4	54.8	57.8	NA
Average fat supply (g per capita per day)	41.0	45.8	45.8	50.6	NA
Average dietary energy requirement (kCal per capita per day)	2,176	2,200	2,226	2,252	2,272
Average dietary energy supply adequacy (%)	105.6	107.4	103.0	106.6	108.0
Prevalence of undernourishment (%)	22.4	18.4	19.6	17.7	15.4
Number of people undernourished (millions)	206.0	184.9	215.1	207.5	192.5
Political stability and absence of violence (index)	NA	-1.0	-1.2	-1.1	-1.2
Domestic food price volatility (index)	NA	NA	5.1	6.6	5.3
Percentage of children under 5 years of age affected by wasting (%)	21.1	19.6	NA	20.0	NA
Percentage of children under 5 years of age who are stunted (%)	57.1	49.8	NA	46.3	NA
Percentage of children under 5 years of age who are underweight (%)	50.7	42.8	NA	41.9	NA
GDP per capita (in PPP) (constant 2011 international \$)	1,838	2,263	2,748	3,732	4,886

g = gram, GDP = gross domestic product, kCal = kilocalorie, NA = not available, PPP = purchasing power parity.

Source: Based on Food and Agriculture Organization of the United Nations. FAOSTAT. Food Security Indicators. <http://www.fao.org/faostat/en/#data> (accessed 26 August 2015).

Table 2.8 Estimates of Energy Intake in Rural and Urban All-India (kCal per capita per day)

Decile Group	Rural India					Urban India				
	1972/ 1973	1983	1993/ 1994	1999/ 2000	2004/ 2005	1972/ 1973	1983	1993/ 1994	1999/ 2000	2004/ 2005
0–10	1,192	1,356	1,460	1,491	1,481	1,299	1,332	1,444	1,521	1,511
10–20	1,592	1,682	1,731	1,731	1,681	1,576	1,588	1,702	1,731	1,688
20–30	1,783	1,848	1,850	1,865	1,800	1,746	1,724	1,803	1,913	1,833
30–40	1,944	1,952	1,972	1,955	1,882	1,802	1,861	1,897	1,970	1,856
40–50	2,115	2,112	2,056	2,049	1,959	1,980	1,912	1,993	2,093	1,945
50–60	2,210	2,230	2,156	2,171	2,044	2,035	2,046	2,075	2,188	2,024
60–70	2,451	2,322	2,275	2,288	2,158	2,266	2,221	2,186	2,299	2,111
70–80	2,581	2,507	2,410	2,403	2,290	2,382	2,294	2,297	2,468	2,209
80–90	2,929	2,780	2,585	2,583	2,376	2,659	2,501	2,471	2,536	2,343
90–100	3,862	3,422	3,034	2,954	2,798	3,325	3,410	2,843	2,842	2,681
All	2,266	2,221	2,153	2,149	2,047	2,107	2,089	2,071	2,156	2,020

kCal = kilocalorie.

Source: Suryanarayana, M. 2009. Nutritional Norms for Poverty: Issues and Implications. Concept paper prepared for the Expert Group to Review the Methodology for Estimation of Poverty. Government of India, Planning Commission.

Root Causes of India's Low Level of Food Security

There are a number of fundamental factors that are responsible for India's low level of food security at the national level and the substantial food insecurity at the household and individual levels. The most important ones include (i) lack of sustained reforms and high economic growth, (ii) poor income distribution and insufficient will to alleviate poverty, (iii) government inefficiency, and (iv) corruption, all of which call for more concerted efforts to deal with.

Slow reforms and economic growth. After independence, over a long period, India's economic planning and policies heavily pursued self-sufficiency in everything rather than export- and trade-oriented growth. It also closely followed socialist policies, which called for government control for too long rather than switching to market-oriented policies for better economic growth. The choice of India's economic development strategies and its slowness in carrying out reforms seriously retarded the country's economic expansion. The economic reforms that began in the early 1990s were a fortunate development and have enabled

India to experience continuous economic growth. Further reforms and more innovations to its economic management will be most valuable for generating the momentum needed to boost consumers' income, which is crucial to help them improve their food security.

Lack of sufficient effort and will to reduce income inequality and poverty. The lack of substantial economic expansion for a long time did not allow the people of India to have sustained income growth, while the population expanded quickly. Slow income growth coupled with poor income distribution are responsible for the high incidence of poverty in India. Using the Asia-specific poverty line of \$1.51 per person per day, India's population in poverty was 55.8% for 2005, 52.3% for 2008, and 47.70% for 2010 (ADB 2014). The corresponding numbers were 636.93 million, 622.61 million, and 584.33 million, respectively. Despite the improved economic growth since the early 1990s, a large segment of the poor in India has not meaningfully gained from the growth. This indicates a lack of political will to reduce inequalities and poverty on the part of both politicians and the general public, especially the relatively wealthy public. India is a highly democratic country.

The public has the power to encourage, or if necessary, pressurize politicians to adopt inclusive growth policies and measures that will help to reduce poverty.

Government inefficiency. There is room to improve efficiency in the operation of India's governments. There are many good and efficient bureaucrats and officers in government departments. However, the balance of power is generally tilted toward politicians, and these highly-qualified officials and bureaucrats are often left helpless to carry out operations efficiently. Efficient government operations can help improve a nation's productivity, which in turn improves a country's overall ability to foster an environment conducive to achieving a higher level of food security. Reforms are therefore needed in government systems. The monitoring of government operations and accountability of politicians also need to be strengthened. Opposition parties should act in the best interest of the nation and learn how to oppose rather than keep opposing government decisions just for the sake of it (or to not allow the governments to perform well) so that they can win the next election.

Corruption. The government's food distribution system suffers from numerous inefficiencies as well as corruption, which frequently reduce the access to food for those who are most food insecure. Corruption at various stages of the PDS undermines the country's ability to achieve a higher level of food security. Some supply chain members abuse the system for private gains, leading to significant leakages and waste. Sometimes, the government may have well-intentioned interventions and controls in food markets. Unfortunately, in many cases, such interventions and controls invite corruption, which often defeats the purpose and instead perpetuates inefficiency and food insecurity.

Other Major Challenges

Hence, improving government efficiency and curtailing corruption are fundamental to further improving India's future food security. This, coupled with poverty alleviation and more inclusive growth policies, can help reduce large-scale poverty, which in turn will help improve the country's overall food security. In addition to these fundamental measures, India's government and the public have to deal diligently with several other major challenges.

Curtailing population growth. After independence, the Government of India adopted various measures

to improve health-care services so as to reduce and eradicate the incidence and impact of lethal diseases that regularly plagued the country. Subsequently, the overall death rate was significantly improved. The declining death rate and a continuing high birth rate resulted in rapid population growth, from 1.7% in the early 1950s to 2.4% in the late 1970s. The population growth rate has since started to decline, but still stood at about 1.4% in the late 2010s. Given its large population base, this growth rate still yields a huge number of additional mouths to be fed each year. Over the years, the ever-increasing population has had a huge impact on the country's food needs and demand, contributing substantially to the food security challenge.

In the 1970s, some strong measures of population control were tried by the then-Prime Minister Indira Gandhi. They were hugely unpopular. Later governments have not tried many strong measures. Nonetheless, measures to encourage reduction in the birth rate and raise the standard of living are highly necessary. Otherwise, with income growth, the large population will endanger India's long-term food security.

Investing in agricultural infrastructure, research and development, and extension. India has made substantial investments to improve essential infrastructure for agricultural production and to improve its agricultural R&D capacity for fostering high productivity. Such investment has played a crucial role in helping the country meet its ever-increasing demand for food and the need to increase food output. However, some recent developments, especially the tendency to reduce such investment, warrant close attention.

After independence, irrigation development received attention from the government to fight droughts and water scarcity, which were the major causes of food shortage in the past. A large number of projects were completed by 1997 (232 major irrigation projects and 911 medium-sized irrigation projects). The percentage of irrigated area had grown from 17.1% in 1950 to 40.2% in 1998 (increasing at an annual rate of 1.8%). However, there has been a slowdown in the growth of irrigated areas since then, registering only a mere increase of 6.7 percentage points (from 40.2% in 1998 to 46.9% in 2011, an annual rate of 1.2%) (Government of India 2015). Given the critical importance of irrigation in both increasing and stabilizing food production, adequate and

sustained investment to increase the irrigated area and make more efficient use of water resources will be critical for achieving the necessary growth in food production in the future.

Agricultural research was not given much priority in the initial decade after independence. The major thrust on agricultural research came only after the food crisis of the early 1960s. At the national level, the Indian Council of Agricultural Research was formed to lead and develop the agricultural research system in the country. All these initiatives came out of the lessons learned in the 1950s and the 1960s that irrigation and extension services alone cannot result in the required food production growth unless accompanied by the development of new and cutting-edge agricultural technologies, for which agricultural research is a must. However, international comparisons show that India has not invested enough in agricultural research, especially in the more recent years. For example, the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) shows 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. ABARES partly attributed this difference to slower productivity growth in India (ABARES 2014: 9). Higher productivity can be achieved through investment in agricultural R&D, extension, and education. India's crop yields are generally low, and there is great scope for increasing farm productivity that needs to be tapped.

Investing substantially in agriculture has been a major positive lesson emerging from the management of food security in India. Investments have been the most important driver of food production growth in the country. India would need to at least maintain the same rate of investment in agriculture, though preferably aim at a higher rate. Any neglect of investment or any attempt to reduce it can have grave consequences for the country's future food security. Our simulation results in Part 4 of this report clearly indicate that investment levels lower than today's can be very detrimental for India.

Preserving the environment and resources for sustainable food production. Like in many other countries, water and land resource scarcities in India pose a serious challenge to further food production growth. Not only is the quantity of the resources a concern, but also the fact that their deteriorating quality has

increasingly become alarming. Environmental pollution and degradation is widespread in India, affecting both the output and quality of food production. In the future, the demand for food in India will inevitably increase when incomes further improve and the population increases. This makes it extremely important and urgent for the country to preserve its limited food production resources and at the same time protect and rehabilitate the environment to sustain food production into the future.

Exploring new ways to manage the country's food security. Some policy instruments used in managing India's food security might have been adequate in the past, but may have become less appropriate in the changed environment, considering the fact that India's economy and society have experienced many changes since the economic reforms that started in the early 1990s. Many existing policy measures have extensive government involvement and control, which often create handicaps, reduce efficiency, lead to corrupt practices, result in large food and agricultural subsidies, and also produce waste in the food system.

While some government involvement is important and necessary for food security, there is a need to reform the current food security management. The markets and private enterprise capabilities have developed, and they have the ability to not only take over some of the functions performed by the government but also perform them in a better manner. India's government should consider moving away from the current policy of extensive intervention and allow the market to play wider roles in managing the country's food security, at least during peacetime. In an emergency situation, the government could revert to assuming a greater role in monitoring food production and distribution, and ensuring reasonable prices and access for the poor and the vulnerable sections of the population.

For several decades, the large PDS (nowadays more often called TPDS) for food grains played a major role in preventing distress, famines, and deaths due to droughts. However, this system has become increasingly costly. Direct income transfers should be on the agenda of the government as part of its reforms to the current system. Income transfers can help improve efficiencies and reduce subsidies. There is also a need to use global markets to overcome constraints rather than just focusing on finding domestic solutions.

2.4 Indonesia

Indonesia is an archipelagic nation containing over 18,000 islands, officially known as the Republic of Indonesia. It 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. During 1942–1945, Japan occupied the islands. In August 1945, Indonesia declared independence. Indonesia has a land area of a little over 1.8 million km². It had a population of around 255 million in 2014, being the world's fourth most populous country.

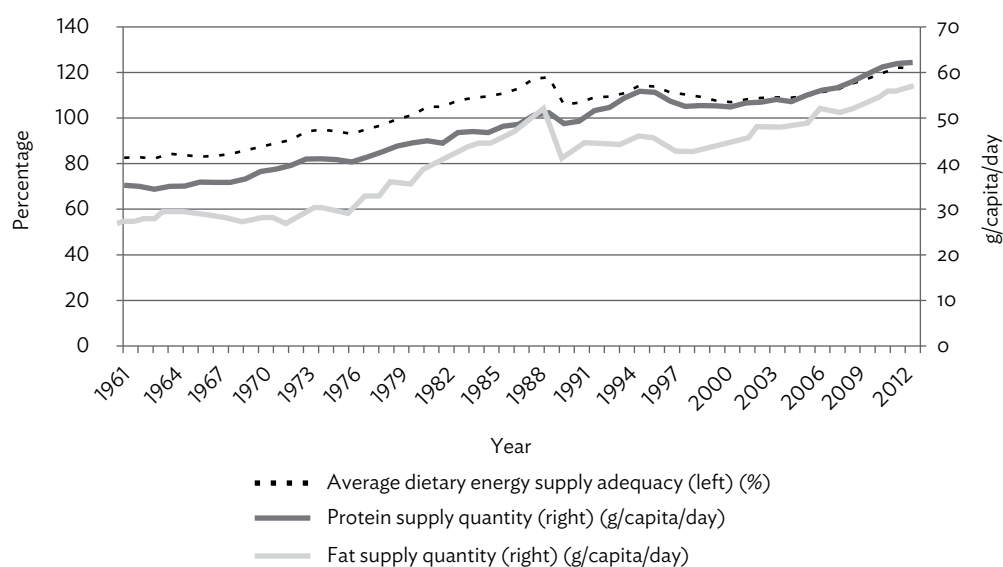
In 2014, its per capita GDP (PPP) was \$10,099 (2011 constant) (World Bank 2015). Poverty, unemployment, inadequate infrastructure, corruption, and a complex regulatory environment are some of the major issues that the country has to deal with (CIA, The World Factbook). Its corruption level is very high (with the CPI being 34%) (Transparency International 2015). It is regarded as a “flawed democracy,” with a democracy index of 69.5% in 2014 (EIU 2015). The GFSI was 46.6% (EIU 2014). The number of people undernourished stood at 19.4 million in 2014 (FAO 2015b).

Since independence, Indonesia has been trying hard to ensure an adequate amount of food for its people. This has neither been smooth nor easy. Famines still occurred often (Van der Eng 2012; EM-DAT 2015). In the early 1970s, the pursuit of full food self-sufficiency became a major policy commitment of the Indonesian government (Bourgeois and Kusumaningrum 2008). In 1980, for the first time since independence, the per capita intake of energy exceeded the ADER as reflected by the ADESA being over 100% (Figure 2.4). However, the per capita intake of both protein and fat has been low, although the improvement is remarkable.

In 1997, the Asian financial crisis hit Indonesia. GDP growth dropped sharply by 1998. By May 1998, the price of food had increased 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 started declining.

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. Its meat output is still very low. In 2013, it produced 0.59 mt of beef, 0.11 mt of

Figure 2.4 Average Dietary Energy Supply Adequacy, and Protein and Fat Supply of Indonesia, 1961–2013



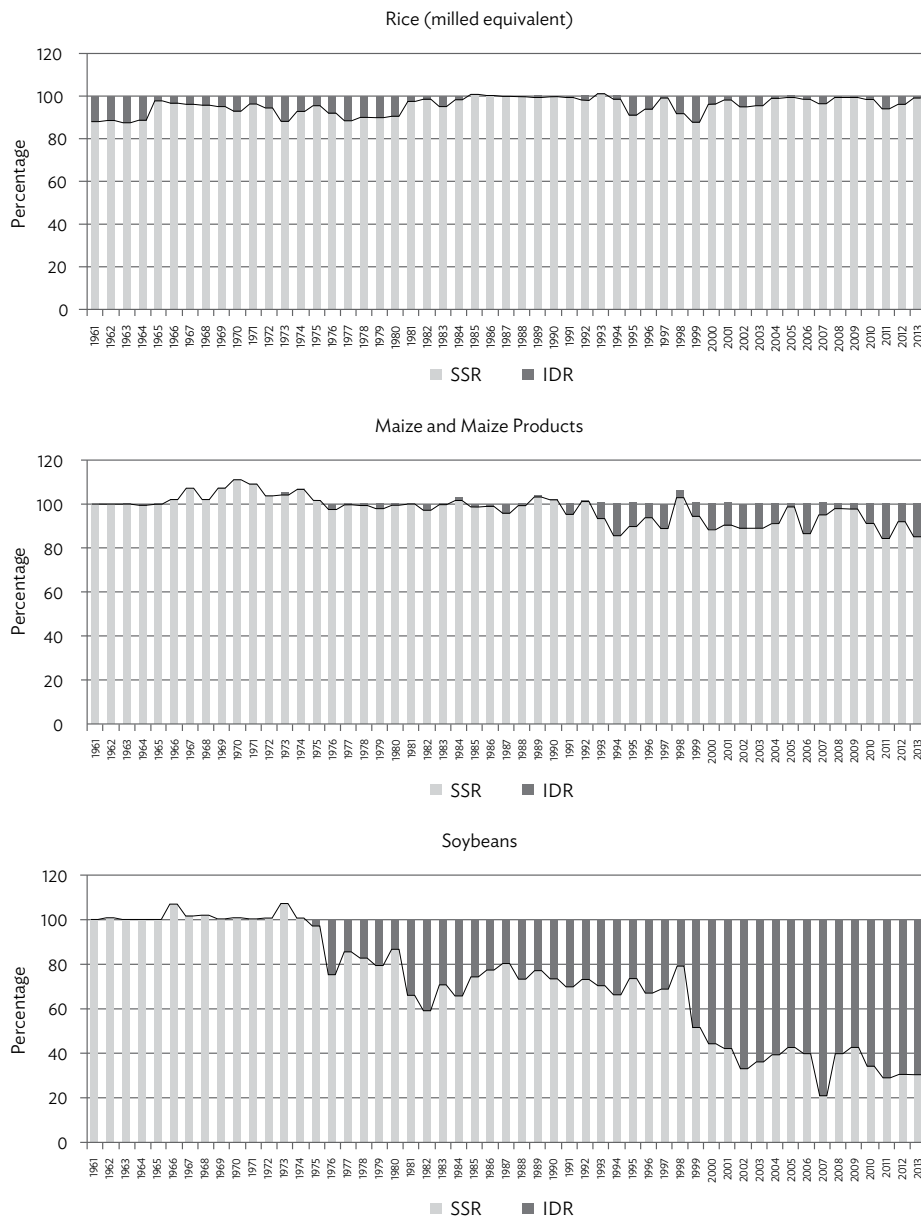
g = gram.

Source: Food and Agriculture Organization of the United Nations. FAOSTAT. Food Security Indicators. <http://www.fao.org/faostat/en/#data> (accessed 25 October 2015).

mutton and goat meat, and 0.74 mt of pork. The only meat with higher production is poultry meat, 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).

Rice used to have a low self-sufficiency ratio (SSR), being 88% in 1961. By the mid-1980s, it improved significantly, reaching 100% briefly (Figure 2.5). It has since remained at a high level most of the time except for a couple of years in the late 1990s due to the Asian

Figure 2.5 Self-Sufficiency Ratios and Import Dependency Ratios of Rice, Maize, and Soybeans in Indonesia, 1961–2013



IDR = import dependency ratio, SSR = self-sufficiency ratio.

Source: Food and Agriculture Organization of the United Nations. FAOSTAT. Food Balance Sheets. <http://www.fao.org/faostat/en/#data/FBS> (accessed 15 May 2015).

financial crisis. During the crisis, the rupiah dropped in value heavily (from around Rp2,400 per dollar in mid-1997 to Rp15,000 per dollar in mid-1998, and finally settling at Rp8,000–Rp9,000 per dollar 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, Indonesia's rice SSR dropped, being only 88%. It has since recovered very quickly and has stayed at around 95% or higher in most of the years. The SSR for maize and soybean is around 90% and 30%, respectively. The import dependency ratio (IDR) for wheat and barley is 100% or higher. The SSRs of all meats are very high, at 98% in 2013, despite the low level of meat output. This implies that the per capita consumption of meat is very low in Indonesia.

The improvement in food security in Indonesia has been remarkable since the 1980s. The advent of new agricultural technologies, chiefly new and high-yielding crop varieties resulting from the Green Revolution, and massive agricultural investments have helped the country to improve its food security status. The Green

Revolution in rice production helped significantly boost rice availability in the country. Large investments in key rural infrastructure including irrigation and the ready availability of fertilizers have also helped raise agricultural productivity (Timmer 2004; Van der Eng 2012).

By 2015, Indonesia did not quite reach the WFS goal (reducing the number of undernourished people from 35.9 million in 1990–1992 to 19.4 million in 2014–2016, a reduction of 45.9% and thus 4.1% short of the goal). However, it reduced the proportion of the undernourished in the total population by 61.6% (from 19.7% in 1990–1992 to 7.6% in 2014–2016), 11.6% over the MDG 1 goal. Other key food security indicators prepared by the FAO in Table 2.9 suggest that more improvements are still needed. Some weak areas include low levels of intake of protein and fat; relatively high domestic food price volatility; and the high rates of wasting, stunting, and underweight for children under 5 years of age (Table 2.9). In addition, the rate of anemia among pregnant women in the early 2010s was still as high as 30% (FAO 2015b). For children under 5 years of age, this rate was 33%.

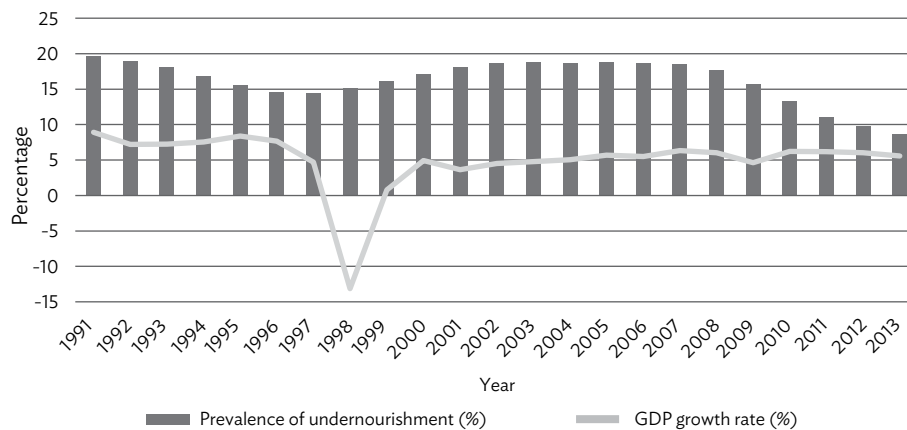
Table 2.9 Key Indicators of Food Security in Indonesia (5-year average)

	1990– 1994	1995– 1999	2000– 2004	2005– 2009	2010– 2014
Dietary energy supply (kCal per capita per day)	2,444	2,486	2,458	2,564	2,756
Average protein supply (g per capita per day)	52.6	53.6	53.6	57.2	NA
Average fat supply (g per capita per day)	44.8	43.8	47.0	52.0	NA
Average dietary energy requirement (kCal per capita per 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 (millions)	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
Percentage of children under 5 years of age affected by wasting (%)	NA	NA	8.4	14.8	12.9
Percentage of children under 5 years of age who are stunted (%)	NA	NA	37.5	40.1	37.8
Percentage of 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 = kilocalorie, NA = not available, PPP = purchasing power parity.

Source: Based on Food and Agriculture Organization of the United Nations. FAOSTAT. Food Security Indicators. <http://www.fao.org/faostat/en/#data> (accessed 26 August 2015)

Figure 2.6 GDP Growth and the Prevalence of Undernourishment in Indonesia, 1991–2013



GDP = gross domestic product.

Sources: Food and Agriculture Organization of the United Nations. FAOSTAT. Food Security Indicators. <http://www.fao.org/faostat/en/#data>; and World Bank. 2015. World Bank Open Data. <http://data.worldbank.org/> (accessed 25 October 2015).

Root Causes of Indonesia's Low Level of Food Security

High level of poverty incidence. In recent years, Indonesia's ADESA has been over 100%. However, the levels of wasting, stunting, and underweight for children under 5 years of age and anemia among pregnant women and children under 5 years of age are high. This suggests that some people do not have the economic means to obtain the required amount of food (FAO 2015b). 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 total number of people in poverty in the corresponding years was 74.9, 81.2, and 67.2 million, respectively.

High level of corruption. In 2014, the CPI for Indonesia was 34%, which suggests corruption is very severe in Indonesia (Transparency International 2015). Like in many other highly corrupt countries, a 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 in the steady decline in the prevalence of undernourishment (Figure 2.6). The shock of the 1997 Asian financial crisis to the economy disrupted the trend, resulting in the reversal of the decline in undernourishment. The steady economic growth after the 1997 crisis finally drove the prevalence of undernourishment to decline again in 2007 and beyond.

