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# The Quiet Revolution in Staple Food Value Chains

## Enter the Dragon, the Elephant, and the Tiger

Thomas Reardon, Kevin Chen, Bart Minten
and Lourdes Adriano

## What the Experts Say

Excellent!—*Ray Goldberg, George M. Moffett Professor of Agriculture and Business, Emeritus, Harvard Business School*

… One of the best, most relevant, and most useful publications I've come across on this topic in the last 50 years (at least)—*Patrick Labaste, Practice Leader, Agriculture and Rural Development, World Bank*

... an important book.... this will become a seminal study whose influence will resonate over the next decade—*Grahame Dixie, Agribusiness Unit Team Leader Agriculture and Rural Development, World Bank*

… the predominance of marginal and small farmers has been growing in South and East Asia. Linking these farmers to markets and increasing efficiency in the food value chain are key issues of agricultural development today. This book makes a substantial contribution in this field by analyzing the transformation of the organization of production, storage, milling, and marketing; and the distribution of marketing margin between farmers and off-farm operators, for rice and potato in Bangladesh, India, and China.* The book is an important milestone in advancing the knowledge of the evolution of agricultural marketing.—*Mahabub Hossain, Executive Director, Bangladesh Rural Advancement Committee, now Building Resources Across Communities*

This is a very important piece of work, made more so because there is a terrible vacuum of such studies in the agricultural development literature.—*Charles Peter Timmer, Thomas D. Cabot Professor of Development Studies, emeritus, Harvard University and nonresident fellow at the Center for Global Development*

I find the analysis in Staple Food Value Chains most interesting.... I am drawing the attention of my colleagues to this important publication.—*M S Swaminathan, Member of Parliament (Rajya Sabha), India, and Emeritus Chairman, M S Swaminathan Research Foundation*

http://www.adb.org/publications/quiet-revolution-staple-food-value-chains

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* The Asian Development Bank refers to this member as the People's Republic of China.

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# Foreword

Feeding nine billion people by 2050 is a top priority on the global agenda for sustainable and inclusive development. This task is especially formidable in Asia, where more than two-thirds of the world's poor and malnourished people live. Food prices in Asia are projected to remain high and volatile, and food production is likely to be challenged by the combined effects of resource degradation and increasing climate variability and change. Ensuring food security in this region requires urgent actions to improve the productivity and climate resilience of agriculture and to upgrade the food value chains to ensure adequate and affordable food supplies.

At the height of the 2008 food price surge, the Asian Development Bank commissioned the International Food Policy Research Institute (through technical assistance TA 3689-REG: Thirteenth Agriculture and Natural Resources Research at International Agricultural Research Centers) to conduct a study to evaluate staple food value chains in Bangladesh, the People's Republic of China, and India. The basic idea was to identify potential areas for reform to make food value chains more responsive to rising food demand and supply constraints.

Staple food value chains in Asia have generally been perceived as operating in a traditional mode, which is typically thought to be an extremely long and fragmented process in dire need of modernization. Surprisingly, the study revealed a totally different situation. Staple food value chains are transforming across the region, with fewer intermediate actors, better integration, and higher receptiveness to technological changes.

This book, as its title denotes, documents the quiet revolution in staple food value chains now changing the face of Asia. It provides a systematic and rigorous review of the structural transformation pathways of these food chains and the catalytic roles that governments, the private sector, civil society, and international development institutions can play in the process. While not intended as a policy analysis for food security, the study provides critical guideposts for assessing and addressing all segments of the food chains that unnecessarily contribute to higher retail food prices. Most significantly, the book provides a clearer picture of how staple food value chains can benefit inclusive economic growth trajectories. More and more, sleepy rural areas are waking up to an increase in jobs and incomes from new links with commercial urban centers and vibrant intermediaries, technologies, infrastructure, and policies.

While there is no "one size fits all" model for modernizing these value chains, this book demonstrates that grassroots efforts are unfolding and gaps in knowledge are closing. With more proactive initiatives from governments, the private sector, civil society, and international development institutions, agriculture in Asia can be effectively transformed and food security ensured.