Other factors. Political instability also affects a country's food security. In Indonesia, political instability has lessened with the return of democracy in the early 2000s. This is likely to render the country with an important institutional framework for better and more sustainable food security. Other factors that also affect its food security include frequent natural disasters, environmental pollution, and higher costs of food supply logistics (due to the isolation of the islands). All these factors, however, are not fundamental. Any well-functioning government can overcome such challenges.

Challenges to Address

The return of democracy in Indonesia is most valuable for helping the country improve its future food security. However, a 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, its 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% and sometimes over 2.5% per annum). Since the mid-1980s, the population growth rate has declined gradually from 1.9% to 1.4% in the early 2010s (World Bank 2015). The 1.4% growth rate, however, is still very high, considering the fact that Indonesia has a very large population base.

The population pressure has already led to an increase in activities that attempt to extract more from nature, stretching its capacity. One such activity is the destruction of forests for arable land. While deforestation undermines the country's long-term sustainable development, smoke and haze caused by forest fires lead to serious air pollution and thus health problems for many people.

Poverty and inequality remain major problems in Indonesia. Although the 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 2015). Inequality and poverty will hurt a country's food security and its social stability and harmony.

Indonesia has tried hard to pursue full food self-sufficiency since the 1970s. Having high levels of food self-sufficiency remains on the agenda of the Indonesian government. Recently, the government reaffirmed its commitment to rice self-sufficiency and extended this commitment to other commodities such as maize, sugar and soybean. Subsequently, tariffs and other government interventions have been used (Bourgeois and Kusumaningrum 2008; Nugroho et al. 2013).

Some have argued that the pursuit of food self-sufficiency is no longer justified, can be economically costly to the country, and can be harmful to the country's food security (Timmer 2004; Bourgeois and Kusumaningrum 2008; Warr 2011). Given the level of social, economic, and political development Indonesia

has achieved, what is more important for achieving a higher level of food security in the future is a high quality of governance and good economic policies. Pursuing high-level self-sufficiency is a means to achieve better food security and in itself is not equal to food security. With higher and more equitable distribution of economic wealth but low self-sufficiency, countries can still achieve high levels of food security, such as Japan and the Republic of Korea. However, Indonesia's population is much larger. As such, the issue of whether a lower SSR is practical, even if Indonesians' income is high enough, should be studied carefully and rigorously before any action is taken.

2.5 Israel

Israel became independent on 14 May 1948. It has a landmass of 22,000 km². In 2014, its total population was about 8.2 million, with a per capita GDP (at PPP) of \$31,180 (2011 constant) (World Bank 2015). Israel is regarded as a "flawed democracy" regime according to the EIU, with a democracy index of 76.3 in 2014 (EIU 2015). Its corruption level is about medium with the CPI being 60 (Transparency International 2015). Israel has achieved a high level of food security—in 2014, its GFSI was 80.6%, making it the second highest in Asia and the 17th highest in the world (EIU 2014).

At the time of independence, however, having adequate food to feed the population was a huge challenge, aggravated by exceptional military pressure and an extremely serious financial crisis. As the grueling War of Independence came to its slow end around July 1949, the country's recovery was further slowed down by an enormous flow of immigrants. Most of these immigrants did not have any financial means. In early 1949, Israel's first elected government began preparations for the institution of an austerity regime to address the issues of immigrant absorption and Israel's dire economic conditions. In April 1949, the government declared its intention to ration food and punish black marketers. The government strongly believed that if it were to let the market determine the prices of goods, many people would not be able to afford basic goods such as food and clothing, and in some parts people would starve, not to mention be affected by the danger of high inflation. The ration supplied, however, was quite generous (Box 2.4).

Box 2.4 Food Rationing in Israel

Soon after independence, the Government of Israel introduced rationing in 1949 to ensure that its people, some of them being immigrants with limited financial means, would be able to afford basic goods such as food or clothing, and to prevent the occurrence of high inflation.

The daily rations were determined by an American nutrition specialist and included the following items:

Name of Food	Ration Quantity (g per day)
Simple standard bread	No limit
Maize	60
Sugar	58
Flour	60
Rice	17
Beans or similar legumes	20
Margarine	20
Noodles	8
Low-fat cheese	200
Onions	600
Biscuits	5

g = gram.

Source: Yosef, D. 1960. *Kiryat Neemana—the Siege of Jerusalem 1948* (Hebrew). Tel Aviv: Shoken. pp. 234–240.

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; greater amounts were made available to pregnant women and babies. The main shortage was that of milk and eggs, which were usually available only in powdered form.

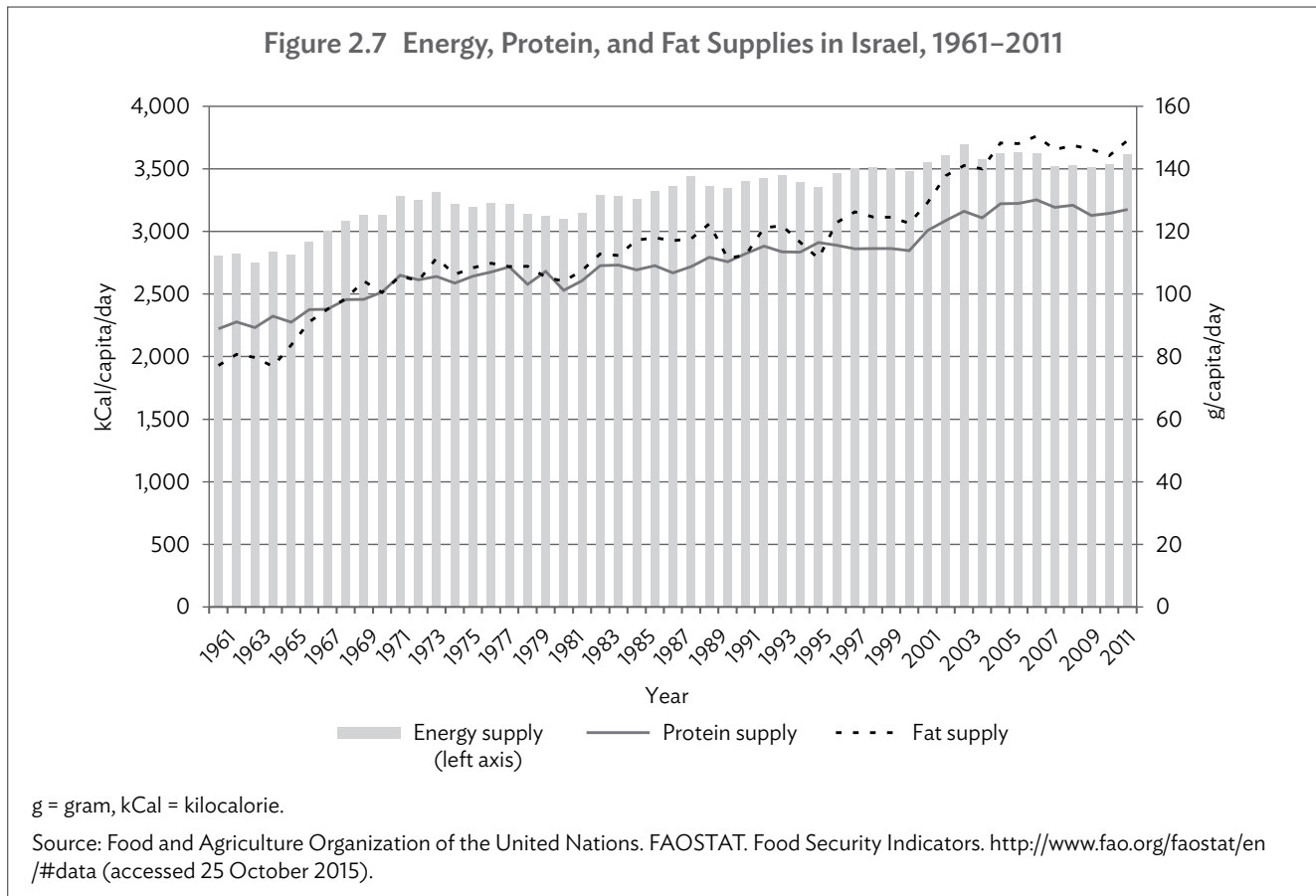
Rationing tickets were distributed to all citizens. The price of the rationed goods was identical throughout Israel.

This rationing policy was later extended to clothing and furniture. Measures were taken to fight against the spread of black markets but without much success. The rationing policy was progressively weakened until it was canceled in 1959.

Source: Authors.

Following the improvements in the overall food supply, food rationing was finally phased out by 1959. Since the early 1960s, food supply in Israel has been more than adequate (Figure 2.7). In fact, by the mid-1960s, the supply of all the three macronutrients—dietary energy, protein, and fat—had exceeded the normal requirements. By the mid-2010s, this excess had become even more excessive.

Israel's natural resources are far from being favorable to agriculture since more than half of the land is desertic and its climate is a priori not very conducive to agriculture. Then, how has Israel managed to achieve such a comfortable food supply situation? It achieved this through boosting domestic production and importing food. Israel's agriculture is highly developed, which has helped the country achieve a



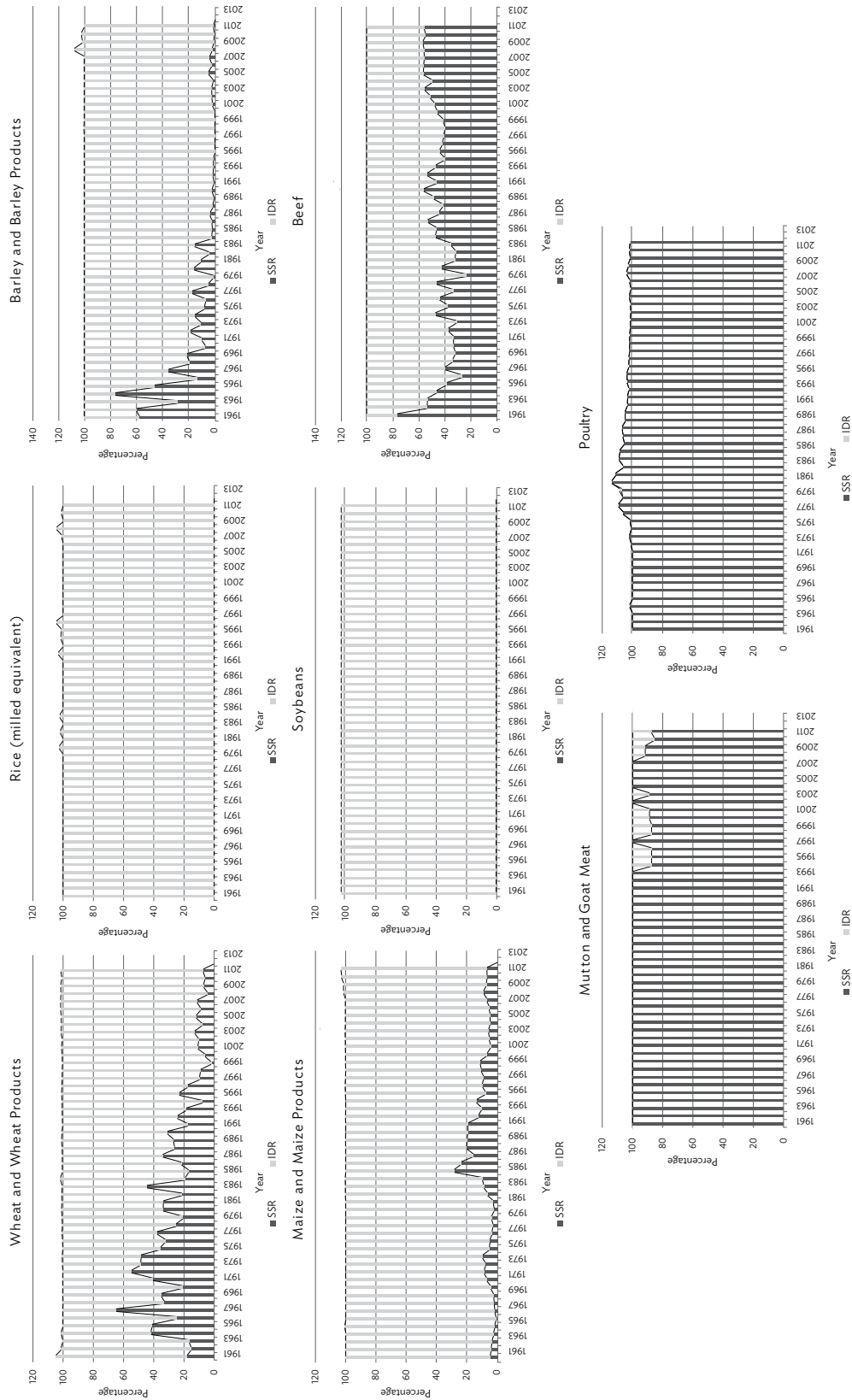
very high level of food self-sufficiency despite resource constraints. Indeed, Israel is considered a leader in agricultural technologies. Its agricultural industries enjoy very high productivity. Although its workforce in agriculture represents only 3.7% of the total labor force, the agriculture sector is able to produce 95% of the country's food requirements.

The main foods Israel imports include grain, oilseeds, meat, coffee, cocoa, and sugar. It does not import poultry and turkey, and there are almost no imports of milk and dairy products. The IDRs in 2012 (latest data available) were 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. Figure 2.8 shows the SSRs and IDRs for some major foods.

In normal times, food availability is not an issue in Israel. Food stocks are maintained to deal with emergencies such as wars and natural disasters. Food stock management is the responsibility of “the supreme authority for food,” which is one of the departments of the “emergency administration” under the Ministry of the Economy (Box 2.5).

Given the limited agricultural land availability (0.04 hectare per capita in Israel, being only marginally higher than that in Japan and the Republic of Korea of 0.03 hectare per capita) and harsh agronomic conditions, Israel's achievement of a high level of food output is most impressive. The factors that contributed most to its high level of agricultural productivity are chiefly attributed to cooperation in the agricultural communities, investment in agricultural R&D and extension, and farmer education.

Figure 2.8 Self-Sufficiency Ratio and Import Dependency Ratio of Major Foods in Israel



IDR = import dependency ratio, SSR = self-sufficiency ratio.

Source: Food and Agriculture Organization of the United Nations. FAOSTAT. Food Balance Sheets. <http://www.fao.org/faostat/en/#data/FBS> (accessed 15 May 2015).

Box 2.5 Food Stocks and Food Emergency Management in Israel

In normal times, food availability is not an issue in Israel. Food stocks are stored to deal with emergencies such as wars and natural disasters. No detailed data on food stocks in Israel are available as this is considered an important national security issue.

The “emergency administration,” which is part of the Ministry of the Economy, is in charge of food emergency management in order to guarantee the delivery of goods and services to ensure the economy continues to function in such situations.

One of the departments of this “emergency 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 the food stocks are adequate and that the local authorities are prepared in case of large-scale disasters such as earthquakes, floods, epidemics, disastrous water pollution, and terrorist attacks.

The activities of this supreme authority for food include the requisition of manpower, vehicles, and equipment for those factories considered vital; the guidance and continuous training of the representatives of the “emergency administration” in the vital factories and in local emergency committees; the regular tracking of additional factories whose activity may be vital in case of emergency; and the preparation (together with the civil defense institutions) of these vital factories for emergency situations.

It turns out that about 200 factories in the food branch find themselves under requisition in states of emergencies (such as bakeries, flour mills, dairies, refrigeration units, and supermarket companies), and they cover major branches such as meat production, rice, coffee, tea, canned food, and baby foods.

The Ministry of the Economy also makes sure that there is always an adequate stock of basic food (e.g., for baby foods, the instructions are to have a stock that would be adequate 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 the civil defense institutions may also intervene if necessary, as has been the case in the past during wartime.

Source: Authors.

Israel’s Experience in Boosting Food Output Cooperation in agricultural communities. It is estimated that one full-time agricultural worker in Israel supplied food for 17 people in the early 1950s. This figure had risen to 113 by 2010 (IEICI 2011). In addition to the enormous contribution of investment in agricultural research to such an increase in productivity, the widespread cooperation in the Israeli agricultural communities, through the kibbutz and the moshav, has also contributed significantly (Box 2.6). Such cooperation allows the scale of production to increase and, in the meantime, makes investment in agriculture more effective.

Investment in agricultural research and development and extension. In the 1950s and 1960s, important resources in Israel had already been devoted to agricultural R&D and extension. What has happened to agriculture in Israel during the past 65 years clearly illustrates the importance of such an investment. Gelb and Kislev (1982) point out that agricultural output in Israel more than tripled in value (in constant prices) in a period of 20 years, despite a large reduction in the farm labor force. Since capital accumulation hardly offset this decrease in the labor force, 90% of the growth in output resulted from growth in productivity and only 10% from growth in conventional inputs (Gelb and Kislev 1982). They further note that “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 past two decades.”

Israel’s Ministry of Agriculture has played an important role in promoting agricultural R&D, extension, and education. Its specialists give regular and often free help to farmers. Among the services that the Ministry of Agriculture provides, the most important ones are (i) instruction (providing updated agricultural knowledge to farmers), (ii) training (providing farmers with concentrated professional knowledge allowing the adoption of new and advanced technologies), and (iii) producing applied knowledge. The “agricultural extension service” of the Ministry of Agriculture, in cooperation with regional R&D units and universities, conducts many experiments aimed at finding solutions

Box 2.6 Cooperative Communities in Israel's Agriculture: Development and Evolution

Israel is home to two very special types of cooperative agricultural communities: the kibbutz and the moshav. They were founded during the first quarter of the 20th century before Israel was established (and their location was an important factor in determining the borders of Israel).

A kibbutz 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 the job he or she held. The lifestyle in the kibbutz used to be quite ascetic, and its members had to completely identify with its ideology and live under the motto “from each according to his ability, to each according to his need.” An interesting analysis of the allocation of resources in the kibbutz can be found in Sadan (1963).

A moshav 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 or family farm units. The first moshav, Nahalal, was founded in 1922. A specific type of moshav is the “collective moshav,” an institution that shares the 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 farm 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 size of the kibbutzim (plural of kibbutz) and moshavim (plural of moshav) was not very big. They could not use their assets as collateral and lacked direct access to the capital market in the 1950s and the 1960s. The government supported the kibbutzim and moshavim that were in financial difficulties with government-backed long-term loans. Consequently, cooperative agriculture was very successful in Israel. In fact, banks were very interested in having cooperatives as their clients. Such arrangements started to change in the late 1970s.

In addition to the kibbutzim and moshavim, the moshava is a different type of farming community. It is a non-cooperative community of farmers who generally live on privately owned land. Moshava farmers, however, often share services related to farm production, such as packing houses and wineries. There is also 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 of the Arab farmers use modern agricultural technology such as greenhouses.

More details about the kibbutz and moshav and some useful references can be found at the website of the Jewish Virtual Library: http://www.jewishvirtuallibrary.org/jsource/Society_&_Culture/kibbutztoc.html

Source: Authors.

to problems faced by farmers in the fields of water use, including water recycling, adoption of new technologies and automations, improvement of agricultural produce quality to meet international standards, and reduction in the use of pesticides.

As a result, Israeli farmers have been very successful in highly mechanizing their production, making an intensive use of greenhouses and adopting very complex, profitable, and computerized irrigation systems to overcome the shortage of water, land, and

manpower and to boost farm output. The following are some illustrations of these technological advances in Israeli agriculture.

1. The cattle and milk industry is extremely automated. Almost all dairy farms have become computerized. Every cow is connected to a sensor that transmits to the computer information on its health and the composition of its milk. Israel holds the world record in the yield of milk per cow.

2. 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 allows controlling the amount of water, fertilizers, and pesticides.
3. The intensive use of greenhouses allows a computerized control of the temperature, humidity, light, and fertilizer amount, significantly boosting crop yields.
4. Fish farming in greenhouse pools allows the production of fish in relatively desertic areas by using salted water. These pools are often covered with plastic in order to lessen the amount of evaporation.
5. Biotechnological developments have enabled some varieties of vegetables and fruits to be transformed genetically so that they can be sold in new colors (e.g., pepper) or made more resistant to diseases. More recently, there has also been an increasing production of organic food.

Investment in agricultural R&D, extension, and education has significantly increased the ability of Israel's agriculture sector to supply a very high portion of the food needed by Israelis. In addition, the sector has also been able to export foods and is currently very much export oriented. Exports have become an important source of income for Israeli farmers.

Farmer education. *Kibbutz* and *moshav* members generally have a high level of education. Literacy has been almost universal among male Jews for more than 1,500 years. Within the *kibbutzim* and *moshavim*, gender equality has been increasingly promoted. Hence, female members nowadays also have a very high level of education. Even in the 1950s and 1960s, *kibbutz* and *moshav* members had a level of education that was much higher than that observed among farmers in countries with a level of development similar to Israel. The high level of education may explain why *kibbutz* and *moshav* members have been quick to adopt new agricultural technologies.

High Level of Food Security Attainment

Table 2.10 shows per capita food intake in Israel between 1950 and 2012. During the past 60 years, the consumption of calories increased by 40%, from 2,610 kCal to 3,630 kCal per person per day. The data clearly show that even during the so-called austerity period in the early 1950s, the average per capita calorie intake was much higher than the minimum dietary energy requirement (kCal per person per day) set by the FAO in accordance with the structure by age of the population of each country (about 1,820 kCal per person for Israel for the past 20 years). In 2012, the number of calories per person per day in Israel was among the highest in developed countries. Proteins consumed have experienced an increase of about 30% during the past 60 years. Most of the increase comes from animal product consumption, while the amount of proteins

Table 2.10 Supply of Macro Nutrients in Israel (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	265	379	460	413	482	651	351	452
Legumes, ² oil grains, and nuts	62	85	96	114	152	142	199	199
Vegetables and melons ³	65	67	77	69	103	103	124	132
Fruits	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	NA	NA	NA	NA	NA	NA	37	35

continued on next page

Table 2.10 *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 ¹	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 ²	0.2	0.1	0.3	0.4	0.5	1.3	0.0	NA
Legumes, ³ 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 ⁴	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	NA	NA	NA	NA	NA	NA	0.8	0.9
Total Fat (grams)	73.9	86.7	104.3	111.5	117.6	139.6	145.5	140.5
Animals ¹	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	1.3	0.8	1.8	2.0	2.2	6.6	0.0	NA
Legumes, ³ 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
Fruit ⁴	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	NA	NA	NA	NA	NA	NA	0.7	0.8

kCal = kilocalorie, NA = not available.

Notes:

1. Including meat, eggs, fish, and milk and its products.

2. Until 2000, the group included chocolate, sweets, sugar, jam, and honey.

3. Including soybeans.

4. Until 2000, "fruit" included melons.

Source: Central Bureau of Statistics. 2014. Statistical Abstract of Israel 2014. Jerusalem. Table 19.24.

derived from grains and their products has declined. At the same time, fat intake has increased sharply (an increase of 90% during the same period).

Fighting Food Insecurity at the Household and Individual Level

Hence, in Israel, there is no problem of food availability at the national level. The country has in recent years

increasingly paid more attention to the food security status at the household and individual levels, with a focus on the food security of people at the bottom of the income distribution. To get a more detailed picture of food security at the micro level, Israel is one of the few developed countries that have conducted food security surveys of households and individuals. Israel conducted a survey in 2011 and 2012 by following the

household food security measure developed in the United States.

Analyses of the surveys suggest that food insecurity exists in Israel at the micro levels. 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. It is also observed that the higher the level of education of the head of the household, the lower the degree of food insecurity. To improve the food security of low-income people, the Israeli government provides them with a safety net protection. The government also works together with more than 200 nongovernment organizations that distribute food to the poor.

2.6 Japan

Japan had a population of 127 million in 2014 with a landmass of 365,000 km². It is a country with a high population density. Its per capita GDP (at PPP) was \$35,635 (2011 constant) (World Bank 2015). The CPI for Japan was 76% (Transparency International 2015). Its democracy index was 80.8, the highest in Asia and one of the two Asian countries regarded by the EIU as a “full democracy” regime (together with the Republic of Korea) (EIU 2015). In 2014, its GFSI was 78%, being the third highest in Asia and the 21st highest in the world (EIU 2014). Japan has come a long way in improving its food security since the mid-1940s when it suffered from a severe food shortage.