**Bindu Lohani**
Vice President (Knowledge Management and Sustainable Development)
Asian Development Bank

**Shenggen Fan**
Director General
International Food Policy Research Institute

# The Authors

Thomas Reardon is Professor in the Department of Agricultural, Food, and Resource Economics at Michigan State University; a Visiting Fellow at the International Food Policy Research Institute (IFPRI); and 1000 Talents Program Scholar in the School of Agricultural Economics and Rural Development at Renmin University of China.* He has a master's degree from Columbia University and the University of Nice, and he received his PhD from the University of California at Berkeley. He has had extensive research experience on food industry transformation, in particular the "supermarket revolution," as well as transformation of the wholesale market, mill, and cold storage sectors, and their impacts on the evolution of value chains and food security in Asia, Latin America, and Africa.

Kevin Chen is China Program Leader and Senior Research Fellow at IFPRI, based in Beijing. He is also Executive Director of the International Center for Agricultural and Rural Development, jointly run by the Chinese Academy of Agricultural Sciences and IFPRI. He earned his doctoral degree in agricultural economics and food marketing from the University of Guelph. His current research interests are food market transformation and value chain development, quantitative impact assessment of public investments and policies, climate change adaptation in agriculture, and South–South cooperation.

Bart Minten is Program Leader of the Ethiopian Strategy Support Program, based in Addis Ababa, and Senior Research Fellow at IFPRI. He received his doctorate in agricultural and resource economics from Cornell University, for which he later worked as Senior Research Associate for the Food and Nutrition Policy Program in Madagascar. His research focuses on the effects of agribusiness development and changes in agricultural marketing on the structure of food systems and value chains.

Lourdes Adriano is Advisor and concurrently Practice Leader (Agriculture, Food Security, and Rural Development) and Head of the Agriculture, Rural Development and Food Security Unit of the Asian Development Bank's Regional and Sustainable Development Department. She received her graduate education and postgraduate training in development economics and agricultural economics at the University of Cambridge, University of Sussex, and University of the Philippines. Her technical and work experiences have been in the fields of food security; agricultural, rural, and regional development; agricultural trade; and poverty reduction.

* ADB recognizes this member by the name People's Republic of China.

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# Abbreviations and Acronyms

| | | |
|---|---|---|
| ADB | – | Asian Development Bank |
| APMC | – | Agricultural Produce Marketing Committee |
| ATT | – | average treatment effect for the treated |
| BADC | – | Bangladesh Agricultural Development Corporation |
| CIP | – | Centre Internationale de la Papa (International Potato Center) |
| CNY | – | PRC yuan |
| CPRI | – | Central Potato Research Institute |
| CRRI | – | China Rice Research Institute |
| CSF | – | cold storage facility |
| CY | – | crop year |
| FAO | – | Food and Agriculture Organization |
| FCI | – | Food Corporation of India |
| FDI | – | foreign direct investment |
| FPMU | – | Food Planning and Monitoring Unit |
| HYV | – | high-yielding variety |
| IFPRI | – | International Food Policy Research Institute |
| NARS | – | national agricultural research system |
| NBARD | – | National Bank of Agriculture and Rural Development |
| PACS | – | primary agricultural credit society |
| PRC | – | People's Republic of China |
| Rs | – | Indian rupees |
| SSB | – | State Statistics Bureau |
| Tk | – | Bangladesh taka |

### Weights and measures

| | | |
|---|---|---|
| d | – | day |
| ha | – | hectare |
| kg | – | kilogram |
| km | – | kilometer |
| t | – | ton |

# EXECUTIVE SUMMARY

# Executive Summary

This book presents findings from a detailed study of how domestic staples value chains are structured and performing in Asia after the food price hike of 2007–2008. Three questions are asked in the study: (1) Are staples value chains transforming structurally? (2) Is the conduct of staples value chains' actors transforming? (3) Is the performance of staples value chains leading to the inclusion of small-scale farmers, small-scale midstream actors, and workers, and (all else being equal) to lower food costs for consumers? To address the questions, about 3,500 farmers, traders, millers, cold storage facilities, and modern and traditional retailers of rice and potato value chains were surveyed in key rural producing centers that serve the large urban centers (Dhaka, Beijing, and Delhi) of three economies (Bangladesh, the People's Republic of China [PRC], and India). Domestic value chains were chosen, as they accommodate 98% of the staples in the region. Rice and potatoes are the main grain and the main vegetable staple in these countries.