Battling Food Crisis after World War II

The food crisis in 1946 was the worst event for food security in Japan’s recent history. Before the end of World War II, food was already in shortage and a food control system was already in place. The main components of this control system 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 onward and integrated into, 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: 127–130). Almost all other goods were also controlled.

A delivery quota was allotted to each hamlet (i.e., a subgroup in a village) (Tama 2013b: 186–187; Tanabe 1948: 234–236). Crops were collected by farmers’ organizations under the control of the semi-government body called the Agricultural Association (Nogyokai) (Tanabe 1948: 63–64). Retail and wholesale industries were transformed into semi-government ration organizations (Shokuryo Eidan) (Tanabe 1948: 69–71). The ration rate per person differed according to age, labor intensity, and gender. The food ration, which was already very low at that time, was cut down by a further 10% 3 months before the war ended. The level of rice rationing, 297 gram/day per adult (both sexes), was equivalent to only 974 kCal/day (calculated from data shown in Tanabe 1948: 365). The necessary level for an adult male was considered to be 2,400 kCal/day (Tanabe 1948: 303). The food control system nonetheless enabled a relatively equitable distribution of food.

Three key factors resulted in the severe food crisis after the war (i) import disruptions, (ii) crop failure in 1945, and (iii) malfunction of the “rice delivery system.” After the war ended, the Allied Powers occupied Japan from August 1945 to April 1952. They, primarily the US military, ruled Japan indirectly through the Japanese government. The rule by the Allied Powers made food imports conditional on permission from the General Headquarters of the Supreme Commander for the Allied Powers and the availability of foreign exchange. Obtaining any of these was difficult, causing disruptions to food imports. In 1945, because of adverse weather, the harvest of rice was very low. Moreover, farmers were reluctant to deliver their harvests to the government, partly because they had little stock and partly because the black market price was much higher.

The main countermeasures used to deal with the food crisis were a combination of rice delivery by force and by imports. Each single measure was not enough to deal with the situation. Requests for food imports to the general headquarters by the Japanese government did not lead to immediate imports. In February 1946, the Ministry of Agriculture and Forestry implemented emergency food policy measures in the form of an emergency imperial ordinance. The main measure was compulsory delivery of rice, i.e., through expropriation. In the cases of significant withholding of rice, officers searched individual farms and collected rice, sometimes with the assistance of the US military police.

In the spring of 1946, delays in ration provision became continuous and spread out. The situation of food in urban areas got worse in April and May. The actual ration amount was reported to be around 80% of the requisite in Tokyo and a few of other cities. Protest demonstrations took place in many areas, with people surrounding ration stations and local government offices. Reportedly 250,000 people participated in the “Food May Day” demonstration in Tokyo on 19 May (Oda 2012: 203–204). In northern cities such as Sapporo and Aomori, the ration delay in June exceeded 1 month and reached 50 days and 32 days, respectively.

From March 1946, the amount of food from domestic sources available for ration in Tokyo shrank rapidly to a negligible level by July. In the second-largest city, Osaka, the total ration decreased by 40% from the previous month in June. In Tokyo, as of May, the energy intake per day dropped to 1,352 kCal, of which the ration was 775 kCal (ISR 1970: 60). The situation was on the brink of a catastrophe. Fortunately, a catastrophe was avoided thanks to food imports that started in May. By July, the ration in five out of Japan’s six largest cities relied heavily on imports. At the national level, the ration of imported food was concentrated in July to September (ISR 1970: 74), after which the domestic early crop of rice and sweet potatoes came.

The imports and early crops of 1946 provided real relief and were essential for avoiding a catastrophe in the off-crop season (ISR 1970: 60–61), 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. On another front, utilization of early crops implied consumption in advance and meant a decline in the supply for the next rice year (MAF 1972: 15). Hence, people survived, but hunger continued unabated. In 1946, the caloric intake dropped to 1,361 kCal/day. The situation was worse in urban areas. Given the shortfall and delay in ration supply, people had to purchase supplemental food from the black market to survive. The delay in the ration 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 resulted in the cancellation of the remaining supply to consumers through ration (Sakurai 1989: 19).

Recovery from hunger relied on an 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 came from better weather and replenishment of inputs and labor. Other policy measures also encouraged farmers to produce and deliver more, e.g., a higher official producer price. By 1951, rice supply significantly improved. By 1956, the Japanese economy was no longer termed a postwar economy.

Adopting “Selective Expansion of Agricultural Production”

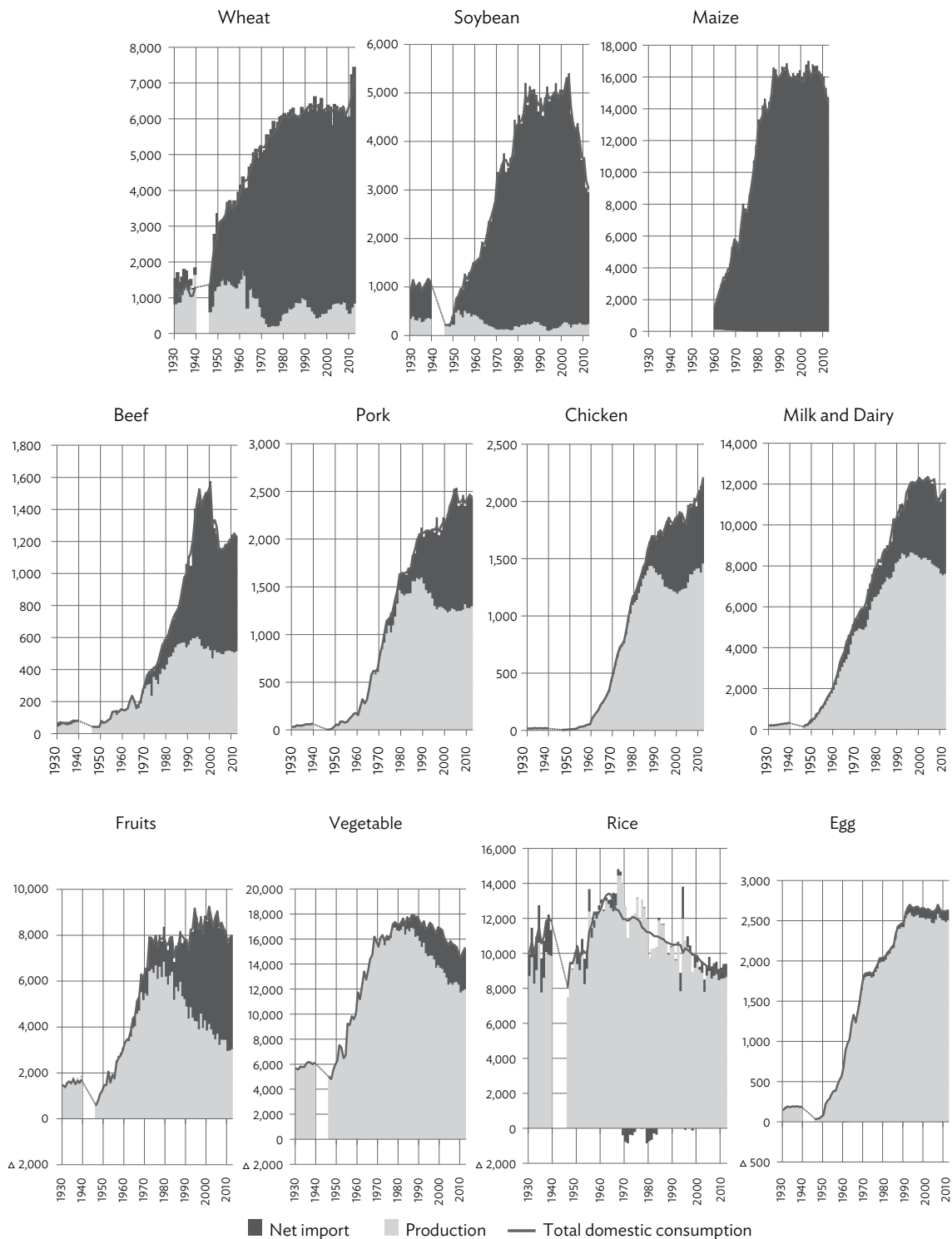
In the early 1960s, the “selective expansion of agricultural production” became one of the key concepts in the Agricultural Basic Act (Act No. 127 of 1961). In essence, it was a shift from land-extensive farming to relatively land-saving farming. Rice was an exception, which was maintained and expected to be rationalized (i.e., lowering production cost) through scaling up of farms.³ The selective expansion framework determined the composition of Japan’s agriculture sector, which continues to this day. As a result of the selective expansion approach as dictated by the lack of agricultural production resources, imports of some food crops increased rapidly and their self-sufficiency ratio dropped significantly since the early 1960s, especially for maize, soybean, and wheat (Figure 2.9). Japan tried hard to maintain a relatively higher self-sufficiency ratio in other foods but with mixed success. So far, the only two food items for which Japan has been able to maintain a high level of self-sufficiency are rice and eggs.

Comfortable Food Supply

Because of the increasing domestic production and imports, Japan’s food security improved notably by the early 1960s. Its dietary energy supply had become adequate in the beginning of the 1960s. By the early

³ 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: 78). The official rice price had a political role as compensation for agricultural trade liberalization (Tama 2013a: 208). The distribution and price of rice was gradually deregulated and the Foodstuff Control Act of 1942 was eliminated in 1995.

Figure 2.9 Changes in Food Imports, Production, and Consumption in Japan since 1930 (1,000 tons)



Note: Data for some years is not available.

Sources: Ministry of Agriculture and Forestry. 1976. 農林大臣官房調査課編『食料需要に関する基礎統計』 [Basic Statistics on Food Demand]. Tokyo: MAF and Norinto-kyokai; and Ministry of Agriculture, Forestry and Fishery. 2014. 「食料需給表 平成24年度」 [Food Balance Sheets 2012]. Tokyo.

1970s, its protein supply became satisfactory. Its fat supply became satisfactory by the mid-1980s (Figure 2.10). Since the early 2000s, the per capita intake of dietary energy has notably declined, possibly a reflection of the aging population (the elderly require less dietary energy) and the pursuit of lower body weight (energy tends to increase body weight).

Preparatory and Preventive Approach for Successful Food Security Management

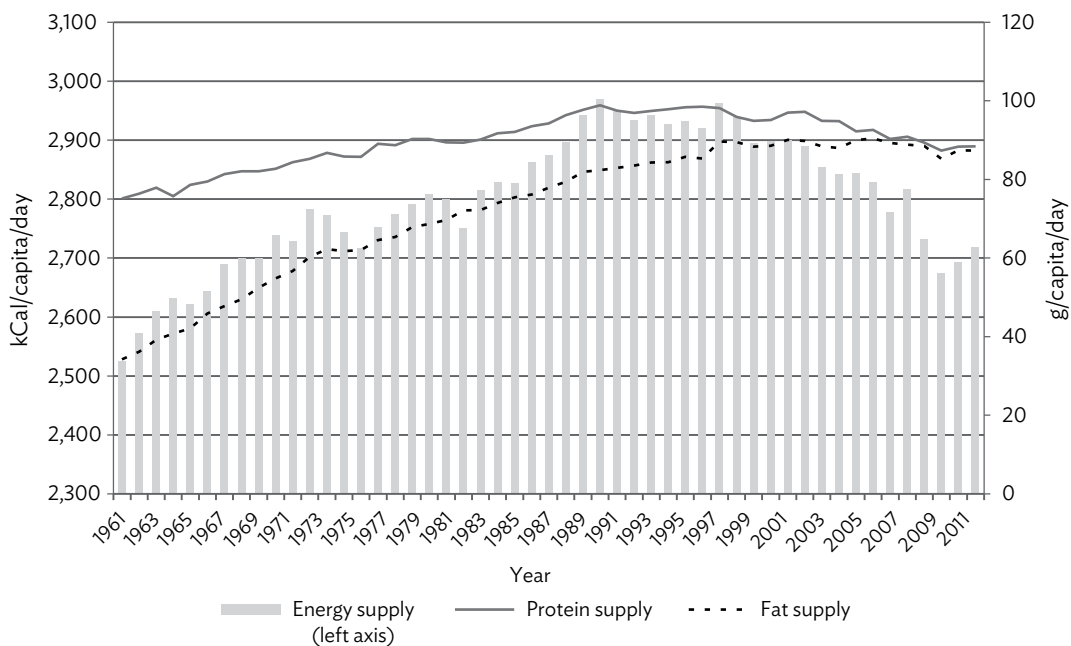
The high dependence on imports, especially the large imports from one country (the US for cereals and soybeans), was not without concerns and costs. In June 1973, without any prior notification or consultation with Japan, the US banned soybeans export as a part of its anti-inflation policy. The soybean embargo and possible embargoes on other foods was unexpected and frightening for Japan, which depended on the US for most of its supply of soybeans, maize, and wheat. Domestic production of these foods had dropped to a negligible level since the introduction of selective expansion (Figure 2.9). Since soybean is an important

food in the Japanese diet, the embargo was hard on the Japanese.

The embargo episode made Japan more cautious about high import dependence, although it was later able to secure food imports. As a result, Japan became vigilant in preparing for any such shocks in the future. Key measures adopted include securing imports from the US through contracts, better understanding of global food demand and supply situations, diversification of import sources, and buffer stocking.

Two of the measures are worth particular mention. First, Japan was a pioneer for investing in developing a model to better understand major structural changes in food demand and supply in the world (MAF 1975: 74–77). The late IMPACT model of the International Food Policy Research Institute and the AGLINK-COSMO model of the Organisation for Economic Co-operation and Development–Food and Agriculture Organization (OECD–FAO) all benefited from Japan’s initiative (MAFF 2009). Second, Japan expanded its international

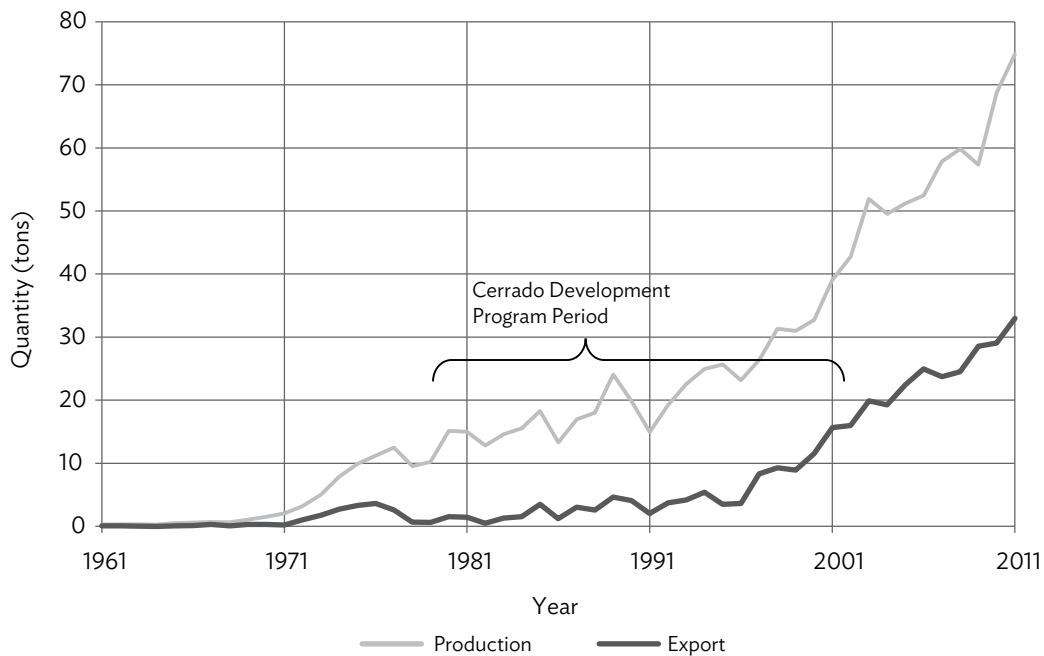
Figure 2.10 Energy, Protein, and Fat Supplies in Japan, 1961–2011



g = gram, kCal = kilocalorie.

Source: Food and Agriculture Organization of the United Nations. FAOSTAT. Food Security Indicators. <http://www.fao.org/faostat/en/#data> (accessed 25 October 2015).

Figure 2.11 Trends of Soybean in Brazil: Production and Export



Source: Food and Agriculture Organization of the United Nations. FAOSTAT. Commodity Balances—Crops Primary Equivalent. <http://www.fao.org/faostat/en/#data/BC> (accessed 31 January 2015).

cooperation for agricultural development with the Japan International Cooperation Agency (JICA) established in 1974 to help develop agriculture in overseas countries and diversify import sources.

One of JICA's great successes was to assist Brazil's Cerrado region (1979–2001) in becoming the second top-exporting country of soybeans comparable to the US (Figure 2.11). The PRC and not Japan has become Brazil's major destination of soybean exports. However, Brazil's expansion in soybean production and export significantly boosted global supply. As a result, the competition with Japan for soybean imports has lessened significantly. This has indirectly helped stabilize Japan's soybean imports and also allowed Japan to be able to import soybean at a price that would otherwise be much higher.

Since the 1970s, the Japanese government has been diligent in initiating measures to safeguard the much-

improved food security in the country. This culminated in the development of an explicit food security policy in 1999 under the new basic act and basic plans for preparedness even during normal times (Box 2.7). As such, Japan's food security management today is largely preparatory and preventive in nature.

Under the new basic act, the current food security policy has developed on the basis of a series of basic plans drawn up every 5 years. Following the stipulation by the Basic Plan of 2000 (MAFF 2000), which was the first basic plan under the new act, 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 followed in ordinary times, classification of emergency situations, arrangement of organizations to deal with the situations, and measures for each level of emergency (Box 2.8). Since the first basic plan, three more have been issued—in 2005, 2010, and 2015.

Box 2.7 Japan's Basic Act and Basic Plans

In 1999, the Food, Agriculture and Rural Areas Basic Act (Act No. 106 of 16 July 1999) replaced the Agricultural Basic Act of 1961. In the formulation 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 People's Republic of China (PRC) and other emerging countries in the future. The issue, "Who will feed China," caused wide concern 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 as important sources (Article 2 [2]).

The target rate of food self-sufficiency ratio is set in the Basic Plan for Food, Agriculture and Rural Areas, which is issued every 5 years. This was the first time that such a target was set by law. But the levels of the targets were quite ambitious to be achieved 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;
- (3) 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:

- (1) 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.

To secure a stable food supply, the act has included the following policies: 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 for 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.

Box 2.7 *continued*

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 ...

Source of the translation of the Basic Act: Japanese Law Translation. <http://www.japaneselawtranslation.go.jp/law/detail/?id=2339&vm=04&re=01> (translated 23 May 2013).

Under the new basic act, the first basic plan was issued in 2000 (MAFF 2000). This first basic plan introduced, in 2002, the Food Security Manual for Emergency Situations (renamed Guidelines for Food Security in Emergency Situations in 2012) (MAFF 2002).

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 tariff, as well as stockpiling of cereals and others.

The basic plan of 2010 (MAFF 2010) introduced the following additional policy measures for “establishing comprehensive food security”:

- enduring supply of agricultural inputs such as fertilizers and genetic resources;
- appropriate and efficient operation of stockpiling of rice and wheat,
- enhancement of sanitary and phytosanitary measures;
- measures against disruption of commercial distribution,
- enhancement of 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;
- international 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.

The latest basic plan of 2015 (MAFF 2015) introduced the following new key elements:

- “food self-sufficiency capacity,” which represents the potential capacity of domestic production in the case of emergency, and 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; and
- 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.

continued on next page

Box 2.7 *continued*

For the food self-sufficiency capacity, an indicator—available calorie supplies per capita per day by domestic production of agriculture, forestry, and fishery based on a certain scenario of conversion in agricultural production—was developed. The Government of Japan publishes the latest values of the indicator based on four different scenarios every year (see the table below).

Indicator of Food Self-Sufficiency Capacity for the Fiscal Year 2013

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

kCal = kilocalorie.

Source: Compiled by authors from Ministry of Agriculture, Forestry and Fishery (2015). 「食料・農業・農村基本計画」 [Basic Plan for Food, Agriculture and Rural Areas]. Tokyo.

Box 2.8 Japan's Food Security Manual for Emergency Situations

Following the stipulation by the basic plan of 2000 (MAFF 2000), 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 to the 1950s. There are three levels of emergency corresponding to the extent of severity (see table below). Level 0 may include an anticipated major crop failure domestically or in the foreign production region. Level 1 may include export restrictions in the main exporting countries like what happened in the United States in 1973. Level 2 corresponds to a significant decrease in imports of cereals and soybeans due to disturbances caused by major events such as wars. The measures for this level are seemingly equivalent to those in wartime, such as production control (conversion and use of nonarable land), rationing, price caps, and allocation of oil. The measures are based on existing laws such as the Act for Stabilization of Supply–Demand and Prices of Staple Food (Act No. 113, 1994), which 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.

Levels of Food Emergency and Countermeasures in the Food Security Manual

Level 0	Level 1	Level 2
<ul style="list-style-type: none"> • Supply-related information • Utilizing stock and ensuring import • Minimizing loss • Monitoring prices 	<ul style="list-style-type: none"> • Additional planting • Correction of regional imbalance and excessive stockpiling • Standard price 	<ul style="list-style-type: none"> • Production conversion (energy-efficient crops, fallow areas) • Land-use change (wilderness, rangeland) • Rationing • Price cap • Fuel-oil allocation

Source: Compiled by authors from Ministry of Agriculture, Forestry and Fishery (2000). 「食料・農業・農村基本計画」 [Basic Plan for Food, Agriculture and Rural Areas. March]. Tokyo.

Another factor contributing to Japan's successful food security management is private-sector investment in foreign food and agricultural industries. General trading companies such as Marubeni, Sumitomo, and Mitsui invest directly in countries like Brazil, Argentina, and Australia. The trend is that the private sector is expanding mainly in the later stages of the food supply chain (away from engaging in farmland purchase or crop production) and is moving to help exporters diversify sales destinations with a focus on Asia.

Aspects that Warrant Attention in the Future

Looking into the future, per capita agricultural land resource endowment in Japan is set to change because of changes in the population. Japanese population may decrease by around one-third by 2060 and around 60% by 2100 compared with 2010. Even in the most moderate case, the population will decrease by half by the end of the 21st century. A lower population translates into more land per capita. This means that the land resource constraint on Japan's food security can be eased to some extent provided agricultural lands are maintained and used appropriately, an aspect that warrants attention from the Japanese government. Even so, Japan will still have to rely on large amounts of food imports for ensuring food security. Japan has been vigilant in securing stable and diverse sources of imports in addition to maintaining a steady domestic production.

At the more micro level, there are indications that food insecurity at the household and individual levels among the low-income groups may increase. Disparity in income levels has increased during the past 3 decades as shown by the Gini coefficient, which has been upward since the 1980s. There have been reports that school lunch is the main source of food for some children (e.g., Abe 2014). Japan has been an equitable society economically after World War II. Stable jobs, popularization of advanced education, income redistribution with progressive taxation, a social security system, and reallocation of tax money to low-income regions are some of the measures that contributed toward the equality. But since the late 1980s, the stability of jobs, the level of salary, and the system of income redistribution have degraded gradually. So far, there is no sign of a reversal. Therefore, the likelihood of more food insecurity in Japan at the low-income household and individual levels in the future presents a concern.

2.7 Democratic People's Republic of Korea

The Democratic People's Republic of Korea and the Republic of Korea used to be the same country: Korea. In 1945, Korea gained its independence from Japanese colonial rule and was divided into two countries soon after. 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 US Armed Forces were stationed in the Republic of Korea, while the Soviet Armed Forces in the Democratic People's Republic of Korea.