The survey's findings indicate that a transformational modernization is under way in these staple food chains, albeit at different speeds. In the rice value chain transformation, the leader is the PRC, which appears to be changing faster or has transformed further, especially in the remarkable development of its rice milling sector.  In the potato value chain, India is taking the lead, with the spectacular rise of potato cold storage facilities (CSFs) in Agra.

## Rapid but Differentiated Transformation

This transformation is a "quiet revolution," as these changes are grassroots in nature. Important drivers of the transformation of rice and potato value chains have been the increase in scale and change in technology of rice milling and potato storage. On the demand side, there was a surge in the demand for potatoes and other vegetables with increases in incomes and in megacities' populations. This created, in turn, a demand for off-season supply of potatoes and for higher-quality rice. On the supply side, the number of medium–large mills with modernized technologies and of modern CSFs has increased rapidly. Both the diffusion of CSFs and the modernization of mills have been favored by direct government subsidies as well as indirect government support through major investments in road improvement and the installation of energy grids so crucial to milling and cooling.

Specific features of the transformation by value-chain segment are as follows:

- **Upstream segments of the value chains.** There is great heterogeneity in farm sizes and distribution of nonland assets. But all farmers, regardless of how small their plots are, are commercializing as they engage in nonfarm labor markets and use more external inputs per hectare. Factor markets for farm machines, water, and land rental are vibrant. Armed with mobile phones, farmers are more informed of what, how, and for whom to produce.

- **Midstream segments.** Rice mills are modernizing. Driven primarily by the private sector, and coupled with technological change, mills are consolidating. The number of small village mills has declined rapidly, particularly in the PRC and India. Especially in the PRC, and to some extent in Bangladesh, rice mills have changed their procedures and are buying directly from farmers, selling directly to agents in wholesale markets, and branding and packaging the rice. These changes may make the chain more efficient, and certainly help in quality differentiation and traceability.

  The rice and paddy wholesale segment has also been transforming rapidly, especially in the PRC and Bangladesh, and somewhat in India. The roles of village traders linking farmers and rural wholesale markets or mills, and of semi-wholesalers linking rural mills and urban wholesale markets or supermarket chains, have diminished greatly. Traders in wholesale markets have made important investments in warehouses and trucks and have on average increased their scale.

  There has been a rapid spread of modern potato CSFs, especially in India and secondly in Bangladesh. Farmers rapidly took up using cold storage and dropped their traditional storage methods. Massive investments went into CSFs of all sizes. The scale has been rising over time, and thus a process of consolidation is occurring. Investment in CSFs has been encouraged by partial government subsidies and by government investment in the electricity grid. Most of the trading has shifted to the CSFs from the government-mandated wholesale markets. Farmers, even small-scale ones, ubiquitously use the CSFs, and have gained significant price advantages from storing.

  Consumers gained the advantage of greater year-round access to potatoes. The surveys found that two-thirds of the potatoes sold in Delhi and Dhaka had been cold stored.

- **Downstream segments.** Supermarkets have penetrated urban rice retail, most deeply and widely in Beijing, where they have about half the market. Delhi supermarkets have only started to penetrate the rice market, with about 7% of sales. This penetration can be expected to accelerate, given that foreign direct investment in retail was liberalized in September 2012. In Bangladesh, supermarkets have barely started to enter the market. Supermarkets have been slower to penetrate the urban market for potatoes, as well as for other fresh produce (a lag that follows international patterns).

  Supermarkets and traditional rice shops and stalls have been shifting from loose, unbranded rice to packaged, branded rice. This has progressed furthest and fastest in the PRC, driven by the practices of modernizing rice mills. Branding allows traceability in the supply chain for rice in particular, an important development. Packaging also helps signal quality differentiation. Traditional retailers in Beijing tend to buy rice from wholesale markets, where an important share of traders are agents of large mills, and wholesalers sell rice packaged with mill brands. Supermarket chains buy some rice from the wholesale markets, and some directly from large mills.

  Governments in Bangladesh and the PRC no longer directly engage in rice retail, but the government still does so in India. The survey showed that the Fair Price Shops' share of retail sales was only about 15% in Delhi.

## Catalytic Roles of Government

Government's roles have been important in enabling and at times providing incentives for the transformation:

- First, governments have spurred transformation by investing in rural areas through (1) research and development, and distribution of seeds; (2) investments in irrigation canal, road, and railway systems; rural wholesale markets; power grids; and mobile phone communication grids in the 1990s and 2000s, all being essential to the transformation in the midstream that the study observed; and (3) investment in extension, which was important overall, but the data suggest a limited impact and availability of extension services in some areas, particularly in the Uttar Pradesh study zone in India.