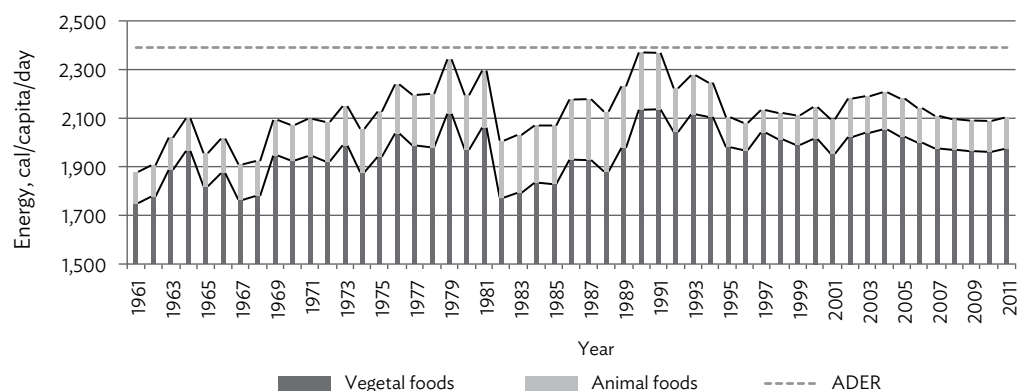
In 1950, the Korean War occurred and a fierce battle continued for 3 years. On 27 July 1953, the two countries signed an armistice to make a new border with the Military Demarcation Line. The massively fortified strip (the Korean Demilitarized Zone) bisects the Korean Peninsula and has been one of the world's most dangerous potential flash points throughout the Cold War until today. As a result, people in the Republic of Korea and the Democratic People's Republic of Korea have lived totally different lives under totally different regimes. The Republic of Korea chose to be a market-based economy as a democratic country; the Democratic People's Republic of Korea was based on a centrally planned economy as a socialist state.

The Democratic People's Republic of Korea has a land area of 120,000 km². In 2014, its population was about 25 million with a per capita GDP (at PPP) of \$1,800 (2011 constant) (World Bank 2015). Major problems facing this country include poor infrastructure, severe corruption, severe food shortage, extreme poverty, and lack of economic and political reforms. In 2014, the CPI for this country was 8%, making it among the most corrupt countries in the world. The EIU classifies the country as an "authoritarian regime," with a democracy index score of 10.8 (EIU 2015), making it one of the least democratic countries. Its overall food security level has been very low. A GFSI is not available for the Democratic People's Republic of Korea; perhaps, the EIU cannot get enough information for this country.

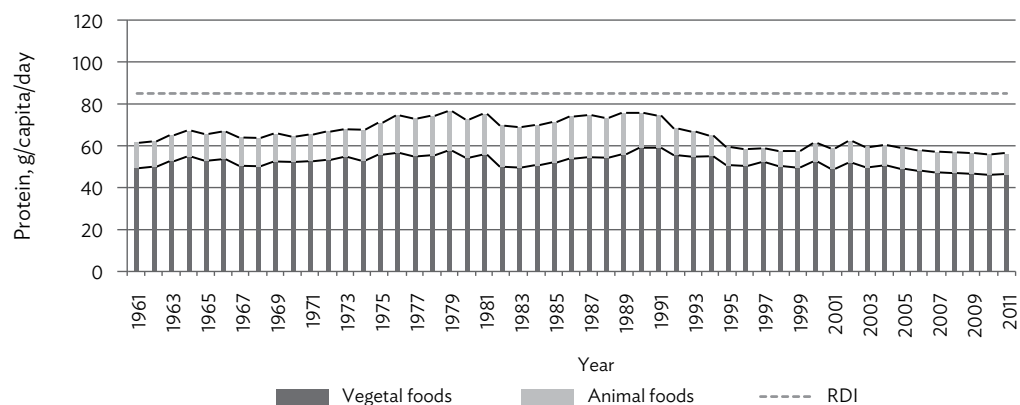
Figure 2.12 shows that food supply has rarely been adequate at the aggregate level in the Democratic People's Republic of Korea. The intake of all the macronutrients

Figure 2.12 Dietary Intake per Day per Capita in the Democratic People's Republic of Korea

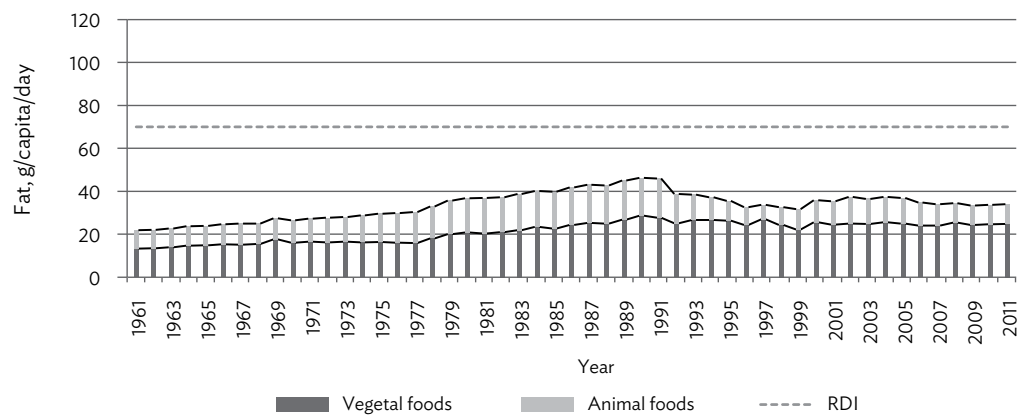
A. Energy Intake



B. Protein Intake



C. Fat Intake



g = gram, RDI = reference daily intake.

Source: Food and Agriculture Organization of the United Nations. FAOSTAT. Food Security Indicators. <http://www.fao.org/faostat/en/#data> (accessed 25 October 2015).

is below the normal requirements. In the case of protein and fat, the intake is only about half the requirements in recent years. The sharp drop in 1991 in all the three macronutrients was followed by a severe famine in the following years until 1998, in which millions of people in the country died from starvation or hunger-related illnesses.

As a result of food shortage, the prevalence of undernourishment has steadily increased in the Democratic People's Republic of Korea, from 23% in 1990 to 42% in 2014 (FAO 2015b). During the same time, the number of people undernourished increased from 4.8 million to 10.5 million. Other key food security indicators by the FAO in Table 2.11 also suggest the overall low level of food security in the country. The rates of wasting, stunting, and underweight for children under 5 years of age were high in the late 1990s, but have shown a sharp decline since the mid-2010s. (It is not clear why there is such a big drop given that the food has been short in the country.) The rate of anemia among pregnant women has also shown a declining trend from 39% in 1990 to 27% in 2011. For children

under 5 years of age, this rate reduced from 48% in 1990 to 34% in 2011 (FAO 2015b).

According to the FAO, the Democratic People's Republic of Korea is one of 38 countries that need food support from other countries (FAO 2014). Among these countries, 29 are located in Africa, 5 countries including the Democratic People's Republic of Korea in Asia, and 4 in South America. The Assessment Capacities Project operated by three private international relief organizations (Save the Children International, Action Contre la Faim, and Norwegian Refugee Council) suggests that 16 million out of 24.6 million people in the Democratic People's Republic of Korea experience chronic unstable food supply (ACAPS 2015).

Before the 1990s, the Democratic People's Republic of Korea could obtain some assistance from various socialist states for being their ally. The collapse of many socialist states starting from the late 1980s has made it difficult for the Democratic People's Republic of Korea to obtain aid to help with its food supply. As one of the few socialist states refusing to carry out substantial reforms,

Table 2.11 Key Indicators of Food Security in the Democratic People's Republic of Korea (5-year average)

	1990– 1994	1995– 1999	2000– 2004	2005– 2009	2010– 2014
Dietary energy supply (kCal per capita per day)	2,241	2,117	2,172	2,108	2,102
Average protein supply (g per capita per day)	67.0	58.6	60.2	56.8	NA
Average fat supply (g per capita per day)	39.0	33.4	36.4	34.2	NA
Average dietary energy requirement (kCal per capita per day)	2,345	2,344	2,357	2,375	2,395
Average dietary energy supply adequacy (%)	95.6	90.4	92.2	88.8	88.0
Prevalence of undernourishment (%)	26.9	36.9	35.8	39.1	41.8
Number of people undernourished (millions)	5.7	8.3	8.4	9.5	10.4
Political stability and absence of violence (index)	NA	–0.5	0.2	0.2	–0.3
Domestic food price volatility (index)	NA	NA	NA	NA	NA
Percentage of children under 5 years of age affected by wasting (%)	NA	20.8	9.8	5.2	4.0
Percentage of children under 5 years of age who are stunted (%)	NA	63.9	46.3	32.4	27.9
Percentage of children under 5 years of age who are underweight (%)	NA	55.5	21.0	18.8	15.2
GDP per capita (in PPP) (constant 2011 international \$)	NA	NA	NA	NA	NA

g = gram, GDP = gross domestic product, kCal = kilocalorie, NA = not available, PPP = purchasing power parity.

Source: Based on Food and Agriculture Organization of the United Nations. FAOSTAT. Food Security Indicators. <http://www.fao.org/faostat/en/#data> (accessed 26 August 2015).

its overall economy has suffered from lack of growth. Slow economic growth coupled with self-isolation has often resulted in inadequate food supply to its residents, causing widespread undernourishment and even death from starvation. Its political and economic institutional arrangements have also led to various other difficulties that have undermined its food supply and security.

Root Causes of the Lack of Food Security in the Democratic People's Republic of Korea

Cooperative farming and lack of economic incentives.

The adoption and continuance of the model of forced collective farming is a major factor responsible for food shortage. In the Democratic People's Republic of Korea, collective farms and state farms coexist ("collective farms" have been literally referred to as "cooperative farms" in the Democratic People's Republic of Korea, but this terminology is inadequate according to the original concept of "cooperatives"). The operations of these farms are based on government commands. Most farm output is purchased at mandatory but low prices by the government.

Like many other previously socialist states, in the Democratic People's Republic of Korea, farmers do not own land. The country carried out land reforms that made it possible for the government to forcibly take over land from large landowners and then distribute it to farmers without land or with a small piece of land for free. After the land reforms, the government began to organize farmers into collectives, and the collectivization was completed in 1958. By then, individual farmers had lost their land. The collective farming has since continued. Collective farming does not guarantee individual farming rights and lacks economic incentives for individuals in production, thus lowering agricultural productivity.

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 certain good results. However, the collective farming system needs a major overhaul, but this is not forthcoming as the government still follows the principles of collective farming. The collective farming system of the country will continue to undermine its ability to boost its food output.

Lack of investment in agriculture, especially in agricultural research and development. After its establishment, the Government of the Democratic

People's Republic of Korea followed an approach in which heavy and chemical industries were first developed. A lower level of 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 was already impoverished before heavy and chemical industries could make steady headway. Subsequently, little money could be spared to invest in agriculture, especially in agricultural research and development, to boost output. Another reason why the Democratic People's Republic of Korea has been short of funds to invest in agriculture is the "military first" strategy—money has to be used on military expenses first.

Damage to natural resources. The pressure of producing more food over the past decades has caused serious damage to the natural resources. Activities such as deforestation, converting slopes into terrace cropping fields, and cutting trees for fuel have resulted in unsustainable uses of natural resources. Further, they contribute to a 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 foods.

Lack of food imports and foreign food aid. 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 imported about 2 million tons of food grains every year, food supply would have significantly improved. The government did not do so because of a lack of foreign exchange. On the other hand, foreign exchange has been used for purchasing foreign goods to maintain the lavish lifestyle of the elite and for military equipment to back the political agenda.

Lack of food import capacity, or more accurately lack of willingness to devote resources to import food may, to some extent, be mitigated by the support of international food aid. However, food aid to the Democratic People's Republic of Korea has been declining in recent years due to refusal on the part of the government or lack of willing donors. In early 2000, the country had the opportunity to secure some food aid. While foreign food support continued, people came to know more about the outside world. The government felt politically uncomfortable and

refused to continue receiving food aid as it did not want questions to be raised on its rule.

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 other previously socialist states, the Democratic People's Republic of Korea fully plans and controls its economy. The control over its agriculture sector is perhaps even stricter than some other socialist states. The collective farms, which are grassroots 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 grains procured at prices that are often low and do not even cover the costs. This offers very limited incentives for farmers to till the land harder and smarter.

Uncertainties Surrounding Future Food Security in the Democratic People's Republic of Korea

In the most recent years, there have been attempts to bring about some changes in the Democratic People's Republic of Korea. 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 Pojeon Program has reduced the size of a "sub-work 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 sub-work team from 15 to 5. Farmers have also been allowed more freedom in disposing of their products, instead of just handing them over to the government. (The previous 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. If the Pojeon Program can be fully implemented, it will further enhance the

country's agricultural productivity and increase its grain output. Further, if the Democratic People's Republic of Korea introduces a family-based farming system, food production is expected to be even higher in view of the experiences of the PRC and Viet Nam. This would have a great positive impact on better food security.

We note, however, that the Government of the Democratic People's Republic of Korea still insists on a "military first" strategy (not people's livelihoods first). This will most likely jeopardize its capacity to produce more food and hence have an adverse impact on the status of its food security for the future because of resource misallocation and other related problems. Even if a family-based farming system is adopted in the future, for it to be successful, the supply of essential agricultural inputs such as fertilizers, machinery, and pesticides is necessary. The supply also needs to be stable and reliable. Unfortunately, the country 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 non-transparent policy environment, it is hard to anticipate that any foreign investor would soon go there to invest.

Food security cannot be achieved by just increasing grain production. It is also essential to increase the availability of diverse foods, enhance accessibility to foods, and provide safe and quality foods. 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 in the Democratic People's Republic of Korea have grown quite impressively and have gradually extended into many aspects of the lives of the people in the country. Although the government is still trying to control the market whenever and wherever it can, 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. In reality, it has become increasingly harder for the government to deny the existence and the role of the market. The revitalized market will have a positive impact on food security in the Democratic People's Republic of Korea.

It is hard to make predictions regarding the longer-term food security status of the Democratic People's Republic of Korea because of 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, institutional reforms to its political arrangements are necessary. The political arrangements need to be able to foster a government that places people’s livelihoods first, has transparent policies, and efficient administration. Only by doing so can a fair society be fostered, which in turn will encourage greater farm output and will also encourage foreigners to invest in the country. Whether and how such a transformation may take place in the Democratic People’s Republic of Korea is yet to be seen.

2.8 Pakistan

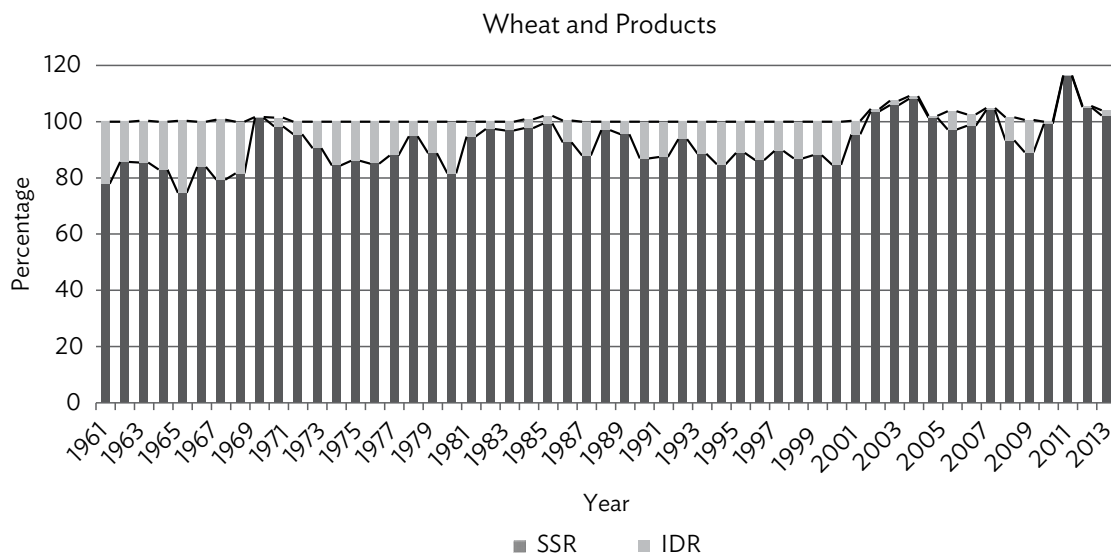
The Islamic Republic of Pakistan came into being in 1947 after its separation from India. It had a population of 185 million in 2014, with a land mass of 770,880 km² (World Bank 2015). A CPI of 29% suggests that corruption is very high in this country (Transparency International 2015). Its democracy index was 46.4% in 2014, and it is regarded as a “hybrid regime” (EIU 2015). Its level of food security is low with its GFSI being 43.6% in 2014 (EIU 2014). Pakistan is a lower-middle-income country—its 2014 per capita GDP was \$4,619 (PPP, 2011 constant).

Major food crops produced in Pakistan (in 2013) include wheat (24.23 mt), rice (6.77 mt), 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. The major animal product produced in 2013 was beef (1.65 mt), followed by poultry meat with a big margin (0.91 mt) and then by mutton and goat meat again with a big margin (0.46 mt). Wheat is the staple food of the Pakistanis followed by rice. Beef is the major meat consumed. Pulses and beef provide 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 has sometimes been as high as 20%. Food aid has been accepted to help bridge the wheat shortage (Ahmad and Farooq 2010). Since the early 2000s, there has been improvement in wheat’s self-sufficiency ratio (Figure 2.13).

Despite the generally high SSRs in most food items, the prevalence of undernourishment is still tenaciously

Figure 2.13 Self-Sufficiency Ratio and Import Dependency Ratio of Wheat in Pakistan, 1961–2013



IDR = import dependency ratio, SSR = self-sufficiency ratio.

Source: Food and Agriculture Organization of the United Nations. FAOSTAT. Food Balance Sheets. <http://www.fao.org/faostat/en/#data/FBS> (accessed 15 May 2015).

high in Pakistan. Data show that in the past 2 decades, the prevalence of undernourishment was high and fluctuating. In some years, it had been as high as 25% (Table 2.12). Pakistan did not succeed in achieving either of the two 2015 international hunger reduction targets. For the WFS goal, the number of people undernourished in 2015 did not decrease compared with that of 1990; instead it went up by 44.2% (from 28.7 million in 1990–1992 to 44.2 million in 2014–2016 (FAO, IFAD, and WFP 2015: 46). For the MDG 1 goal, it only managed to reduce the proportion of undernourished in the total population by 12.4% (from 25.1% in 1990–1992 to 22.0% in 2014–2016).

Most of the other key indicators concerning food security in Table 2.12 also point to the low level of food security in Pakistan. Its protein supply is still below a satisfactory level, although it has improved its supply of fat. Its domestic food price volatility is relatively high. As for the indicators on wasting, stunting, and underweight for children under 5 years of age, none of them rate favorably for Pakistan. The improvement in these three indicators in the past 25 years has also been very slow (Table 2.12). In addition, the prevalence of anemia among pregnant women went up steadily from 46.4% in 2001 to 50.5% in 2011 (FAO 2015b). The prevalence of anemia among children under 5 years of age also went up, from 55.6% in 2001 to 61.1% in 2010.

Root Causes of Pakistan's Low Level of Food Security

High level of poverty incidence. Table 2.12 shows that at the national level, the supply of dietary energy is more than adequate, with the ADESA being over 100 since the early 1990s. Fat supply is also largely satisfactory. Although protein supply is a little low, there has been improvement and it is not far from the desired level. This comfortable food supply situation at the national level would imply that there is enough food for people in the country. The high levels of wasting, stunting, and underweight for children under 5 years of age and a high prevalence of undernourishment suggest that a large number of people do not have sufficient economic access to the required amount of food.

Based on the Asia-specific poverty line of \$1.51 per person per day, Pakistan's population share under poverty was 36.4% for 2005, 36.2% for 2008, and 26.5% for

2010. The corresponding numbers were 57.8 million, 60.5 million, and 46.0 million, respectively (ADB 2014). Poverty and lack of economic access to food is one of the 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 would have improved and its SSRs dropped. A number of other studies have also pointed out clearly that in Pakistan the major cause of food insecurity is mainly a problem of access, chiefly economical and sometimes physical, to food by the poor (e.g., Ahmad and Farooq 2010; Food Security Portal; Gera 2004; Hussain and Routray 2012; and WFP and VAM 2013).

High level of corruption. Pakistan's CPI of 29% is very low, making it one of the most corrupt countries in the world. Corruption causes misuse and misallocation of resources and an inequitable distribution of income. This in turn adversely affects the achievement of a higher level of food security.

Political instability. Pakistan has been politically unstable since its inception in the late 1940s. Its index of "political stability and absence of violence" in recent years is -2.7 (Table 2.12), suggesting political instability and the presence of violence to quite a serious extent.

Various other factors may also affect the level of Pakistan's food security, e.g., conflicts in the border areas, militant and terror activities, and the occurrence of natural disasters. These, however, are not 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.

Challenges to Improving Pakistan's Food Security

To improve its future food security, Pakistan is facing formidable challenges in a number of areas. In particular, it faces significant challenges of poor governance and severe corruption, lack of economic growth, and lack of security within the country and on the border. Pakistan has to overcome these challenges in order to achieve durable societal development outcomes that are fundamental to achieving stable economic growth and in turn to improving its future food security.

Table 2.12 Key Indicators of Food Security in Pakistan (5-year average)

	1990– 1994	1995– 1999	2000– 2004	2005– 2009	2010– 2014
Dietary energy supply (kCal per capita per day)	2,346	2,393	2,323	2,415	2,439
Average protein supply (g per capita per day)	59.6	61.8	59.6	62.6	NA
Average fat supply (g per capita per day)	61.0	64.4	67.0	72.8	NA
Average dietary energy requirement (kCal per capita per 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 (millions)	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
Percentage of children under 5 years of age affected by wasting (%)	14.9	NA	14.2	NA	12.7
Percentage of children under 5 years of age who are stunted (%)	48.6	NA	41.5	NA	44.0
Percentage of 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 = kilocalorie, NA = not available, PPP = purchasing power parity.

Source: Based on Food and Agriculture Organization of the United Nations. FAOSTAT. Food Security Indicators. <http://www.fao.org/faostat/en/#data> (accessed 26 August 2015).

Environment 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, The World Factbook).

The huge pressure resulting from population increase has also made the environment and resource problems worse. Between the 1970s and the 1980s, Pakistan experienced very high population growth (over 3% per annum). In the early 1990s, the growth rate dropped below 3% but was still above 2.5%. Since the early 2000s, despite its further decline, it was still above 1.8%, contributing to a significant increase in the total population each year (World Bank 2015). How Pakistan coordinates the population growth to match its economic and environmental capacities requires serious attention from its government and the public.

In addition, there has been a shortfall of investment in agriculture infrastructure and R&D, leading to limited innovation in the agriculture sector (Gera 2004).

Antiquated farming methods and the inefficient use of resources have contributed to poor productivity (Saleem 2012). The slow, or absence of, significant improvement in agricultural productivity is detrimental to the rural people, especially the rural poor. Two-thirds of the country's population and 80% of the poor population 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 country's mountainous areas, many rural residents still do not have adequate access to food and other essential services (Food Security Portal; Gera 2004).

In the foreseeable future, Pakistan is most likely to continue to be subject to considerable sociopolitical, economic, and environmental volatility. However, deep reforms and thus improvements in governance must first be carried out soon to unleash the country's growth potential. Without substantial improvements in governance and 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.

2.9 Singapore

Singapore, officially known as the Republic of Singapore, is a city-state that came into being in 1965 after being expelled from Malaysia of which it was a part. When it became a separate nation in 1965, there were many uncertainties. Issues that were threatening this new country's development were many, such as unemployment, lack of housing, poor education system, and most worryingly the lack of natural resources and arable land. The new government aimed at building "Singaporean identity" as a multiracial and multilingual society. It designated Malay, Chinese, Tamil, and English as official languages. Manufacturing was promoted as part of its economic strategy. The government intentionally prepared Singapore to become an international 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 50 years of endeavor, Singaporeans have transformed their country into a modern and highly developed society. In 2014, its per capita GDP (PPP) reached \$78,958 (2011 constant). With a population of 5.5 million, its population density is extremely high, at 7,814 persons per km², due to its very small land area. Corruption in this country is extremely low, with a CPI of 84% (Transparency International 2015). The EIU regards it as a "flawed democracy" regime with its democracy index of 60.3% (EIU 2015). Its GFSI was 84.3 in 2014, the highest in Asia and the fifth highest in the world (EIU 2014). Singapore achieved such an enviable high level of food security despite its very limited natural resources.

Experiences in Achieving Very High Level of Food Security

Very low level of corruption. Corruption is very low in Singapore. With its CPI in 2014 being 84%, it is the most "clean" country in Asia and the seventh cleanest in the world. Low levels of corruption encourage more efficient allocation of resources and more equitable distribution of results 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.

Lateral approach to managing 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 a high level of food self-sufficiency, it could have significantly disadvantaged itself economically and hence reduced its financial ability to import foods.

High vigilance in food security management. Despite its very high level of food security status, Singapore has never been too complacent. It has a designated agent 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, has developed Singapore's food security road map. The road map consists of three strategies: "core," "supporting," and "enabling." "Core" strategies place emphasis on diversification of sources of imports, investment abroad, industry development, optimized local production, and stockpiling. "Supporting" strategies involve reduction of food waste, strengthening of 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).

Managing Challenges for Sustained Food Security

Since Singapore heavily relies on imports for its food supply, the major challenge for sustaining a high level of food security is to tackle any disruptions, both expected and unexpected, to its food imports. Supply interruptions caused by widespread epidemics such as the severe acute respiratory syndrome, wars, and natural disasters are generally 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 total needs of finfish, 30% of eggs, and 10% of fresh

vegetables. However, he admits that all these would not be adequate should supplies be disrupted for a prolonged period (Teng 2013).

The other option for Singapore is to diversify its sources of imports to reduce dependency on a single or a few exporting countries. This should be an easy and inexpensive option. 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 (APTERR), Singapore can benefit from the regional “reserve” should any disruption last longer.

As part of the strategy to handle import disruptions, Singapore has also started promoting the use of product substitutes, particularly liquid or powdered eggs and frozen meat cuts instead of fresh chilled meat. It has also started using contract farming through foreign investment and the creation of a designated “food production and processing zone” situated in other countries (Kassim 2011).

Most food supply disruptions caused by epidemic or natural disasters tend to be localized. After initial shocks, a country is usually able to quickly find alternatives to handle food imports. However, if a large-scale war bursts out, the impact can be widespread and prolonged. In this regard, it will be most valuable for Singapore to play an active role in promoting and contributing to regional and global peace. Singapore is highly developed economically and also has strong R&D capabilities. Coupled with its strategic location and friendly relationship with many other countries, Singapore can contribute to many worthwhile initiatives to ensure sustained peace in the region and globally. Singapore will be the ultimate beneficiary of a peaceful world as far as food security is concerned (Teng and Escaler 2010).

While food is abundant in Singapore, Singaporeans also demand high-quality food, especially poultry meat, seafood, vegetables, and fruits. As such, the Singaporean government is obliged to make sure that the available foods are safe to consume for all. However, as it imports over 90% of its food, it is vulnerable to food safety incidences in production countries.

Food waste is another issue. Reducing food waste is equivalent to having an increased food supply. The

Singaporean government has made efforts to reduce food waste by educating food manufacturers, retailers, food importers, food producers, and other stakeholders along the food supply chain on waste management. R&D in food waste reduction and recycling is also encouraged. Efforts have also been made to reduce food waste through better post-harvest management and storage to prolong shelf life (Agri-Food and Veterinary Authority of Singapore).

Like in many other developed economies, excessive food energy intake or the intake of foods without balanced nutrition has also become an issue in Singapore. Coupled with the lack of physical activity, the incidence of obesity has been high. Avoiding excessive food intake and having a balanced nutrition intake will assist not only in preventing and controlling obesity and other health problems but also in making efficient use of foods and relatively increasing the food supply. The Singaporean government has been drawn to pay attention to waste reduction (Gan and Pang 2012).

Overall, Singapore has successfully managed its food security. It continues improving its strategies, seeking new opportunities, and addressing risks in an increasingly complex environment to sustain its high level of food security. It has shown to the world that a high level of food security does not have to be achieved through having high self-sufficiency. Through effectively and equitably distributing food, diversifying food import sources, and having long-term and good partnerships, it is possible for a country with limited natural resource endowments to become highly food secure.

2.10 Republic of Korea

Under Japanese colonial rule, the southern part of the Korean Peninsula was largely an agricultural zone and the northern part an industrial zone. As a result, the Democratic People’s Republic of Korea was economically more developed, and its per capita income was higher to start with after the division of the country. The Democratic People’s Republic of Korea also had a larger land area with less population and thus was in a better position than the Republic of Korea in food provision. However, after decades of separation, the Republic of Korea is food abundant and has become one of the developed economies in the world, while

the Democratic People's Republic of Korea is still chronically short of food.

The Republic of Korea's land area is 97,000 km². In 2014, its per capita GDP (PPP) was \$33,629 (2011 constant), with a population of 50.5 million. Corruption in the country is relatively low, with the CPI being 55% (Transparency International 2015). Moreover, its democracy index of 80.6% is high, being one of the two "full democracy" countries in Asia (EIU 2015). Its GFSI was 73.2 in 2014—the fourth highest in Asia and the 25th highest in the world (EIU 2014).

Before the Republic of Korea achieved this high level of food security, it faced many challenges. At the time of its establishment in 1948, the Republic of Korea could not produce sufficient food to feed its people. The Korean War (1950–1953) worsened the food shortage problem due to loss of grain stocks, interruptions to farm production, and damage to fields and other production infrastructure. The influx of refugees from the Democratic People's Republic of Korea after the war sharply increased the population and thus the demand for food in the Republic of Korea.

Measures to Fight Food Shortage

To cope with the severe food shortage and to stabilize rice price, the government revived the rice compulsory collection system from farmers, which had been enforced during World War II by Japanese colonial ruling. The collected rice was then distributed to government employees, poor people, and military personnel. The procurement price for the rice was below the market price until 1960. This did not make farmers happy and did not contribute to boosting food production.

Right after 1945, a huge amount of foreign aid, mostly from the US, was provided to the Republic of Korea to assuage the economic turmoil and foster economic development. To increase domestic food production, the Government of the Republic of Korea developed two food production expansion five-year plans (1953–1957, 1958–1962). The most important measures were the expansion of cultivated land through land reclamation, increasing supply of fertilizers, developing high-yield varieties, and appropriate application of pesticides and herbicides. 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 supply. In 1978, the Republic of Korea finally attained its rice self-sufficiency target. However, the production of other grain crops has shrunk continuously, and this deficit has been met through imports.

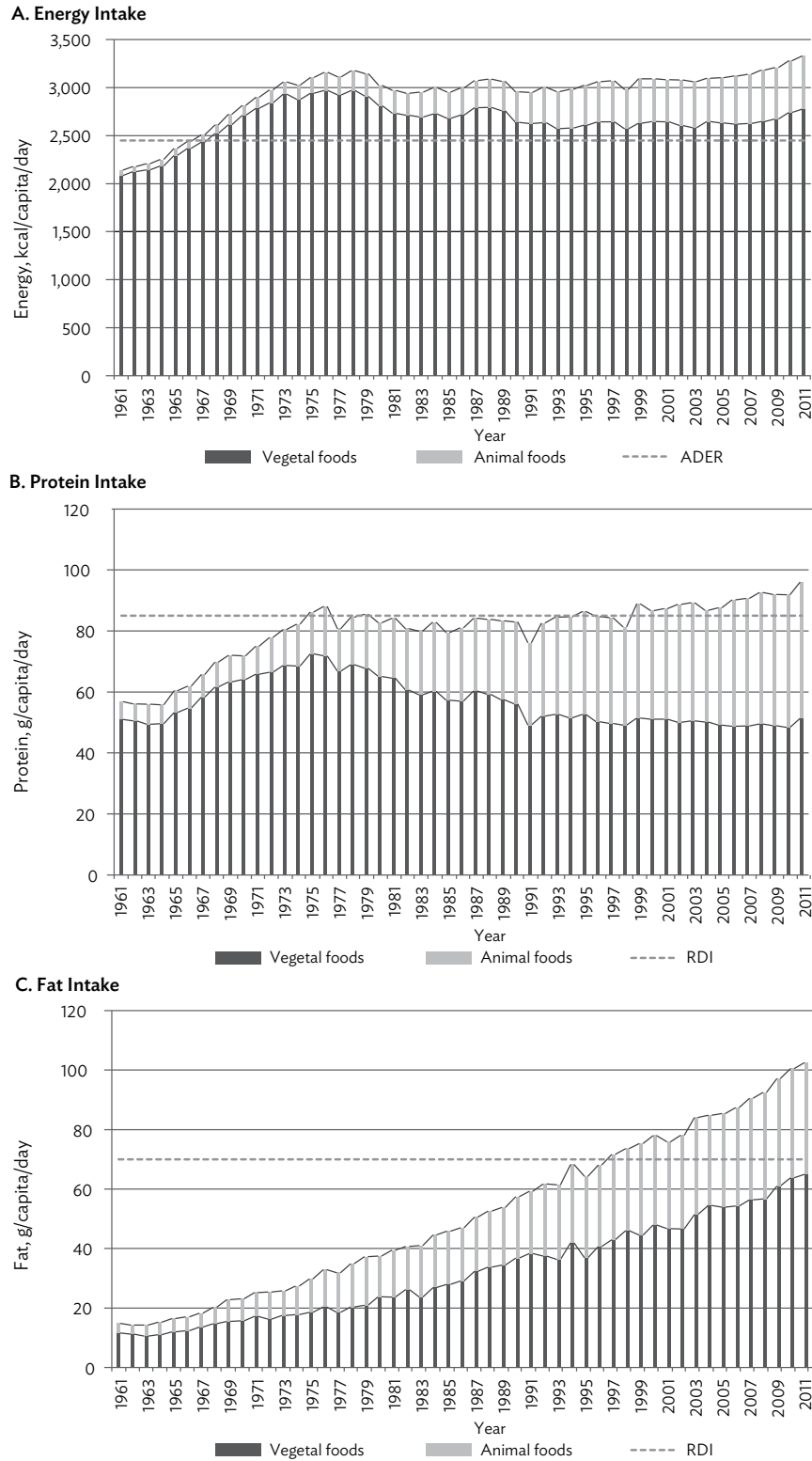
Rice is the staple food of the country and has always accounted for a significant portion of total food consumption. The government encouraged people to eat rice together with barley and coarse grains to reduce the demand for rice during times when rice was short in supply. In the schools, teachers were asked to check whether mixed grains (rice and other grains) were used in students' lunch boxes. The government also monitored restaurants to ensure they were using mixed grains. In the meantime, imported wheat was processed into wheat flour and sold at a very low price to encourage consumers to substitute for rice. Such measures helped the Republic of Korea mitigate the somewhat rigid demand for rice by the consumers during those years of tight supply.

In more recent times, as incomes have grown, people have taken to consuming more meats and vegetables. This has helped reduce the intake of rice. Over the past decades, per capita average consumption of rice has gradually declined from the peak of 136 kg in 1970 to 67.2 kg in 2013. Combined with lower per capita consumption of food grains, the relatively high level of supply of rice from domestic production, through focused efforts, has enabled the Republic of Korea to be in a reasonably comfortable situation in terms of staple food supply, despite the increase in total population.

Comfortable Food Supply

After the Korean War, food supply in the Republic of Korea continued to improve and the achievement in increasing residents' food intake has been most impressive. As shown in Figure 2.14, the supply of energy has been significantly above the normal requirements since the early 1970s, with increasing portion of the supply coming from animal foods. Protein supply has become largely adequate since the mid-1970s. The fat supply was the last one to meet the necessary requirements, which occurred in the mid-1990s and has been increasing fast.

Figure 2.14 Dietary Intake per Capita per Day in the Republic of Korea



g = gram, RDI = reference daily intake.

Source: Food and Agriculture Organization of the United Nations. FAOSTAT. Food Security Indicators. <http://www.fao.org/faostat/en/#data> (accessed 25 October 2015).

Nowadays, few people in the Republic of Korea worry about whether they may not have meals to eat. Poor people also seldom suffer from starvation thanks to various social safety-net programs. If there are existing problems, these are those caused by the “too comfortable” food availability, such as obesity and food waste. Then, what policy measures has the Government of the Republic of Korea used to transform the country from a situation of severe food shortage to a high level of food security? Which policies are more successful and which are less?

Policy Initiatives to Transform Food Shortage to Food Abundance

Compulsory rice-collecting policies. In the 1950s, especially after the Korean War, hyperinflation prevailed and private grain markets did not function well to help curtail inflation. A compulsory system was used to collect rice for the government to distribute to pockets of the population. The price paid to farmers, however, was lower than market prices and even lower than production costs to keep food prices low. This policy did not help increase grain production. The compulsory collecting system was abolished in 1956 and changed to the government procurement system that purchased rice from farmers who wanted to sell it at predetermined prices. However, because the purchase price was lower than the production cost, not many farmers sold their rice to the government. The ratio of the quantity purchased by the government over total production quantity remained very low at around 5% until 1960.

Price support. In the early 1960s, there were sharp drops in grain self-sufficiency, especially wheat and maize. Ensuring a certain level of the self-sufficiency ratio was on the government’s policy agenda. In the mid-1960s, price support for grain production was introduced. Grain procurement price was increased substantially. A rise in total grain production followed. This resulted in large and increasing government expenditure on the support of 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 these two foods.

Public stockholding program. Many governments maintain public stockholdings or buffer stocks in their

quest for better food security. The Republic of Korea also uses this approach to enhance its food security. It started a stockholding program in the 1950s. The volume of purchased rice gradually increased. Since 1975, the government has maintained the purchased volume over 16% of total rice produced.

After the completion of the Uruguay Round, the World Trade Organization (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 new rules, the public stockholding program was to be operated within the aggregate measurement of support (AMS) limit. The AMS limit of the Republic of Korea was W2,182.6 billion in 1995, and it gradually reduced to W1,490 billion in 2004. The Republic of Korea used most of the AMS limits for rice, while 97% of the AMS limits were used up in 2004, in which 92% were used for rice price support, around 3% for barley, and the rest for maize, rapeseed, and soybean (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. Payment is made to rice growers through a direct payment program to compensate them for their loss of price support.

Tariff protection. The high cost of producing agricultural products in the Republic of Korea implies low global competitiveness. Therefore, the government has tried to inhibit imports by keeping tariffs high. Consequently, prices of most agricultural products in the Republic of Korea are much higher than global prices. Since 1995, all WTO members were no longer able 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 tariffication of rice for 10 years (1995–2004). In 2004, tariffication of rice was delayed for another 10 years through renegotiation. The trade-off the Republic of Korea had to make in order to have this tariffication 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 Republic of Korea’s rice industry without exposure to global competition. However, in 2015, the Republic of Korea finally moved to tariffication of 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, established in 1961, significantly contributed to boosting agricultural productivity by improving crop varieties, promoting machinery use in agriculture, and providing agricultural technology guidance and advice to farmers. The Agricultural Product Quality Management Service (APQMS) was established in 1998 by expanding and restructuring the agricultural product inspection service established in 1949. The APQMS oversees certifying agricultural product quality, safety control of harmful substances including agricultural chemicals, and quality assurance. The APQMS has contributed to enhancing consumers' confidence in the safety and quality of agricultural products produced in the Republic of Korea. The Ministry of Food and Drug Safety is responsible for monitoring food safety including recalling harmful foods, promoting healthy living, and managing food-related regulations.

Managing a High Level of Food Import Dependency for Sustained Food Security

Despite the high level of food security achievements, the Republic of Korea's food supply relies heavily on imports due to very limited agricultural resource endowment. Figure 2.15 shows the changes in its food self-sufficiency and import dependency. 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. Even this is subject to challenges in the future due to the tariffication in 2015. The low, and declining, level of grain self-sufficiency is a source of concern to the government and the public.

For the Republic of Korea to maintain a high level of food security into the future, there are many challenges. The two major ones are (i) maintaining a level of food self-sufficiency ratio that is socially and politically acceptable and (ii) coping with global food supply instability. Limited resources available have resulted in a low and declining self-sufficiency in the Republic of Korea. While a low self-sufficiency ratio is not necessarily detrimental to food security, it does disturb the minds of the public

who have suffered bitterly in the past from insecure food provisions. This in turn bothers the politicians.

The potential for the Republic of Korea to produce more food domestically, however, is not optimistic. How stable the future global food market will be is also hard to foresee. Further, as a small player, the Republic of Korea can exert little influence over what is going to happen in the global food market. Hence, handling neither of the challenges is easy. Nonetheless, the Republic of Korea has taken actions or adopted various measures in a number of areas to pursue a sustained high level of food security into the future.

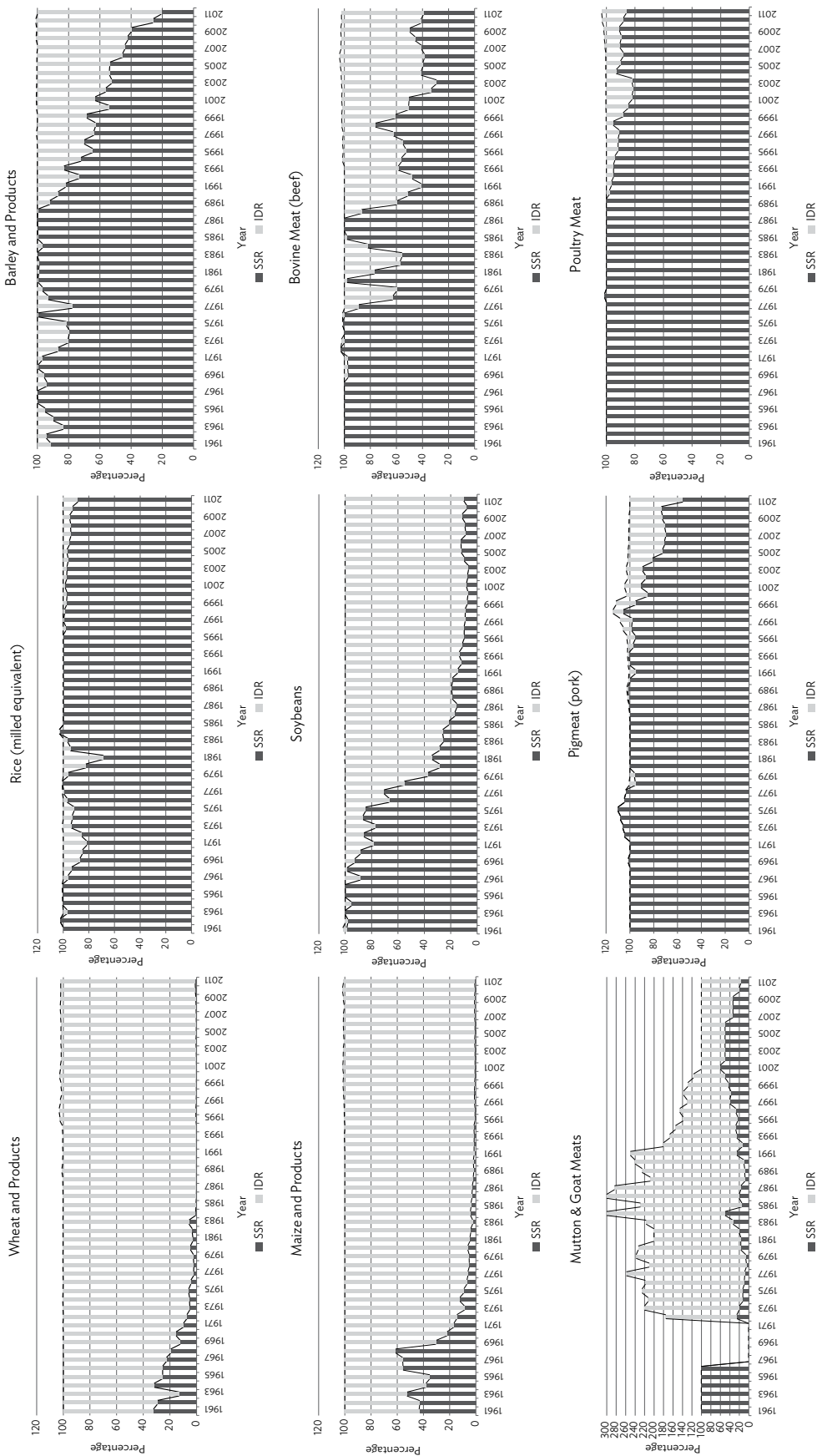
Global cooperation. Global cooperation can be an effective approach for import-dependent countries such as the Republic of Korea to ensure food security. The Republic of Korea joined the APTERR, an international emergency rice reserve initiative, in 2012. It is expected to continue its effort in promoting this and other available avenues of international cooperation.

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

Reducing and avoiding food waste. Reducing food waste helps improve the food supply position. The Republic of Korea has made efforts to reduce food waste and losses. Its people like to put a lot of food on their dining table, although they cannot eat all the food. This is especially the case when they entertain guests and friends. The food waste in the Republic of Korea is close to 5 million tons every year, and the cost for treating the waste is approximately W808 billion (approximately \$735 million) (MoE 2012). A volume-based food waste collecting fee system has been introduced in 2013.

Minimum food self-sufficiency targets. The Republic of Korea has established self-sufficiency targets for

Figure 2.15 Self-Sufficiency Ratio and Import Dependency Ratio of Major Foods in the Republic of Korea



IDR = import dependency ratio, SSR = self-sufficiency ratio.

Source: Food and Agriculture Organization of the United Nations. FAOSTAT. Food Balance Sheets. <http://www.fao.org/faostat/en/#data/FBS> (accessed 15 May 2015).

Table 2.13 Food Self-Sufficiency Targets in the 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	NA	57	60
Calorie SSR	49.3	47	52	55

NA = not available, SSR = self-sufficiency ratio.

Source: Ministry of Agriculture, Food and Rural Affairs. 2013. History of Grain Policy in Korea. Seoul (in Korean).

food grains and calories. The Basic Act on Agriculture and Rural Community enacted in 1999 regulates that “the government shall establish and keep 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 self-sufficiency targets for total grain and calories were set for the country for the first time—at 25% and 47%, respectively—to be met by 2015 (Table 2.13). In 2011, in view of the global food price crisis during 2007–2008, these targets were raised to 30% and 52%, respectively for 2015. A new self-sufficiency target for food grain was also set for 2015 at 57%. At the same time,

the targets for 2020 were also set: 32% for all grains, 60% for food grains, and 55% for calories (MAFRA 2013).

A self-sufficiency ratio of around 30% in total grains is very low. Even if it is achieved, its role in the likelihood of a prolonged serious global food shortage may be quite limited. On the other hand, the costs to pursue it may be very high. However, taking into account the importance of food and the severe adverse impact of food shortages in the past on the Republic of Korea’s public, such self-sufficiency targets may still be hugely valuable in the sense that they can act as an important psychological safety net for 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.

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* ADB recognizes “China” as the People’s Republic of China; “Hong Kong” as Hong Kong, China; “South Korea” as the Republic of Korea; and “North Korea” as the Democratic People’s Republic of Korea.

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3 Achieving Food Security: Country Experiences Compared

Country experiences show that the levels of food security so far attained by selected Asian countries have differed significantly. Israel, Japan, Singapore, and the Republic of Korea have achieved a very high level of food security. In Bangladesh, the People's Republic of China (PRC), India, Indonesia, the Democratic People's Republic of Korea, and Pakistan, much remains to be done. Of course, these countries are different from each other in many ways. But then what differences account for such large variations in levels of food security? Based on the elaborations in Part 2, this part highlights the similarities and differences in food security practices of these countries, together with the lessons and the experiences in their quest for food security.

3.1 Similarities and Differences

The endowment of natural resources and the size of population are not major determinants of food security

It has been commonly held that if a country is short of natural resource endowment or has a large population, then its food security would be negatively affected. This kind of view is particularly prevalent in some of the most populous countries such as in Bangladesh, the PRC, and India. Country experiences in Asia, however, do not support such a claim.

Resource endowment is closely related to the size of a country's population. Given the 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 better reflect a country's resource endowment. Table 3.1 shows that Israel, Japan, Singapore, and the Republic of Korea all have very high population densities but very low per capita arable land. Yet, their levels of food security are high. On the other hand, the countries with lower population densities but

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 has often been claimed that if a country has a very large population, then compared with a country that has a smaller population, it would be more difficult for the former to manage its food demand and supply and thus more difficult for it to achieve a high level of food security. This myth has already been ruptured by the much-improved food security status in the PRC. In 1974, the PRC's total population was 909 million. In 2014, it had 455 million more, amounting to 1,364 million. Yet, compared with 1974, the PRC's food security level today is much higher. Today one can buy whatever food one wants so long as one can afford it. In 1974, the PRC had a smaller population but relatively higher per capita resource endowment. However, food availability was very poor at that time and one could not buy the food one wanted even if one had money. Clearly, the size of population is not, and should not be used as, an excuse for a lower level of food security. (Otherwise, we would have seen many countries with smaller populations having much higher levels of food security, which is not the case.)