- Second, government subsidies have had important effects, but evidence of accessibility to and the impact of the services is mixed. Subsidies for rice seed and fertilizer sales in all the study countries, private tube wells in Bangladesh and India, CSFs in India, and mill upgrading in all the zones all appear to have encouraged use of and investments in all these productive items, and all the items have played important roles in transforming the value chains.

However, the survey results show that sometimes the subsidies were not going to the target beneficiaries. For example, tube well, fertilizer, credit, and seed subsidies in India went mostly to medium and large farmers, with little going to marginal farmers. A key policy implication is that, if large subsidies are distributed, great care should be taken to assure that they are properly targeted and delivered.

- Third, the study points to the importance of farm input supply chains upstream from farmers and of midstream and downstream postharvest activities such as logistics and wholesale, cold storage and milling, and retailing. Little empirical research work has been done on these areas, but is needed for the policy debate and the systematic evaluation of policy impacts on food security.

  There needs to be a concerted public policy debate on how to enable and encourage input supply chains to become modernized, and on how to get midstream and downstream businesses to invest in upgrading equipment and expanding.

## Food Security and Growth Strategy for Asia

The book provides guideposts on strategies for growth and food security.

- First, the off-farm components of the value chains are equally important even for staples—they account for about 40% of the total margins in the rice chain and 36% in the potato chain. Despite the importance of the postharvest segments, the food security debates in the Asian region focus on farm yields, and even just on rice farm yields. The productivity of processing, storage, and distribution merits nearly equal weight with the productivity of farms in the Asian food security debate.

- Second, there is no "silver bullet" for the challenges facing staples value chains in the region. Rather, a variety of policy and program measures is needed at various levels of the supply chains in order to stimulate the efficiency and competitiveness of expanding staples markets. The most effective indirect government interventions occurred with a cluster of activities that supported various parts of the value chains in an integrated way.

- Third, the transformation and successes of governments and the private sector in dynamic areas feeding major cities documented in this study may provide lessons that could be applied elsewhere, in particular to other nearby zones and, if possible, to the poorest and hinterland areas.

- Fourth, different policies are needed for the widely different zones and farm strata within them. Asian staples-producing farm areas and strata of farmers are not homogeneous. Rather, there is a wide degree of heterogeneity across rice and potato areas, and major differences across farmer strata. This implies that "one size does not fit all" and that government strategies need to be tailored to widely different situations. In particular, marginal farmers (compared with small and medium farmers) are at a disadvantage in these transformations. Hinterland zones can be at an initial disadvantage, but can learn from the experiences of the now dynamic zones where value chains are rapidly transforming.

- Last, the growth, market modernization, and agribusiness and food industry themes and debates are often held at arm's length from policy discussions on poverty reduction and food security. This study has shown that value chain transformation is important to farmers' incomes, rural employment, and access to and affordability of staples for urban consumers. This is especially important, given that Asia's urban areas are home to half of Asia's population and account for two-thirds to three-quarters of its food demand. Harnessing the value chain transformation for food security should be front and center in the policy agenda of the 21st century.

# PART A
# FOOD VALUE CHAINS

# 1 Introduction

## The Context: The Debate over the Causes of the Recent Rice Crisis

During the last 50 years, Asia had gradually started to shift from concentrating on the general problem of growing enough grain to feed its populations—that is, sufficient "simple aggregate access to staples"—to also thinking about a new food economy. Attention thus shifted to issues such as grain quality, equity of distribution, how to sustain the environment of staples production, and diversification into high-value products beyond staples. The trappings of a controlled staples economy fell gradually by dismantling most of the input and marketing parastatal system (except in India), reducing controls on foreign trade in grain, and partly liberalizing domestic markets.

This double shift was encouraged by a trend of falling prices of rice and other staples such as potatoes. The shift was also fed by the Green Revolution that had rolled out over decades. While longer-term visions of climate change and sustainability challenges somewhat troubled the perception that the grain problem had been resolved, and shocks such as the world food crisis of 1973–1975 occurred, in general, the reigning feeling in Asia was that the traditional grain problem had receded. As Headey and Fan (2010: x) noted "Cheap food has been taken for granted for almost 30 years. From their peak in the 1970s crisis, real food prices steadily declined in the 1980s and 1990s and eventually reached an all-time low in the early 2000s."