Economic growth and thus higher consumer income is important for better food security

One may argue that the PRC's much improved food security today is largely due to its fast economic expansion in the past 3 decades, which enabled a much-higher consumer income. This is largely true. Table 3.1 indicates that all the Asian countries with higher levels of food security have higher per capita income. The case of Indonesia also lends strong support to this trend. As shown in Figure 2.6, its economy suffered from a major setback due to the 1997 Asian financial crisis. This had a significant negative impact on its food security. With sustained economic recovery over the past decade, however, its food security has again started improving.

Table 3.1 Level of Food Security and Associated Variables of Selected Asian Countries, 2014

Country	Global Food Security Index (%)	Corruption Perception Index (%)	Democracy Index (%)	Per Capita GDP, PPP (2011 Constant) (\$)	Total Population ('000)	Total Land Area ('000 km ²)	Population Density (No. of persons per km ²)	Arable Land Out of Total (%)	Total Arable Land Area ('000 km ²)	Per Capita Arable Land (ha per capita)
Bangladesh	36.5	25.0	57.8	2,991	158,513	130	1,217.7	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	NA	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	7,813.9	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, km² = square kilometer, PPP = purchasing power parity, PRC = People's Republic of China.

Notes and Sources:

Global Food Security Index: The higher the index, the higher the level of food security. Obtained from the Economist Intelligence Unit (EIU). 2014. *Global Food Security Index 2014: An Annual Measure of the State of Global Food Security*. London: The Economist.

Corruption Perception Index: The higher the index, the lower the level of perceived corruption. Obtained from Transparency International. 2015. *Corruption Perceptions Index 2014*. <http://www.transparency.org/cpi2014/results> (accessed 2 September 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; Authoritarian Regimes: 0 to 39. Obtained from the EIU. 2015. *Democracy Index 2014: Democracy and Its Discontents*. London: The Economist.

Per capita GDP, population, land area, and proportion of arable land: World Bank. 2015. World Bank Open Data. <http://data.worldbank.org/> (accessed 25 October 2015).

Higher levels of democracy generally lead to higher levels of food security

The relationship between the Global Food Security Index (GFSI) and Democracy Index in Table 3.1 suggests that higher levels of democracy are generally related to higher levels of food security, e.g., in Japan and the Republic of Korea. On the other hand, a low democracy index is generally associated with a low level of food security, e.g., in the Democratic People's Republic of Korea and Pakistan (the GFSI is not available for the Democratic People's Republic of Korea; however, its food security is very low as shown in Part 2 of this report). There are also cases where a country's higher level of democracy helps but does not necessarily guarantee that the country will achieve a higher level of food security, e.g., India, where some other aspects of its institutions are weak and indulge severe and widespread corruption and inequality. Similarly, a country's relatively lower level of democracy may not necessarily restrict it from achieving a higher level of food security, e.g., Singapore, where institutional settings effectively curtail the level of corruption and ensure a decent social security safety net. Hence, other aspects of institutions also need to be strong to work together with the democracy factor 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 3.1 clearly shows that food security is strongly inversely related to a country's corruption level. 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 importantly affect its food security. If a country is seriously corrupt, its food security is severely compromised.

Corrupt systems hurt food security in various ways. For example, when there is a lack of, or nonenforcement of, food quality and safety regulations and legislations, low-quality and unsafe foods become widespread in the market (such as in the PRC and India). Damages to the environment compromise food security today and into the future (such as in Bangladesh, the PRC, and India). Corruption leads to leaks and wastage in

the operation of the public food distribution systems (as in India) and to mismanagement of buffer reserves that seriously undermine a country's food security in case of emergencies (as in the PRC). People who suffer most from the reduced level of food security because of corruption are the powerless poverty-stricken people. In corrupt systems, inequality and discrimination against the poor are common, keeping the poor mired in the 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 and seriously cause food insecurity to the low-income residents through the lack of economic access to food. In all the 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, the country's food security also suffers.

It must be pointed out that although on the surface food insecurity is closely related to poverty, poverty itself is not the fundamental cause of food insecurity. The fundamental causes, as noted earlier, are serious inequality and corruption. In most developing countries, the poor have continuously been taken advantage of by those with power and been marginalized by corrupt systems, but few voices defend their interests in society.

Investment in agriculture holds the key to improved food security

Adequate investment in agriculture in general and in research and development (R&D) in particular has been frequently emphasized as playing a significant role in improving a country's food supply and thus promoting food security in that country. Israel, Japan, and the Republic of Korea have all benefited from their investment in agriculture in their quest for better food security. In the case of Israel, it has been claimed that investment in agriculture is the major factor behind the higher level of food security in the country.

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 (TFP), which in turn helped achieve a sustained high level of grain output. Between 1990 and

2010, total agricultural production grew by 4.5% in the PRC but only by 2.9% in India (ABARES 2014: 9).

In all other countries included in this report that had lower levels of food security, their investment in agriculture has also helped them raise their food output, e.g., in Bangladesh, India, and Indonesia. Otherwise, their food security level would have been much lower. However, their investment in agriculture has been generally insufficient or patchy.

How food production is organized affects food security

Since the end of World War II, different farm production models have been tried in the countries included in this report. These models have had different, sometimes drastically different, effects on food security.

- **Producing through cooperatives.** Some countries used cooperatives to help boost agricultural output. For example, in Israeli agriculture, cooperatives were widely used. Farmers join or exit the cooperatives on a voluntary basis. These cooperatives have been proven to be practical and effective. The PRC also used cooperatives, which proved to be effective during 1954–1956 when farmers could join them voluntarily. Unfortunately, farmers were soon hastily chased into collectivized production.
- **Producing through highly collectivized arrangements.** The PRC started mobilizing farmers to produce through highly collectivized arrangements in 1957, and all farmers were chased to join the commune system where farm production and many aspects of life were highly collectivized or organized. The consequences were disastrous, resulting in vastly lower or stagnant food output. The return to the traditional family-based production system 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 several decades. It has begun trying to move away from such a highly collectivized model, but this process has been very slow and is sometimes marked with retreats. (In the

Democratic People's Republic of Korea, the term "agricultural cooperatives" is used, but these are highly collectivized working units and are not cooperatives as per the standard definition of cooperatives.)

- **Producing through family- or household-based farming units.** This model has been most widely used. It has also proven to be most effective in many societies. In the foreseeable future, family-based farming units are likely to dominate in 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 have succeeded. From 1953 to 1993, farmers in the PRC were forced to deliver grains, 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 Government of the Democratic People's Republic of Korea also uses the same approach to get its farmers to deliver grains to it. The negative effects on food production are similar to the PRC's. When food was in very short supply after World War II, both Japan and the Republic of Korea also resorted to forcing delivery from farmers to the governments, often at low prices, but both failed to gain the farmers' cooperation. These two countries stopped using this method long ago when they discovered it would not work well, and in the meantime, their food supply has improved. In all of these countries, when government procurement was in place, black markets were active unless there was serious crackdown by the government as in the PRC and the Democratic People's Republic of Korea during some time periods.

The market has an important role to play in achieving food security

From the experiences of all the countries included in this report, it is clear that the market has an important role to play in helping a country achieve food security. When the market was not allowed to function, food shortages tended to get further aggravated and vice versa. Nowadays, markets in all four more food-secure countries are allowed, or even encouraged, to participate in the operations of their food economies, although

they were briefly controlled during episodes of food emergency 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 was generally worse. During several brief occasions when the controls were a bit relaxed, food supply always improved. With the market being gradually deregulated since the late 1970s, the PRC's food supply has continued to improve. This is also the case in the Democratic People's Republic of Korea today. In recent years, 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, though at higher prices. Many of its people have benefited from, and liked, these markets, and it may become harder 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 much more efficient and effective in food distribution in peacetime, it may not work well during food emergencies. Therefore, during normal times, the market should be allowed to function freely. However, when a food crisis emerges, certain levels of government control could be justified.

Countries have handled food emergencies very differently

When there were serious and devastating food shortages after World War II, the governments of Japan and the Republic of Korea resorted to imports to avoid catastrophic consequences; the governments of the PRC and the Democratic People's Republic of Korea often did not import foods at times when food was badly needed or even refused to accept food aid from other countries (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, India's union government and state governments worked together and acted quickly to bring the situation under control to minimize severe casualties to the citizens. The public was also allowed to air its grievances to the government so that the latter could help those in need. In other countries, the handling of such situations has often been startlingly different. During the Great Famine in the PRC and famines in the Democratic People's Republic of Korea, governments were often slow or

took no action to help those in need. During the Great Famine in the PRC, the nationwide famine lasted for several years due to the lack of government assistance. Added to this, those suffering were also deprived of the chance to survive by begging in other regions. Similarly, in the Democratic People's Republic of Korea, residents have had few alternatives to resort to for survival during famines.

During an emergency, many countries have used controlled food distribution, e.g., through food rationing, especially in urban areas. In both Japan and the Republic of Korea, food rationing was used during food shortages, but was lifted soon after food supply improved. In Israel, during the "austerity period," food rationing was used. However, its rations were abundant (Box 2.4). Hence, controlled food distribution can be a useful tool to manage food scarcity during an emergency, as demonstrated by the experience of many other countries in similar situations such as the United Kingdom during World War II. In the PRC and the Democratic People's Republic of Korea, food ration was used in the early 1950s to handle food 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 today).

Countries use different approaches to handle food crisis information

In some countries, the news of famine occurrence was suppressed, e.g., during the Great Famine in the PRC, during famines in the Democratic People's Republic of Korea, and during famines in the 1950s and the 1960s in Indonesia. During the PRC's 1958–1962 Great Famine, the media was not allowed to publicize the food crisis, and local cadres prevented the famine news to spread under their jurisdiction by banning hungry people from begging in other areas. The PRC government also tried to hide the famine news from the international community. In Indonesia, famines occurred frequently during the 1950s and 1960s, with casualties in excess of 100,000 according to available statistics. However, the local media was not allowed to report the famine because local authorities feared being blamed for poor administration (van der Eng 2012). Similarly, in the Democratic People's Republic of Korea, the media is not free to report famines.

On the contrary, famine news is well publicized in India. During several severe food crises, India's public was informed of the extent and depth of the famines. The public made use of such news to pressurize the governments to do more to assist those in need through public protests and other means. Protests during the Maharashtra Drought were vividly reported in the media—Drèze and Sen have noted that many accounts of popular protests could be found in the columns of India's popular and influential journal *Economic and Political Weekly* (Drèze and Sen 1989: 133). Drèze and Sen also attribute 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 food insecurity prevention. One of the key similarities in their insecurity prevention policy is that the governments take the responsibility to ensure food security, and the law protects the right to food of each and every individual. Under such guidance, these governments have also innovatively implemented various measures to sustain their high level of food security. All these four countries have a designated government agency that is in charge of the maintenance of the country's food security.

Japan's preventive approaches are worth mentioning in particular. As noted earlier, since the 1970s, the Japanese government has been exercising a high level of diligence and innovation in devising preventive measures to ensure the country's food security. The following are some impressive examples:

- (1) **Supporting foreign agricultural development to help Japan's own food imports.** Brazil's increased capacity to produce and export soybean due to the assistance of the JICA (Japan International Cooperation Agency, started in the late 1970s) notably increased the global supply since the 2000s. 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 Cerrado development in Brazil, Japan has begun another agricultural development program of the savanna area in Mozambique based on a tripartite cooperation that includes Brazil.

- (2) **Conceiving models to better understand global food demand–supply conditions.** Understanding and being able to forecast possible changes in the global food demand and supply is very important when a country has to use imports to manage its food supply and food security. In the mid-1970s, Japan started to devote resources to develop for the first time a global food supply–demand model, which has benefited similar models that were developed elsewhere later (MAFF 2009).
- (3) **Categorizing food security emergencies to act accordingly.** Food security emergencies may have different severities. Handling emergencies without identifying and addressing the level of severity can be costly and less effective. Japan's categorization of food security emergency according to the extent of severity is not only a sensible approach but also valuable for other countries to learn from.

Since independence, India has had famine prevention policies in place. The deployment of such policy measures has enormously helped reduce mortalities during the many famines. The zero death record in the “1972 Maharashtra Drought” is well known for the successful utilization of famine prevention policies. After the PRC was founded, there were no famine prevention measures in place. Therefore, when the 1958–1962 famine began, there were no “measures” to deploy. Much progress has been made in the PRC since the 1980s in terms of preparedness for food emergencies, such as the building up of buffer stocks. However, it is still not very 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 report rely on imports to ensure domestic food supply. Stable import sources are crucial for them, especially 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 sources of imports, e.g., Japan, the Republic of Korea, Singapore, and the PRC.

Investing in exporting countries' food production is certainly a valuable approach to securing sources of imports. However, such an approach may sometimes cause conflicts between the 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 on two innovative fronts. One is to provide assistance to other countries to produce more foods, without the requirement of exporting the produced foods to Japan. The other is to encourage its private sector to actively expand into, and focus on, the later stages of food supply chains (away from engaging in farmland purchase or crop production).

The latter approach is an important initiative. Farmers in exporting countries, especially those in developed exporting countries like New Zealand and Australia, know how to produce very well. Their major challenge is to find a market for their products. Japan's efforts at enabling them to diversify their sales destinations with a focus on Asia help reduce the tension between the locals and investors (avoiding the sensitivity of land acquisition or environment protection issues due to lack of local knowledge of requirements). Such an approach is most likely to be welcomed by producers of any exporting country. It helps these producers produce and sell more while helping Asian countries expand their 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 countries included in this study have made efforts one way or the other to engage in regional cooperation to deal with any unexpected disruptions to their food supply. Currently, the ASEAN Plus Three Emergency Rice Reserve (APTERR) is a major initiative in the Asian region. Indonesia, Singapore, the PRC, Japan, and the Republic of Korea are part of the APTERR. Whether the initiative is capable of working according to expectations is yet to be tested. It is believed that more substantial commitments would be needed

from member countries to make it a system that member countries can rely upon when in need.

Reducing food wastage is on the agenda

Food wastage has been extensive in many countries from post-harvest to the dinner table. Reducing food wastage is equivalent to improving food availability, or increasing production resources. While there is much scope for reducing food wastage between post-harvest and prior to the dinner table, the potential to reduce food wastage at the dinner table is also enormous. In some cultures, food wastage on the dinner table tends to be excessive, e.g., the PRC and the Republic of Korea. Some countries have started making efforts to educate consumers about reducing or avoiding food wastage at the dinner table. The PRC uses public media for this purpose, while the Republic of Korea collects levies for treating food wastage collected from dinner tables. Singapore has started working with various stakeholders in food supply chains to reduce post-harvest food wastage.

3.2 Empirical Verifications

The preceding comparisons and analyses indicate that many forces have affected food security in the chosen countries in various ways. However, it has to be said that some of the forces are more fundamental than others. For example, it has been widely held that investment in agriculture (including in important infrastructure, R&D, extension, and education) helps a country improve its agricultural total factor productivity and thus contribute to better food security. Then, why did 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 invested insufficiently? One would argue that, as we proposed in the beginning of this report, primarily and ultimately, institutions 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 to function, and vice versa.

Causal observations of the data in Table 3.1 also confirm that 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. On the other hand, there is no strong correlation between the GFSI and resource

and population variables. These lend support to the propositions we raised earlier that a country's food security might be more significantly affected by institutional factors rather than factors such as resource endowment and the size of the population that are commonly held as important. It would be valuable if we could empirically verify such assertions. Fortunately, data are available nowadays to carry out such verifications.

Based on the preceding argument, we formulate that the level of food security in a country is a function of the degree of corruption, the level of democracy, the level of income, resource endowment, and the size of population. 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 (EIU). A corruption index referred to as Corruption Perceptions Index (CPI) is available from Transparency International. A democracy index can also be obtained from the EIU. Per capita gross domestic product (PCGDP), per capita arable land (PCLAND), and country population (POP) are obtained or calculated on the basis of data from the open database maintained by the World Bank. Per capita GDP is used as a measure of income and is converted into 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 hectare) divided by its population.

Since the GFSI only started in 2012 consisting of 109 countries and most of other indicators are available till 2014, we are able to form a 109×3 panel data set. GFSI, CPI, and DI are in percentages. PCGDP is in international dollars. PCLAND is in hectare. 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 $i = 1, 2, \dots, N$ and $t = 1, 2, \dots, T$. The β 's are parameters to be estimated, u_i is the individual heterogeneity that can be fixed or random, and ε_{it} is a random variable with mean zero and variance σ_ε^2 .

CPI is expressed in percentage. If a country's corruption level is perceived to be low, it has a high percentage; else, 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 percentage. If a country has a high level of democracy, it has a high percentage and vice versa. 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 the resource endowment and the size of a country's population, 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 prevailing views are correct, we would expect the coefficient of PCLAND (per capita arable land, representing natural resource endowment) to be positive and significant and the coefficient of POP (total population of a country) to be negative and significant.

Following various tests for any existence of multicollinearity, heterogeneity, and the appropriateness of FEM (fixed effect model) and REM (random effect model), a REM log-log model was estimated. A log-log model offers the convenience of producing elasticities and helps reduce heterogeneity. After an initial estimation, a likelihood-ratio test is conducted to test for any remaining heterogeneity. Homogeneity was rejected by the likelihood ratio test. Thus, the model was reestimated to obtain heteroskedasticity-corrected consistent standard error. The results of the final model estimation are provided in Table 3.2. The R-squared of the model is 0.9255.

The findings from the econometric verifications 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

Table 3.2 Estimation Results of the Food Security Function

	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.

country's level of food security. When a country's income improves, so does its food security. On the other hand, our results provide no support to the claims that food security would be importantly affected by resource endowment and the size of a country's population. Although the per capita arable land variable has a positive sign, it is not statistically significant, suggesting it is not a factor that importantly 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 very statistically significant.

3.3 Implications

Valuable implications can be drawn from the cross-country comparisons and analyses. The most important implication based on the findings of this report is that countries have to get their institutions right if they wish to achieve a high level of food security for their people. Getting the institutions right is the most fundamental requirement for a country to improve and achieve its food security. Israel, Japan, Singapore, and the Republic of Korea have all achieved a high level of food security—they all have stronger institutional settings characterized by higher levels of democracy, stronger judiciary systems, and lower levels of corruption. On the other hand, the levels of food security in Bangladesh, the PRC, India, Indonesia, the Democratic People's Republic of Korea, and Pakistan are relatively low—they all have weaker institutional arrangements, as reflected by the very high levels of corruption.

3.3.1 Getting the Institutions Right

For countries with low levels of food security, necessary reforms to their government and economic institutions

are essential. Government institutions are established and maintained to ensure that governments are accountable to their citizens, their policy processes transparent, and their operations 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 the government and economic institutions are strong, and in particular to keep corruption low.

Partial achievements of these institutional fundamentals may help a country improve its food security to some extent, but may not warrant the attainment of 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 to government institutions has prevented the country from achieving a higher level of food security. India's high level of democracy and various democratic institutions have helped the country prevent or effectively deal with large-scale famines and thus reduce the hardships of those affected. But the country has so far been unable to provide an adequate amount of food to a large segment of its population due to the presence of weak institutions such as the inefficient and weak judiciary systems that have to a great extent indulged the widespread corruption in the country.

3.3.2 Economic Growth and Sharing Its Proceeds Equitably

Countries with low income and low food security levels need to grow their economies diligently and share the resulting benefits among all the citizens equitably. There is no basis for these countries to claim that their low levels of food security are due to their low levels of income. In the first instance, it is these countries' failure in growing their economy that is responsible for their low food security levels. The economies of all the countries represented in this report suffered from wars (World War II and other wars; the PRC, India, Indonesia, Japan, the Republic of Korea, the Democratic People's 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 those of others' have grown only in a limited manner.

Examining the causes of faster or slower economic growth is beyond the scope of this report. 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 faster economic growth.

Higher economic growth alone is not sufficient for improving a country's food security at the national level in general or at the household and individual levels in particular. Proceeds from faster economic growth need to be shared among all citizens equitably. The safety net of social security needs to be established and well operated so that all residents have the access to an adequate amount of foods for healthy living and for productive activities.

3.3.3 Other Important Implications

Investments in agriculture. Maintaining an adequate level of investment in key agricultural infrastructure and agricultural R&D, extension, and education is crucial for a country to improve its food security. Food output expansion chiefly comes from improvements in agricultural TFP, which in turn relies on improvements in a country's key infrastructure, advancements in R&D, and the level of agricultural extension and education. Studies have shown that returns from investments in agricultural R&D are very high (Pardey, Alston, and Piggott 2006). Hence, there is no justification for a government to not maintain an adequate level of investment in its 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 very important during both peacetime and food emergencies. In peacetime, such an agency is charged with responsibilities of routine management of the country's food security matters, including taking measures to avoid food insecurity crises and recognizing any potential or emerging problems and crises. During a crisis, this body is expected to take a leading role in responding to emergencies appropriately and effectively. It should be equipped with 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 is most valuable for other countries to follow. In these two countries,

resources to cope with food emergencies have already been appointed. Some of these are at the immediate disposal of a designated government agency, while others comprise ordinary resources existing in the society that can be mobilized during times of need. The level of emergency determines the deployment of such resources. This approach to food emergency handling by distinguishing the level of severity is most 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 forces affecting them often change and sometimes abruptly so. Policies to manage a country's food security need to be modified to suit its conditions and requirements. 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 five years, is a great example other Asian countries can learn from. In order 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.

The 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 into 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, of course, requires the presence of strong institutions in the country, especially strong government and economic institutions.

Investing in overseas food production and exports. 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 or not. Another beneficial investment is to help exporting countries to export. Again, foods such exported do not have to go to

the investing country but can be exported to any country. Japan has been leading on these two 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 supply. As such, stable food imports will become more and more important. Such import stability can only be best protected by world peace. In this regard, making contributions to long-term world peace would be most rewarding. Individual 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 United States soybean trade embargo on 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, even just a single instance, can significantly derail their food security strategies (e.g., turning to higher self-sufficiency that is costly and no good to 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 wastage. In all countries, either developed or developing, there is a huge potential to reduce food wastage at all stages from post-harvest to the dinner table. New technologies should be developed to reduce wastage between post-harvest and cooking. Consumers need to be educated to reduce food wastage at all stages of purchasing, storing, cooking, and eating.

Safeguarding food safety and quality. In recent decades, pollution of the soil, water, and air has been widespread and serious in many fast-growing economies. This has posed significant challenges to producing quality and safe foods in many countries. On the other hand, the demand for better quality and safer foods 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, an important part of achieving a high level of food security.

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4 Looking into the Future: The Role of the People's Republic of China and India in Regional and Global Food Security

Due to the sheer size of the People's Republic of China (PRC) and India, it would be incomplete to address Asia's food security without considering probable changes in these two countries' future food demand and supply and how such changes may affect their own food security as well as food security regionally and globally. Although the self-sufficiency ratio (SSR) of a country is not deterministic of its food security level as demonstrated in other parts of the report, the size of each of these two countries dictates that even a small reduction in their food SSR may translate into an extra dependence on imports, which other countries find to be very large. Hence, to what extent these two countries will be able to feed themselves and to what extent they will need to rely on the international market warrants close attention.

While the PRC and India have made impressive progress in feeding their peoples in the past decades, challenges are still formidable to further improve their level of food security. On the demand side, their huge and increasing populations, rising consumer incomes, and growing urbanization will continue increasing 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 all place enormous pressure to further increase domestic food production.

In this part of the report, simulations are carried out to examine, under various scenarios, the following (i) What are the likely changes in the food demand and supply of the PRC and India?; (ii) How will such changes affect food markets in other regions and globally and to what extent?; and (iii) What implications will such changes have for food security nationally (for the PRC and India), regionally, and globally by 2030 and 2050? The year 2030 is significant mainly because of an expected

major change in the PRC's population: the PRC's total population will continue growing and is expected to reach its peak by the early or the mid-2030s, after which it is expected to decline. The expected decline will complicate studies on the PRC's demand for food. It is therefore useful and necessary to simulate the PRC's food demand when the population is expected to decline.

A brief overview of the PRC and India's current food demand and supply and the key factors that affect their food demand and supply are highlighted in the next section. Section 4.2 gives details about scenario design and associated assumptions. The data used are explained in Section 4.3. Section 4.4 reports on and discusses the findings of the simulations. Finally, conclusions are given in Section 4.5.

4.1 Food Demand and Supply in the People's Republic of China and India: The Current and the Future Scenarios

Food demand and supply for major food items in the PRC and India are summarized in Table 4.1. Per capita consumption of major cereals is quite comparable in these two countries. On average, people from the PRC consume more soybeans than their counterparts in India, while those in India consume more pulses than the former. However, at the per capita level, those in the PRC consume significantly more foods of animal origin (except milk) than those in India. For most animal products, consumption in India is less than one-fifth of that in the PRC. In the case of milk, however, consumption in India is 2.5 times that in the PRC. People from India also consume significantly more sugar than people from the PRC.

Table 4.1 Food Demand and Supply in the People's Republic of China and India
(3-year average, 2011–2013; 1,000 tons unless otherwise indicated)

	Panel A: People's Republic of China													
	Wheat and Products	Rice (milled equivalent)	Barley and Products	Maize and Products	Soybeans	Pulses	Sugar	Bovine Meat (beef)	Mutton and Goat Meat	Pig Meat (pork)	Poultry Meat	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	0	0	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 (kg)	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	5,797	1,901
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

continued on next page

Table 4.1 continued
Panel B: India

	Wheat and Products	Rice (milled equivalent)	Barley and Products	Maize and Products	Soybeans	Pulses	Sugar	Bovine Meat (beef)	Mutton and Goat Meat	Pig Meat (pork)	Poultry Meat	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 (kg)	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 dependency ratio, kg = kilogram, SSR = self-sufficiency ratio.

Source: Food and Agriculture Organization of the United Nations. 2015. Food Balance Sheets. <http://faostat3.fao.org/download/FB/FBS/E>.

Consumption preferences partly explain the differences. Many people in India are vegetarians, although they consume milk and other dairy products. When consuming dairy products, adding sugar is often customary in India, which is one reason for the higher sugar consumption. Pulses are a major source of protein for most of India's vegetarian 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 level in India continues improving, then total food demand may experience some major increases in the future.¹

Currently, food supplies in both the PRC and India seem sufficient. The PRC is a net importer of food from the world market, while India is a net exporter. For the three major cereals, i.e., wheat, rice, and maize, the PRC's self-sufficiency ratio (SSR) in 2013 was 98%, while India's was 112%. For major meats (beef, mutton and goat meat, pork, and poultry meat), the PRC's SSR in 2013 was 99%, while India's was 136% because of its larger output but lower consumption.

India's higher food SSRs have puzzled many people given that (i) its total food output is much lower than that of the PRC's, (ii) its population is similar to the PRC's, and (iii) it is a net exporter of food. In 2013, India's total output of major cereals (wheat, rice, and maize) was 223 metric tons (mt), while the PRC's was 476 mt; India's total output of meat (beef, mutton, goat meat, pork, and poultry meat) was 6 mt, while the PRC's was 82 mt. In terms of total population, India's 1,252 million in 2013 was only slightly lower than the PRC's 1,386 million. Consequently, India's per capita food consumption should be much lower than the PRC's. Yet, India is still a net exporter of 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. However, India's lower level of consumer income and the presence of a large portion of the population in poverty may be the key factors behind the lower per capita consumption and, thus, higher food SSRs.

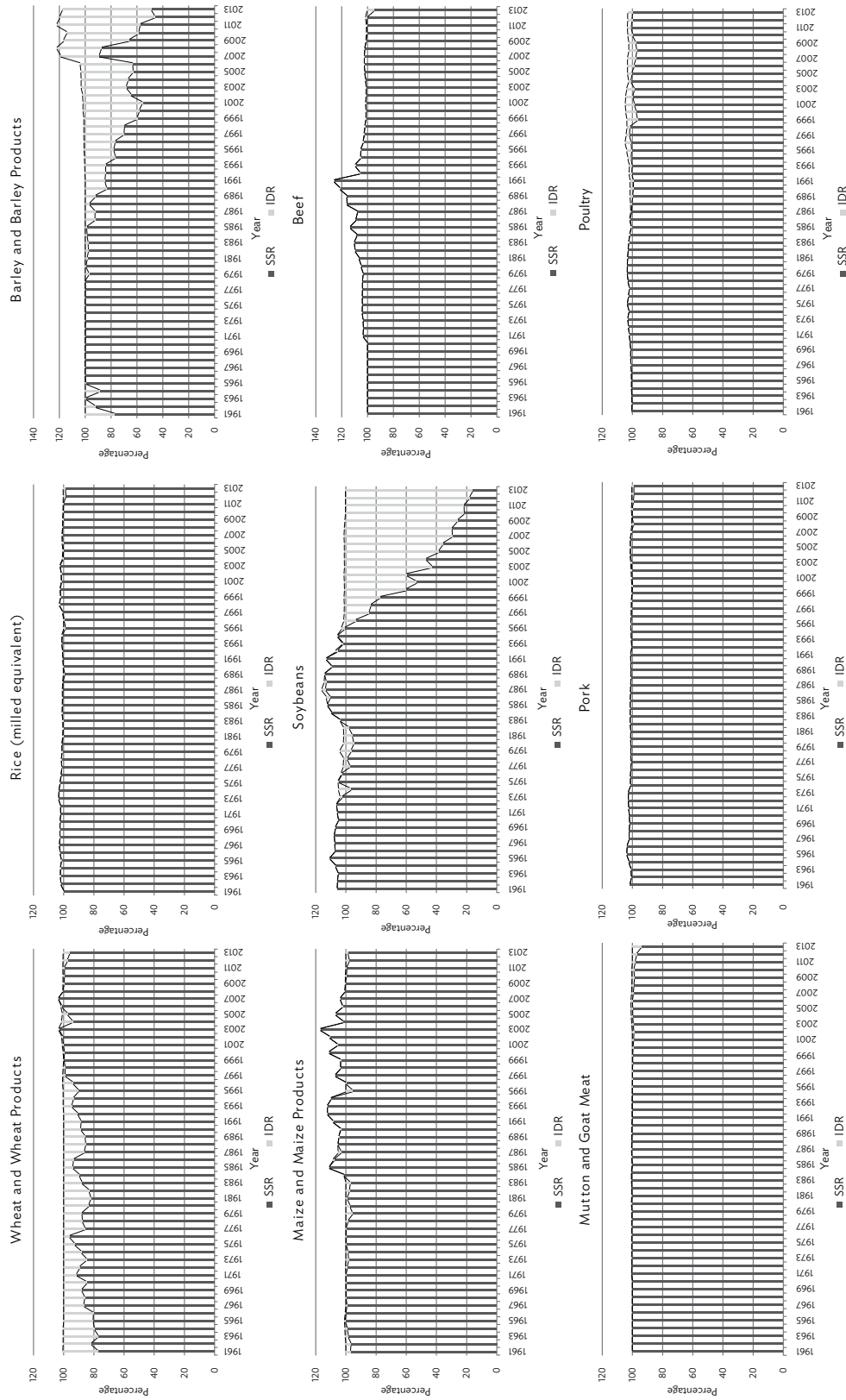
In 2013 (3-year average of 2012–2014), the number of people undernourished was still very large in India (190.7 million or 15.2% of the total population). The corresponding numbers for the PRC were 150.8 million and 10.6%, respectively (FAO 2014: 42). The effective demand for food by such a low-income population is very low. Otherwise, India might have had no need to be a net exporter of food, and its food SSRs would have been lower. India's case shows that a country may have a very high level of SSR and yet some of its people may not have an adequate amount of food to eat due to their lack of economic access. As such, while a country's food SSR may be useful to gauge its overall food demand–supply situation, it is hardly indicative of its food security status.

Historical changes in SSR and import dependency ratio for major food items in the PRC and India are given in Figure 4.1. India had some major shortages of soybean supply in the 1960s and wheat supply in the 1960s and 1970s. Since the 1980s, the SSR for all major food items has been around 100 or even greater, e.g., beef and maize. In recent years, India has also exported rice and, occasionally, barley. In the case of the PRC, there have been some interesting developments in terms of food SSRs. 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, wheat SSR has fluctuated around 100% (being above 100% during 1997–2013), but by 2013, it again dropped to 96% (chiefly because of increased wheat imports for feed purpose to substitute higher-priced maize in 2013). The decline in the SSRs of soybean and barley is most remarkable. The PRC used to be largely self-sufficient in both these items, but in 2013, the SSR dropped to 49% for barley and 16% for soybean (protection was removed for these two crops after joining the World Trade Organization in late 2001). For all other major food items, the SSRs dropped 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

¹ The climate in India and the way in which people carry out their daily routine activities may be responsible for reduced nutrition requirements. For example, India's average dietary energy requirement (ADER) in 2014 was 2,277 kilocalorie (kCal)/caput/day, while the PRC's was 2,445 kCal/caput/day. Nonetheless, the intake of protein and fat by the people from India has been quite low, and it is most likely to increase when their incomes increase in the future. It would be valuable to verify the extent of the increase by comparing the consumption levels of those who live at home in India and those who live overseas; this is, however, beyond the scope of this study.

Figure 4.1 Food Self-Sufficiency Ratios and Import Dependency Ratios in the People's Republic of China and India, 1961–2013

People's Republic of China

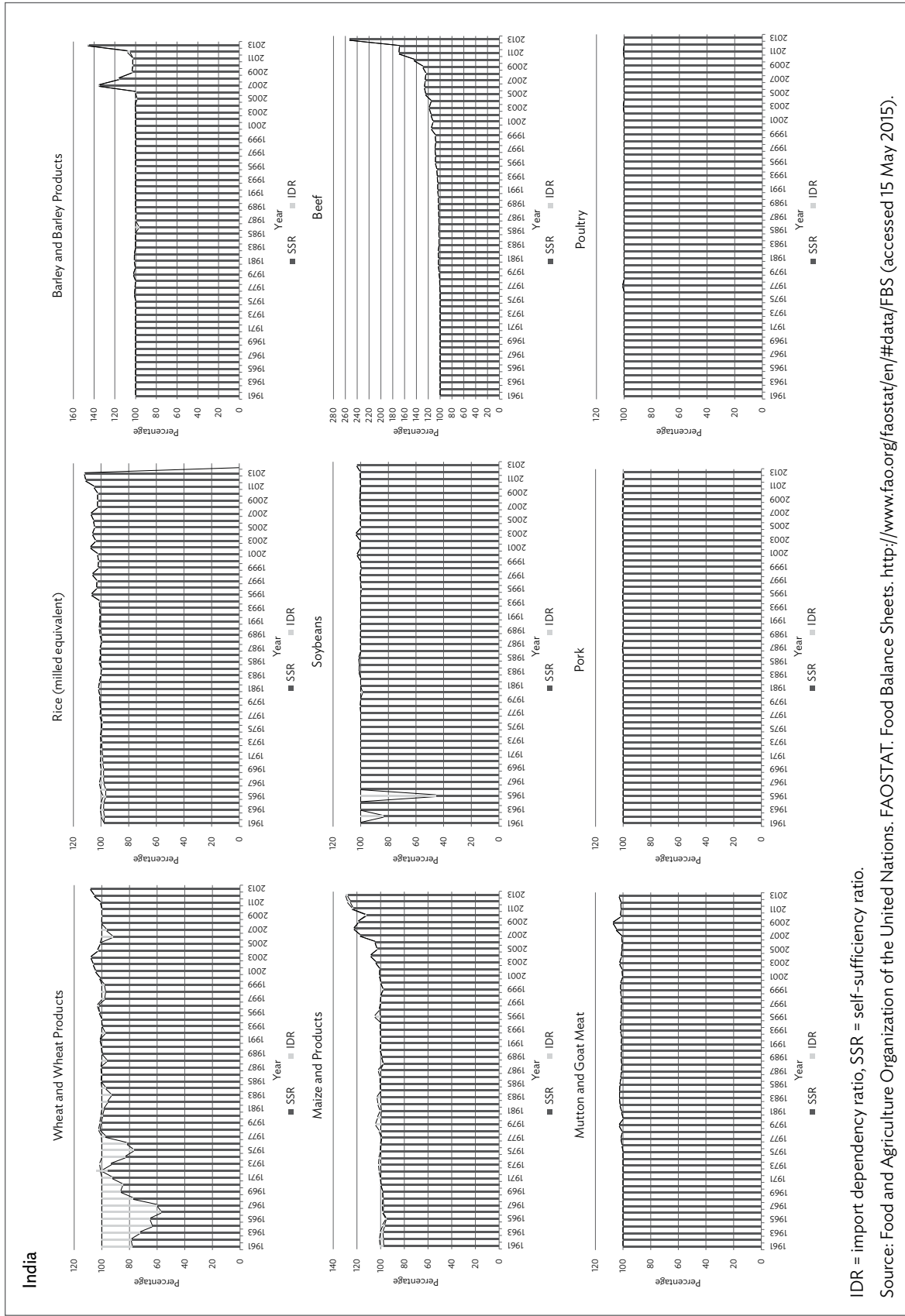


IDR = import dependency ratio, SSR = self-sufficiency ratio.

Source: Food and Agriculture Organization of the United Nations. FAOSTAT. Food Balance Sheets. <http://www.fao.org/faostat/en/#data/FBS> (accessed 15 May 2015).

continued on next page

Figure 4.1 continued



IDR = import dependency ratio, SSR = self-sufficiency ratio.
 Source: Food and Agriculture Organization of the United Nations. FAOSTAT. Food Balance Sheets. <http://www.fao.org/faostat/en/#data/FBS> (accessed 15 May 2015).

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.

Change in the food supply and demand of the PRC and India will depend on many factors. Some important ones include the following:

- population change,
- income growth and distribution,
- the rate of urbanization,
- protection of natural resources and the environment,
- climate variations,
- investment in agriculture,
- global trade liberalization,
- economic growth and structural change, and
- food wastage reduction.

4.2 Scenario Design

Simulation Focus

In addition to the above mentioned important 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 have impact on the PRC and India's food demand and supply are even more uncertain and complex. In fact, even for shorter-term projections (e.g., 10 years), influential forces may change frequently, as reflected in the works of several leading bodies such as the United States Department of Agriculture (USDA 2015), Organisation for Economic Co-operation and Development–Food and Agriculture Organization (OECD–FAO 2015), and Food and Agriculture Policy Research Institute–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 the following:

- population change,
- availability of key factors of production: labor force (both skilled and unskilled), arable land and other natural resources, and capital,
- global trade reforms: reductions in tariff, domestic support, and export subsidy,
- efficiency change in the agriculture sector (the use of factors of production: arable land,

skilled and unskilled labor, capital, and fishery resources),

- efficiency change in other sectors of the economy, and
- income growth.

Among these, the more important forces in the case of the PRC and India are changes in population, income, and agricultural productivity.

Population changes. Both countries have huge populations, being the largest and second largest in the world, respectively, accounting for 36.5% of the total world population. Changes in their populations will have important implications for the demand for food, which in turn may affect their food trade. Population growth prospects in the two countries will, however, differ.

The PRC had a high rate of population growth between 1963 and 1974 of over 2% per annum. Family planning policies caused the growth rate to continue to decline from 1975. In the first few years of the 2010s, the rate has been around 0.5%. If current trends continue, the growth rate will become negative by about the early 2030s. From then on, the PRC's total population will start declining. However, the one-child per family policy has been recently abolished. Any family is now allowed to have two children. How this may affect the population is yet to be seen.

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 down. Nonetheless, it is still as high as 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%, still adding a large number of people to India's total population (India also has greater potential to reduce its mortality rate).

The population growth rates used in the simulations are based on the rates given in Table 4.2. The forecast rates for 2015–2050 are based on *World Population Prospects: The 2012 Revision* by the Population Division of the United Nations (UNDESA 2013). The annual average growth rate between 2011 (the Global Trade Analysis Project [GTAP] database reference year is 2011) and 2030 is derived by using the 2015–2030 forecast rate and the actual rates of 2010–2014. It may be noted that the simulations in this part focus only on changes in the

Table 4.2 Population and GDP Growth in India and the People's Republic of China, Actual and Forecast

	2010	2011	2012	2013	2014			
Population Growth: Actuals and Forecasts								
World Bank								
PRC	0.483	0.479	0.487	0.494	0.506			
India	1.374	1.328	1.286	1.251	1.227			
United Nations						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: Actuals and Forecasts								
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

F = Forecast, GDP = gross domestic product, HSBC = Hongkong and Shanghai Banking Corporation, IMF = International Monetary Fund, OECD = Organisation for Economic Co-operation and Development, PRC = People's Republic of China.

Sources: United Nations Department of Economic and Social Affairs. 2013. World Population Prospects: The 2012 Revision. New York; International Monetary Fund. 2015. Data and Statistics. <http://www.imf.org/external/pubs/ft/weo/2014/02/weodata/weoselgr.aspx> World Bank. 2015. World Bank Open Data. <http://data.worldbank.org/> (accessed 25 October 2015); Organisation for Economic Co-operation and Development. 2015. OECD Economic Outlook. Paris: OECD Publishing; Hongkong and Shanghai Banking Corporation. 2012. The World in 2050: From the Top 30 to the Top 100. Hong Kong, China; Trading Economics. 2015. China GDP Annual Growth Rate Forecast, 2016–2020. <http://www.tradingeconomics.com/china/gdp-growth-annual/forecast> and India GDP Annual Growth Rate Forecast 2016–2020. <http://www.tradingeconomics.com/india/gdp-growth-annual/forecast>; and Y. Lu and F. Cai. 2014. Impacts of Changes in Population Structure on Potential GDP Growth Rates: A Comparison between China and Japan. The World Economy No. 1, pp. 3–29 (in Chinese).

total population. Changes in other aspects related to demography such as aging, change in family size, and urbanization are not incorporated into the simulation.

Income growth. Income has been held as the most important force affecting food demand. Both countries have experienced impressive, fast income growth in the past few decades, which has clearly played a major role in driving up demand for more foods with greater diversity and higher quality. 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 slow down in the future years. There is much uncertainty about the direction of India's growth in the short run. It may go notably either higher or lower than the current rate, and it is hard to predict when this may happen. However, when the size of India's economy further expands, it is generally expected that its growth will slow down over the longer term. As noted earlier, income distribution is also an important factor 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 till 2050 are limited. The long-term forecasts on the growth rates of the PRC and India till 2050 by the Hongkong and Shanghai Banking Corporation (HSBC 2012: 15), Lu and Cai (2014) (for the PRC only), and Trading Economics (2015) are given in Table 4.2. Some other organizations have also provided forecasts but only for limited years or periods. For example, PricewaterhouseCoopers forecasts that by the 2040s, the PRC's GDP growth rate will be around 4% per annum (PwC 2013: 10). Efforts were also made to locate similar forecasts for India by Indian authors, but these were not available.²

For the simulations, a medium annual GDP growth rate was first worked out for each country for 2015–2030 and 2030–2050 based on the sources as shown in Table 4.2. As in the case of population, the actual rates of 2010–2014 were used in calculating the average GDP growth rates for 2011–2030. For the low and high growth rates

of GDP for 2011–2030 and 2030–2050, a 1-percentage point variation was applied to the medium rates—i.e., for a lower/higher GDP growth, 1 percentage point was taken away from or added to the medium rate. The use of 1 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 research and development (R&D), education, and extension—and key infrastructure help raise a country's agricultural productivity. Higher productivity will bring about a higher output, increasing food supply in the country. The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) shows 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. This difference has been partly attributed to a slower productivity growth in India (ABARES 2014a: 9). 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 generally improves these two components, hence improving agricultural TFP.

According to Fuglie (2012), India's average annual agricultural TFP growth was 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: 11). For India, it will be 2.7% (ABARES 2014a: 11). The projected agricultural TFP growth by ABARES for both the PRC and India seems to be on the high side. It is especially so for India, and whether India will invest to such an extent that the rate will reach 2.7% appears quite questionable.

In our simulations, the TFPs for the two baseline scenarios are determined by what is needed to achieve the preset 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

² Extensive efforts were made to locate various growth forecasts produced by sources in India and the PRC. However, such forecasts produced by scholars or organizations in India and the PRC are scarce. We were only able to obtain GDP growth rate forecasts for the PRC from two PRC researchers (Lu and Cai 2014) who have examined how the changes in population structures may affect future GDP growth.

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 agriculture 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 agriculture 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 estimates of the ABARES, especially for India.

Scenarios to simulate

Three scenarios are simulated in this study: baseline scenario, the best (most optimistic), and the worst (most pessimistic) (“The best” and “the worst” are from the perspective of improving agricultural supplies, not of improving overall national welfare). The baseline scenario assumes the population and GDP will grow at medium rates, 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, population will grow at low rates and GDP will increase at high rates as suggested in Table 4.2. 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 these 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. We note that under the best (most optimistic) scenario, the effects 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 most 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. 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 4.3). These assumptions are reflected in the simulations by bringing shocks of varying values for the arable land variable.³

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 4.4. 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

Table 4.3 Possible Changes in Arable Land Area in Region Groups, 2011–2050

Region	Region Name	Assumptions
1	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 to cope with land scarcity.
2	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 later years (2030–2050) due to urbanization and industrialization; will take measures to improve land-use efficiency to cope with land scarcity.
3	Major East Asian food importers	Arable land will continue declining at a rate lower than before; the decreasing rate will become lower and lower over time.
4	Other countries in East Asia, Southeast Asia, and South Asia	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.

continued on next page

³ Details about shocking values for arable land and all other variables can be obtained from the authors.

Table 4.3 *continued*

Region	Region Name	Assumptions
5	Major food exporters	Brazil's arable land will continue increasing but the United States' will decrease. Overall, total area in this region will continue declining but at a decreasing rate.
6	Africa	Total arable land area in this region will continue decreasing but at a decreasing rate.
7	Western Europe and Northern Europe	Arable land area in this region will mostly stay the same.
8	Others	Total arable land area in this region will decrease very slowly and the rate of decline will hardly change.

Source: Compiled on the basis of information from the World Bank and the Food and Agriculture Organization of the United Nations.

Table 4.4 Scenario Assumptions

Scenario	Assumption
2030 baseline	<ul style="list-style-type: none"> 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 Europe and Northern Europe, and major food exporters) and by 20% in all other regions; export subsidies are reduced by 50% in all regions. (The effects of growing free trade agreements, bilateral or regional, are too complicated to simulate and therefore 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 optimistic (based on the 2030 baseline scenario)	<ul style="list-style-type: none"> 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 nonagriculture sectors also improves.
2030 pessimistic (based on the 2030 baseline scenario)	<ul style="list-style-type: none"> 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 nonagriculture sectors also declines.
2050 baseline (based on the 2030 baseline scenario)	<ul style="list-style-type: none"> 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 Europe 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).

Source: Authors.

change. This helps to isolate and examine the impact of the 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 may be noted that in Table 4.4, 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 a long-term perspective, the turning point for the PRC's population growth will come around 2030. It is also likely that its economy will enter into a period of slower growth. As such, if there are no major changes 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.

4.3 Data

Data are from the Global Trade Analysis Project (GTAP) Database (GTAP 2015, version 9). 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 GTAP 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 was first aggregated into region and commodity groups. All the countries and regions are placed into region groups (Table 4.5). Any notable changes in the population, income, and TFP in the PRC and India will lead to changes in their domestic food demand–supply equilibria and also their broad macroeconomic structures. Through trade, such changes will impact the global food market and general economy. The impacts will, however,

Table 4.5 Region Aggregation

Region	Region Name	Including
1	PRC	PRC
2	India	India
3	Major East Asian food importers	Japan; Republic of Korea; Singapore; Taipei, China; Hong Kong, China
4	Other countries in East Asia, Southeast Asia, and South Asia	Mongolia, ASEAN members excluding Singapore, and South Asia excluding India
5	Major food exporters	Australia, New Zealand, Argentina, Brazil, United States, and Canada
6	Africa	All African countries
7	Western Europe and Northern Europe	EU25 and countries in Northern Europe
8	Others	All the rest (West Asia, Eastern Europe, and other Latin American countries)

ASEAN = Association of Southeast Asian Nations; EU = European Union; PRC = People's Republic of China.

Source: Based on Global Trade Analysis Project Database, V9.

vary in different countries/regions, depending on whether they are (i) net food importers or exporters, (ii) affluent or poor, and (iii) geographically close to the PRC and India. Countries in 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 India may raise world prices. In the long run, whether the PRC and India will need to significantly increase their food imports remains a question with no clear answer. To date, with the exception of soybean imports into the PRC, the share of most of the PRC and India's food imports of total world trade has been small, with India actually net exporting some cereal foods. If the PRC and India's entry in 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 effects on different countries/regions, the world is divided into eight groups as shown in Table 4.5.