Then came the food price crisis of 2007–2008. Food prices on world markets spiked in the largest rise since the 1973–1975 crisis, and then declined in the second half of 2008, although domestic prices remained higher than before the crisis in some countries. Rice prices in a number of Asian countries rose precipitously. The 2007–2008 crisis revived the fear of the grain problem. The title of an Asian Development Bank (ADB) report in 2008 exemplifies that worry: *Food Prices and Inflation in Developing Asia: Is Poverty Reduction Coming to an End?* (James et al. 2008).

There was an outpouring of analysis and debate and conferences and books on the causes of the sudden crisis (for example, James et al. 2008, Dawe 2010, Fang 2010, Gulati and Dutta 2010, Headey and Fan 2010, Hossain and Deb 2010, and Alavi et al. 2012). The explanations debated ranged from short-term causes (such as droughts, floods, subsidies for biofuels, policies of export restrictions and precautionary imports, energy price increases, depreciation of the United States dollar, lower interest rates, and commodity market speculation) to medium-run causes (such as the rapid rise of the economies of the People's Republic of China [PRC]) to long-run causes (such as declines in grain yield growth and impacts of climate change).

Addressing or evaluating the causes of the 2007–2008 crisis is beyond the scope of this work, but leading analyses emphasize that rice is different. Dawe and Slayton (2010), Headey and Fan (2010), and Timmer and Dawe (2010) note that major Asian rice producers had good harvests in 2008, and that stocks were not low and even had increased in 2007–2008. Rice did not have the supply shock that wheat had (due to drought), the demand shock that corn experienced (caused by policies boosting demand for corn for biofuel processing [Naylor and Falcon 2008]), or the "speculative fervor" in commodity markets that impacted corn and wheat (Timmer 2009). And rice was not being heavily traded in world markets. Rather, Timmer and Dawe (2010: 7) note that while "the supply and demand fundamentals for rice were supportive of the gradual increase in world prices from their lows in 2001, … production had been increasing steadily, stocks relative to use had been increasing since 2003, and supplies available for export were adequate for normal demand."[1]

The gist of the analyses of the 2007–2008 rice crisis is that short-term factors were the main causes of the sharp spike, in particular factors related to policy (including export restrictions and large precautionary imports), coupled secondarily with international trader speculation. These short-term factors are set against longer-term factors such as growth in demand and decline of yield growth. However, the longer-term factors did not provoke the spike, as they had been in place well before it.

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[1] FAOSTAT (online) shows that world output of paddy trended up from 587 million tons in 2003 to 689 million in 2008, dipped a bit to 685 million in 2009, and went to 672 million in 2010, with thus a 14%–15% rise during the 8 years, depending on the end date used. For Asia, paddy output went from 532 million tons in 2003 to 625 million in 2008, then to 619 million in 2009 and 607 million in 2010, hence a 14%–17% increase during the 8 years depending on the end year of the trend. Supply (availability) of rice per capita in kilograms in Bangladesh during 2003–2007 (the available years in FAOSTAT that overlap with the foregoing paddy output trend information) showed a gently sloped trend from 162 kilograms (kg) to 160 kg during the period, with corresponding figures being 80 kg to 77 kg in the PRC and 68 kg to 71 kg in India: these trends show that supply was roughly steady during these years.

## Purpose and Themes

So far, the focus of responses after the crisis has been (1) to turn back to farm production self-sufficiency strategies—Alavi et al. (2012) note a number of illustrative cases; and (2) to revive discussions about buffer stocks. Both were principal elements in the food security debate in the 1970s. The difference now is the emphasis on seeking a regional reserve (Briones 2011). In fact, the food security debate since the crisis has focused on raising farm yields and on addressing trade constraints and stock issues.

However, the debate has not yet taken on as a central theme the improvement of staples value chains. Rice, other grains, and key nongrains such as potatoes are staples in Asian countries. This book devotes attention to that gap in the debate. Such attention is complementary to, and fed in enthusiasm by, the great wave of debate on the recent food crisis.

To be sure, the intraregional and domestic supply chains for staples could not have prevented the crisis and are not now adequate to resolve food price inflation in some countries. This secondary theme can be described as a "structural problem" in staples value chains in the Asian region.

One multicountry work treats the supply chain problem more directly. The World Bank study by Alavi et al. (2012) emphasizes a point made in most of the debate, but adds case studies based on samples of mills and traders and other key informants. They focused on intercountry rice value chains in some countries of the Association of Southeast Asian Nations (ASEAN), including Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam. Alavi et al. note that most small-scale rice farmers continue to use traditional farming methods; transport costs are high (forming a quarter of the import price); wastage rates are high in handling; supply chains are long with many steps from farmer to retail; mills are small and antiquated; and the whole system is fed by large outlays of subsidies. Alavi et al. emphasize the inadequacy of this more or less traditional, inefficient staples chain to respond to incentives or bring the rice economy to a new level—one in which regional trade and private investment can be relied on to prevent a new rice crisis.

In the renewed debate in the region on food security strategy, reports such as Alavi et al. and ADB (2010), and articles in the popular press in Asian countries[2]

[2] In India, for example, news articles frequently assert a link between high food costs and inefficient and wasteful, traditional and exploitative, food supply chains. This was evident

have been spurred by the food crisis and have revived a debate that had been put on the back burner since it had raged in the 1970s. The debate centers on how to solve the problem of the drag on the food economy thought to be created by traditional and poorly performing food supply chains.

The 1970s debate was predicated on the idea that staples value chains in Asia are traditional, stagnant, and poorly performing, both in efficiency and equity, and that they are (1) peopled with "traditional farmers" (farmers using traditional techniques, buying few external inputs, and selling little to the market) who either little engaged in the market or engaged only with an exploitative village trader; (2) composed of long market supply chains of many links and segments (such chains are termed "intermediationally long");[3] (3) prone to exploitative relationships of tied credit–output linkages where traders lend to farmers and thus underpay and exploit them; (4) very wasteful in postharvest processes; (5) unable to differentiate quality and merely supply bulk commodities, not graded, labeled, or branded; and (6) a cause for poor consumers overpaying for their food. Such images of markets had empirical backing when Lele's (1971) important work on the grain economy of India in the 1960s emerged. Lele found a surprising degree of integration and competition in the national rice market in India, in terms of arbitrage among urban wholesalers. However, she also showed that the more standard case (for example, Uttar Pradesh) was characterized by the "traditional" (intermediationally long and inefficient) rice supply chains, with a preponderance of local retail markets and village traders and small mills. Exceptions included very advanced chains such as in the Punjab.

The reaction on the market side to the specter of insufficient grain supply in the 1960s and 1970s was to erect parastatals to side-step the traditional supply chains, and regulations such as the Agricultural Produce Market Committee's Agricultural Produce Marketing (Regulation) Act (referred to as the "APMC Act") still apply in India to control and license the traders and police the practices. The reaction on the farm supply side was to put in place the research, extension, and credit and input supply for a Green Revolution.

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recently in the uproar over onion price spikes, which were linked in the press to wholesaler speculation. The National Food Security Bill, promised in the 2009 general elections and now being vetted by a Parliamentary Standing Committee (*Economic Times* 2012), was engendered by the public debate over the food crisis, as well as long-standing debate over the food security needs of the poor.

[3] This term describes a value chain in terms of the number of its intermediary links. This is a term used in this book to analyze transformation of the value chain.

With success and structural adjustment, in the 1980s–2000s many countries dismantled the parastatal system and liberalized the domestic market regulations. The result was increasing efficiency in grain markets, such as in Bangladesh (Ahmed, Haggblade, and Chowdhury 2000) and the PRC (Rozelle et al. 1997).

However, despite the experience of market liberalization and the Green Revolution, when the 2007–2008 crisis hit, the specter of the traditional supply chain boosting costs and prices was immediately and widely blamed. The blaming entailed employing much language and many images reminiscent of those used in the 1970s—as if the staples value chains had after all not transformed much along with the amazingly changed overall economies in which they functioned—economies in which there have been large income increases, rapid urbanization, diet diversification, and huge rural infrastructure investments. Moreover, government and multilateral institutions, spurred by the food crisis, called for upgrading the food value chains in the region; an example is the *Operational Plan for Sustainable Food Security* (ADB 2010).