In the GTAP database, there are 57 commodity groups. We aggregated them into 12 groups (Table 4.6). Commodities from agricultural industries are less aggregated and placed

Table 4.6 Commodity Aggregation

Group	Group Name	Including
1	Rice	Paddy, processed rice
2	Wheat	Wheat
3	Other cereals	Other cereals
4	Vegetables	Vegetables, fruits (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 foods of agricultural origin	Vegetable oil, sugar, other processed foods, beverages, and tobacco
10	Mining	Forestry, coal, petroleum, natural gas, and other mining activities
11	Manufacturing	Textile, leather, paper, plastic, steel and iron, refining, chemicals, and all other manufacturing activities
12	Services and others	Transportation, trade, financing, and all other services

Source: Based on Global Trade Analysis Project Database, V9.

into nine groups, which enables us to examine in some detail the changes in the major agricultural products. Commodities from all other industries are placed into three groups: mining, manufacturing, and services and others (Table 4.6).

4.4 Findings

4.4.1 Baseline Scenarios

If the economy in the PRC and India grows according to the anticipated trends, household demand for agricultural products (household demand only, not including the use by processing sectors and governments) will experience a major increase by 2030 compared with the demand in 2011. Table 4.7 shows that the total consumption of all major food items in 2030 will increase by 50% or even higher.⁴ The increase in the consumption of foods of higher value, e.g., animal products, dairy products, and processed foods, is much faster in both countries. India is also likely to have a faster increase in the consumption of aquatic products because of its very low per capita annual consumption of 5 kilograms (kg) in 2011 as compared with the PRC's 34 kg (Table 4.1). On the other hand, in both countries, the increase in domestic supply will be lower than that in consumption for most of the food items. The PRC's ability to produce cash crops (which include soybean) 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 basis of the assumptions that the savings rate will continue being high and 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 4.7). At the global level, the total supply of foods 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 4.7). 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 4.8). Table 4.8 also shows that both countries' food imports will increase at a fast pace but exports will drop compared with 2011.

⁴ A few limitations are noted (i) The income elasticities of demand for foods in the GTAP database are probably slightly overstated, (ii) The elasticities would be high for low-income consumers. But after consumers' basic food needs are met and when their income continues increasing over time, the income elasticities of demand for most food items would decline, (iii) Serious food wastage at the consumption stage, especially in the PRC, exists in the present times. Policies that discourage such wastage 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 somewhat lower, especially in the PRC.

Table 4.7 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 fruits	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	-29.2
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 Global Trade Analysis Project Database, V9.

Table 4.8 Change in Food Trade of the People's Republic of China and India 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 fruits	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 Global Trade Analysis Project Database, V9.

During 2030–2050, 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 continue increasing, and it will overtake the PRC to become the most populous country in the world. By 2050, the PRC and India's food consumption

would have grown compared with the 2030 level but at a slower pace than during 2011–2030 (Table 4.9). Overall, the increase in private consumption in India is greater. This is not surprising. In the PRC, basic food needs in terms of quantity would 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 then, adding to its demand for more food. Moreover, Indians will have higher incomes and will therefore be able to 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 at a relatively large margin, 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 price will increase at a very low rate. On balance, due to 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 4.7 and 4.9). The prices of some food items are likely to become lower by 2050, e.g., animal products, dairy products, and processed foods for the PRC; rice, dairy products, aquatic products, and processed foods 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 4.8 and 4.10). Thus, the prices of rice, animal products, milk and dairy products, and other foods will be lower than those in 2030, while the prices of wheat and other cereals, vegetables and fruits, 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 4.10).

Table 4.9 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 fruits	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 Global Trade Analysis Project Database, V9.

Table 4.10 Change in Food Trade of the People's Republic of China and India 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 fruits	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 Global Trade Analysis Project Database, V9.

4.4.2 Best and Worst Scenarios

The significance of conducting this simulation exercise is to understand how changes in population, income, and agricultural TFP may 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. In the best scenario, the population would grow at a lower rate and the GDP at a higher rate. Agricultural TFP would experience 10 percentage-point extra growth compared with other economic sectors—i.e., agriculture will receive extra preferential investment. Under the best scenario, the private consumption of all foods in both countries will be at a higher level compared with the 2030 baseline level (Table 4.11). The increase in the consumption of higher-valued foods would be at a slightly faster pace. The domestic supply of all foods would increase in India, with higher-valued foods increasing at a faster rate. The supply of land-intensive foods will decrease in the PRC, while the supply of higher-value foods will increase. Domestic supply prices will decline for all types of foods except two in India (milk and aquatic products will be at 0.3 and 7.5 percentage points higher, respectively). Globally, both import and export prices of all food items will decline, while changes in total supply will be modest (Table 4.11).

The improved agricultural TFP will lead to greater domestic supply. The need to import will decline and the ability to export will increase. Consequently, all import prices for both countries will be lower than those in the baseline scenario, by about 5–6.5 percentage points (Table 4.12). There will be 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, the increase in exports of other processed foods will be faster than their 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 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 food in India.

Under a pessimistic or worst scenario, the population will grow at a higher rate and the GDP at a low rate. Agricultural TFP will grow by 10 percentage points lower compared with other industries—i.e., agriculture will receive less investment. If this scenario occurs, domestic private consumption of all foods will decline in both countries compared with the 2030 baseline level (Table 4.13). The decline will be in the range of 10–17 percentage points for the PRC and 10–15 percentage points for India. The consumption of higher-valued foods will have a slightly greater decline in both countries.

Table 4.11 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 fruits	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 Global Trade Analysis Project Database, V9.

Table 4.12 Change in Food Trade of the People's Republic of China and India in 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 Global Trade Analysis Project Database, V9.

Slower improvements in agricultural TFP will result in lower supply. Domestic supply of all foods will decline with the exceptions being 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 purpose). In the meantime, some resources used for producing foods with high income elasticities are likely to be spared for producing essential crops such as cereals. On balance, overall domestic food supply will decline, causing domestic supply prices to increase for all the 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 4.13). The decline in global food supply could be the result of the following two forces (i) direct effect—reduction in the supply of land-intensive food crops of the PRC and India and (ii) indirect effect—reduction in the import demand of the PRC and India for foods of higher value such as meats resulting in a reduced supply of these foods from the exporting countries.

In both countries, import prices of all food items will increase by 5–8 percentage points compared with the

baseline scenario (Table 4.14). For the PRC, the quantity imported will increase, while the quantity exported will decrease. With lower TFP growth, overall supply will decrease. Increase in food demand due to slower population decrease (the PRC) or faster population increase (India) will be partially offset by decrease in food demand as a result of slower income increase. Within food items, the demand for foods produced domestically with higher income elasticities may decline more than the decline in their supply, leading to an improvement in the trade balance. For foods produced domestically with lower income elasticities, the opposite is true. On balance, domestic food availability deteriorates, resulting in increased imports but reduced exports.

The changes in the quantity imported or exported in India will not have the same character as in the case of the PRC. There will be an increase in the imports as well as exports of food commodities, except in the case of animal products in which both the imports and exports will reduce. The imports of commodities such as wheat, cash crops, and processed foods will increase, but their exports will decrease. The exports of commodities such as rice, other cereals, vegetables and fruits, milk, and aquatic products will increase, but their imports will decrease.

Table 4.13 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	15.0	28.7	2.0	36.9	44.4	-21.0	35.8	-7.6	-12.4
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 Global Trade Analysis Project Database, V9.

Table 4.14 Change in Food Trade in 2030 of the People's Republic of China and India (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 fruits	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.

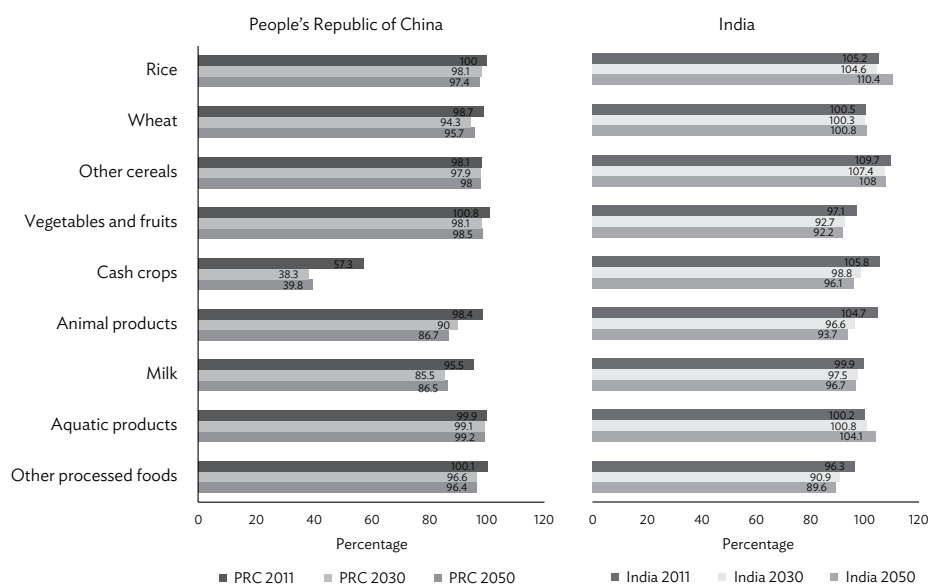
Source: From simulations using Global Trade Analysis Project Database, V9.

4.4.3 Changes in Food Self-Sufficiency Ratios in the People's Republic of China and India

Under the 2030 baseline scenario, both countries' food imports will increase (and at a fast pace), but exports will drop in 2030 (Table 4.8). This increase in imports

and decrease in exports will lead to a decline in the SSR for all the food items in both countries (except aquatic products for India whose SSR registers a 0.6% increase) (Figure 4.2). The decline in SSR will be different for different foods. For animal products, the decline will be

Figure 4.2 Food Self-Sufficiency Ratios in the People's Republic of China and India, 2011, 2030, and 2050



PRC = People's Republic of China.

Source: From simulations using Global Trade Analysis Project Database, V9.

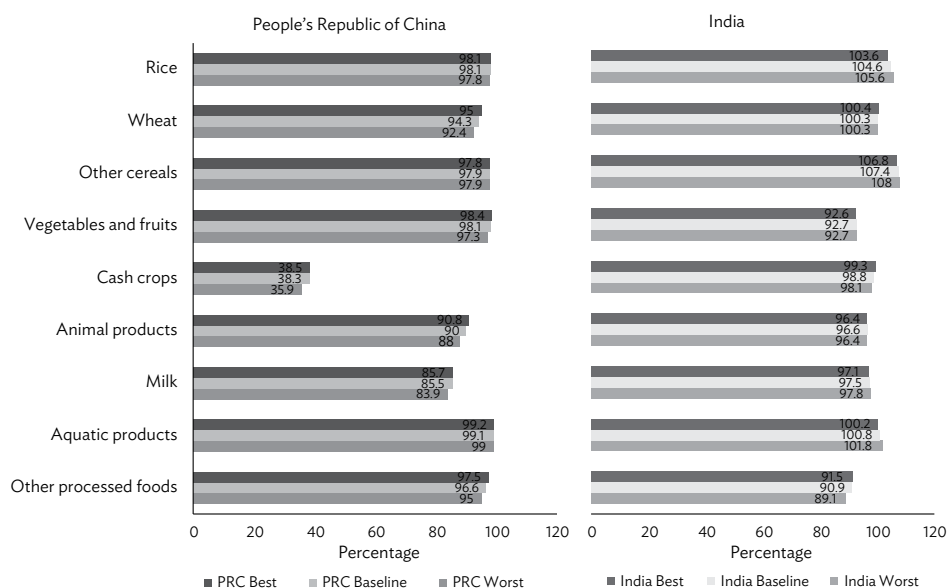
over 8% for both countries. The PRC will experience a major drop in the SSR for cash crops as well (19%) due to the continued large imports of soybean. (We note that some nonfood cash crops such as cotton are also included in the “cash crops” group.) India’s SSR for cash crops will also have a major drop (7%) due to the need to import pulses. The decline in the SSR of dairy products in the PRC will also be 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 will be relatively small. This is due to their very large domestic production but relatively small quantity of imports in 2011.

By 2050, although the SSR for some food items (e.g., rice, animal products, and other foods for the PRC; vegetables and fruits, cash crops, animal products, milk, and other foods for India) will further decrease, that for most 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 4.2). In general, the drop in the SSR will be small. However, it is useful to note that in both countries, the relatively larger drop in the SSR will be in the case of

animal products, roughly 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 will be the added challenge of supplying dairy products to its citizens.

If the best scenario occurs, the SSRs for all food items in the PRC (except for other cereals whose SSR will drop by 0.1 percentage points and rice for which there will be no change) will improve by a varying extent between 0.1 and 0.9 percentage points (Figure 4.3). However, if the worst scenario emerges, the SSRs for all food items (except for other cereals whose SSR will remain unchanged) will deteriorate by a varying degree 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. In any of the scenarios, India will be able to achieve self-sufficiency for rice, wheat, other cereals, and aquatic products. For other food items, the change in the SSRs will be small, although it may be said that the SSRs will tend to be lower under the worst scenario, especially the SSR for other processed foods that will have a relatively larger drop (Figure 4.3).

Figure 4.3 Food Self-Sufficiency Ratios under Three Scenarios in the People’s Republic of China and India, 2030



PRC = People’s Republic of China.

Source: From simulations using Global Trade Analysis Project Database, V9.

4.4.4 Global and Regional Impact of Changes in Food Demand and Supply of the People's Republic of China and India

Our results show that under both the best and 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 the best scenario, 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 roughly 6 percentage points compared with the baseline scenario. If the worst scenario occurs, again total global supply will vary by a small margin, but import prices will increase by about 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 can effectively control their population but achieve a higher growth in GDP and agricultural investment, then their efforts will help improve global food security. It should, however, be noted that the decline in world food prices resulting from increased global supply will affect exporting and importing countries differently. Generally, the former will have reduced export income, while the latter can expect to save on their imports.

At the regional level, changes in food demand and supply of the PRC and India will have some, but varying, effects on food-secure and food-insecure regions. Our discussion here focuses on the three less food-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, Eastern Europe, and other Latin American countries) (see Table 4.15 for information on the region groupings).

In general, SSRs for various food items tend to deteriorate over time in all these three regions (Table 4.15). Countries in Region 4 will have higher SSRs for rice, vegetables and fruits, aquatic products, and processed foods. 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 decline

Table 4.15 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 foods	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 foods	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 foods	94.0	104.6	106.4	104.5	104.6

Source: From simulations using Global Trade Analysis Project Database, V9.

further. In African countries, the SSRs are generally declining. By 2050, only vegetables and fruits, 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 may improve by 2030 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 the best nor the worst scenarios in the PRC and India are likely to cause any major deterioration as far as SSRs are concerned for all the three regions (Table 4.15). The SSRs in the columns of “best” and “worst” are very much 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 tend to affect food security in these three regions through food prices (Table 4.16). If the worst scenario occurs in the PRC and India, the importing prices of foods 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 will increase between 6 and 9 percentage points for most food items (Table 4.16). On the other hand, a best scenario will result in lower food-importing prices (by 5–9 percentage points) and lower domestic food supply prices (by 4–9 percentage points). This suggests that food security in less food-secure countries will be affected by changes in population, income, and agricultural investment in the PRC and India. If the PRC and India successfully control their population, improve their economy, and increase their investment in agriculture, this will benefit the poorer and food-insecure countries in improving their food security.

4.4.5 Some Qualifications

By intuition, the simulation results for India seem to be a bit overly “optimistic.” This is reflected by the relatively high SSRs, especially for cereals in the baseline scenarios (Figure 4.2). It has been generally speculated that India’s demand for food will increase over time and its ability to continue meeting the rising demand will decline, leading to lower SSRs for most food items including cereals. The higher SSRs derived from the simulations are perhaps the result of underestimated demand but overestimated supply.

Table 4.16 Price Change at the Regional Level (in percentage points in relation to the 2030 baseline scenario)

	Best Scenario		Worst Scenario	
	Change in Importing Price	Change in Domestic Supply Price	Change in Importing 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 foods	-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
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 foods	-5.5	-5.6	5.1	5.6

Source: From simulations using Global Trade Analysis Project Database, V9.

The reasons for this “optimism” can be multiple. The most fundamental one lies in the representativeness of the reference year data and some key parameters in the GTAP database. All else 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 generally high in the reference year of 2011 (Figure 4.2). 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 is generally 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, the comparative advantage of agricultural production may further decline and resources may be drawn away from agricultural production. If non-cereal crops earn a higher return, cereal production resources can also get diverted.

Of course, whether such resource diversion will 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 generally expected that under the worst scenario, the cereal output might decrease, leading to lower SSRs for cereal products. Contrary to the expectations, the SSRs for rice, 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.

The price elasticities of supply in the GTAP database affect the changes in supply. These parameters are compiled by the GTAP 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 would lead to an underestimation of the foods demanded. In general, we would think that if India’s poverty further reduces, the increased income of the low-income people would lead to a much higher demand for food.

When consumer income increases, another change that occurs is the composition of foods demanded, e.g., 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 would imply an increased demand for feed, including cereal feed. However, feed is an intermediary product, and its quantity demand 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 in detail this aspect of the demand.

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 strongly indicate that low investment in agriculture will result in reduced food output, increased imports, and higher supply prices; high investment in agriculture, on the other hand, will lead to increased food output, reduced imports, and lower supply prices, hence improving the country’s food security.

4.5 Conclusions and Implications

Given their enormous populations, how the demand for food of the PRC and India and the supply of food will change in the future is of great importance not only for their own future food security but also for that of other parts of Asia and the rest of the world. Simulations of key scenarios using GTAP Database 9 painted a broad picture about how their food demand and supply may change by 2030 and 2050.

Food consumption in the PRC and India will continue to increase till 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 will 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 the 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 will have the capacity to largely meet their domestic demand by 2050.

In the best or the worst scenario, the impact for food supply in the two countries would exhibit rather 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. In the case of the PRC, under the best scenario, 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 more 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 import dependency ratio for cash crops. It has also become increasingly reliant on the world markets for the supply of animal products and dairy products. Although the decline in the total population in the PRC may help reduce its demand for food, thus alleviating the pressure, this will not happen until the early or mid-2030s. In this context, it is extremely 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 are projected to be higher than those of the PRC, perhaps chiefly because of the lack of effective demand from the low-income

population. The challenges remain formidable for India. And, unlike the PRC, the challenges will remain daunting beyond the 2030s for India due to its still fast-growing population and the need to improve the nutrition intake of large numbers of the undernourished. From a longer-term perspective, it is even more important for India to adequately invest in agriculture and, in the meantime, to control population growth and improve consumer income. Our simulation was not able to take into full consideration the likely huge potential in increased food demand by one-fifth of the country's population that is poverty stricken. 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 report indicate. As such, it is extremely important to note that the higher SSRs in future years derived in this simulation exercise provide no basis for any complacency in India. If India's investment in agriculture fails to keep pace, there can be serious consequences for its food security.

The PRC and India will benefit from an 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 will be most beneficial to the poorer and less food-secure countries to improve their food security. In this regard, any international cooperation that can render assistance to the PRC and India to attain the best scenario would also be valuable. Improved food security in the PRC and India will ultimately improve food security elsewhere.

Finally, we note that the main objective of our simulation work is to provide broad indications about how food demand and supply in the PRC and India may change and to what extent, especially in terms of how the key policy options of investment in agriculture, population, and economic growth will affect their food demand and supply and thus impact their food security as well as that of the rest of the world. Although deficiencies inherent in the GTAP model may have affected the results to some extent and require the stating of some caveats, the overall results are significant. These can be used to infer the likely direction and extent of change under different scenarios over a period, though they should not be interpreted as the precise projection of what may happen at a specific point of time.

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* ADB recognizes “China” as the People’s Republic of China; and “Hong Kong” as Hong Kong, China.

5 Conclusions and Recommendations

In this report, we compared and analyzed food security practices of selected Asian countries over the past several decades, to answer the question: What matters if a country wishes to improve and achieve a higher level of food security?

Comparing country experiences has revealed some common factors that affect food security but in different ways. Some of these factors contribute to improving food security while others have a negative effect on a country's food security. There are also factors that do not have a deterministic impact on a country's food security.

Factors that facilitate a higher level of food security include the following:

- responsible governments with their officials accountable, operations efficient, and policy processes transparent;
- the presence of institutional arrangements that promote sustained economic development and equitable income distribution and redistribution;
- the presence of institutions that deter corruption;
- laws and regulations that enable markets to function well; and
- adequate levels of investment in agricultural key infrastructure, agricultural research, development, extension, and education.

Factors that retard a country's food security include the following:

- forced collective farming;
- compulsory delivery of foods from farmers to the government;
- no free markets or heavily controlled markets;
- 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 the following:

- the size of a country's population;
- the availability of food production resources;
- cultural traditions; and
- weather conditions.

The presence of those factors that retard food security will affect a country's food security negatively. On the other hand, the presence of those factors that contribute to improving food security will help a country to improve its food security. Among these contributing factors, strong government and economic institutions are the most fundamental.

A country can be expected to 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 seriously curbed; and
- markets are allowed to function more freely and food producers are rendered financial rewards that are comparable to people working in other industries.

What countries in Asia with low levels of food security need to look into first is not how economically poor or how short of resources they are, but how they are governed. Therefore, they need to pay attention to the most fundamental forces that affect food security—

getting their institutions right and fostering strong institutions in their country. Their governments need to accept that ensuring food security is their responsibility. The right to secure food intake of every individual is written in, and protected by, law.

The governments of the four countries with a higher level of food security—Israel, Japan, Singapore, and the Republic of Korea—have made it clear that ensuring food security to everyone in their countries is their responsibility. They also have laws or other essential institutional arrangements to ensure their countries are able to sustain a high level of food security. Recently, India and the People’s Republic of China (PRC) have moved toward protecting their citizens’ right to food security through legal frameworks, e.g., by promulgating the “National Food Security Act” (India) and preparing the “Grains Act” (the PRC). Such moves should be celebrated. When these two countries make greater efforts in taking care of the food security of their huge populations, this itself is an enormous contribution to better global food security. They have set commendable examples for other countries that have not pledged to ensure their citizens’ food security through laws. Efforts and essential reforms by the PRC and India to develop stronger institutional environments to help them achieve what they have pledged are most welcome.

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. On the other hand, family-based farming does not have to be small in its operations. This is an important area that deserves much 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 exit farming so that the remaining farms can expand their scales of operation.

Stressing the importance of small farms in achieving a country’s food security is an illusion. Overly emphasizing the role of small-scale farming in a country’s quest for a higher level of food security is, at the best, equivalent to maintaining the status quo and, at worst, would lead the country toward worse food insecurity. If farmers are not helped in exiting farming rapidly enough, farm operations will only become smaller over time, further eroding technical and economic efficiencies. Lack 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 so that they are easier to control. Having fewer farmers working the land, of course, should not be misunderstood as promoting the neglect of agriculture or as doing away with farming. What is required is a far more efficient agricultural sector that can produce more food with less labor and various other available resources. In Israel, less than 4% of the total labor force produces 95% of the country’s food requirements despite its very limited land resources. The great success achieved in Israeli agriculture demonstrates enormous hope and potential for food output to expand in many other countries.

To conclude the report, we emphasize that there is no basis for any complacency on the part of Asian governments despite the impressive progress they have made in improving their food security, as there are still many people in Asia who are undernourished. Challenges to help the less fortunate to improve their food security are many and formidable, which is why efforts from their national governments and the better-off public must be in place. In addition to dealing with challenges such as large and rising populations, limited and declining resources, a deteriorating environment, and the impact of possible climate change, national governments and the public of the less food-secure countries must, first and foremost, carry out reforms to strengthen their institutions. After all, the quality of institutions matters if a country really wants to improve and achieve a higher level of food security.

AT A GLANCE

FOOD INSECURITY IN ASIA

Why Institutions Matter

While overall food security has improved remarkably in Asia in the past decades, food insecurity still prevails in many developing countries in the region. According to the Food and Agriculture Organization, over 500 million Asians still suffer from hunger. Sound strategies need to be developed and actions undertaken to fight food insecurity in Asia.

This report suggests that institutional differences between countries are the most fundamental determinants of their divergent food security status. The report takes a comparative approach in selected countries in Asia, focusing on the roles and effects of governmental and economic institutions on food security. These countries share similarities, but also differ in terms of their institutional settings, natural resource endowments, population size, and the level of economic development.

This report will be useful reading for anyone who is interested in food security, including officials of national governments and international bodies, researchers, and university students. A more comprehensive study on the same topic is available in a book, *Food Insecurity in Asia: Why Institutions Matter*.

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