The current debate is both right and wrong in evoking the nature of staples supply chains as potentially important in the formation of prices. The debate is right in that the vilification of the supply chain implicitly admits that the supply chain is important in food price formation: in fact this book shows that the segments of the supply chain after the farm form nearly half of the value added—and costs—of the staples supply chains and thus of food costs facing consumers. But the debate is wrong in being so certain, and so accusatory, of the staples supply chains—assuming that they are so traditional, efficient, static, and stagnant that they remain as they were in the 1970s.

In sharp contrast, the authors started writing this book realizing that, in the 2000s, actually very little systematic empirical evidence was present concerning the functioning of staples supply chains in Asia. There is in fact a major gap in the empirical literature in Asia on food markets, food supply chains, and their links to food security. And the authors ended the writing of the book realizing that, at least in the dynamic areas feeding the large cities of Asia, the staples value chains are now nearly unrecognizable when compared with the traditional ones of the 1970s. They have fundamentally transformed upstream (in the farm segment); midstream (in the mills, cold storage, wholesale, and logistics); and downstream (in the retail segment). Almost no research has been done on this transformation. This book is a contribution to filling the gap.

Further discussion of the gap in the empirical literature evoked above is necessary in order to contrast the empirical base and method used in this book with the empirical approaches of the value-chain and supply-chain studies on staples that have come before. A review of the literature in each zone studied for this book showed that the great majority of studies focused on a specific portion of the value chain, such as the farm or the wholesale markets. Very few of the studies provided an integrated survey-based vision of whole rice and potato value chains. In fact, most value-chain studies used small samples of key informants per segment to "map" value chains, and most studies were on nonstaple items such as horticultural products. Cross-country comparisons tended to be of international value chains, emphasizing the trade aspect. For specific key segments of the staples value chains, amazingly little field survey research has been done: at most, a handful of survey-based rice mill studies have been conducted in Asia, in the 2000s. The same applies to potato cold stores and to rice and potato traders in wholesale markets and village areas.

The paucity of hard evidence based on sample surveys about domestic staples value chains in the 2000s in Asia is because research had turned to documenting the effects of the Green Revolution on the diffusion of farm technology (and knock-on issues of sustaining that revolution). Research had also turned to either focus on policy reforms dismantling the parastatal and price control system, or (in cases such as India, where the government still intervened directly to buy and sell grain) on government actions and policies in lieu of putting significant research into surveys of the functioning of the private (traditional and modern) actors in the staples value chains.

To fill the important knowledge gap concerning the current functioning of staples value chains in the 2000s, ADB commissioned the International Food Policy Research Institute to collaborate with research institutions in the region on a detailed study of rice and potato value chains in Bangladesh, the PRC, India, and Viet Nam (the latter is not reported in this volume).[4]

This book presents the findings of that study, and draws implications. The focus is on (1) domestic value chains of rice and potatoes; (2) private sector action in input supply, farming, processing, storing, trading, and retailing; (3) the incidence of policies and government market actions on private parties; and (4) the implications in terms of domestic market development policies.

The study and book complement the works reviewed above. The study and the book do not (1) aim to inform trade or storage policies or other topics in the trade and buffer stock debate; (2) examine international or intraregional trade in staples in any way; (3) examine government actions in the market except as they

[4] Viet Nam's results will be reported separately owing to methodological differences.

are part of the behavior of the private actors studied, such as the mills' share of rice sold to government; (4) delve into the short-term causes or consequences of the recent crisis; or (5) attempt to explain current food price inflation.

## Sector and Area Focus and Research Questions

The study focuses on rice and potatoes because rice is a staple throughout Asia and potato is a staple in South Asia. Bangladesh, the PRC, and India ("the three economies") are the focus of the book in order to compare East and South Asia. The PRC and India together produce and consume half of the world's rice and a third of its potatoes, and they are the world's first and third largest potato producers and consumers. The study was conducted in six zones (two in each economy, one being the area studied for potato and the other, the area studied for rice).

The study focuses on domestic supply chains because they involve nearly 98% of the rice and potatoes consumed in Bangladesh, the PRC, and India, and relatively little survey evidence is available in the 2000s on the functioning of these value chains, although they are often discussed in the domestic policy debates. The authors also did not want to overlap with the trade and national and regional stocks debate, which is another subject.

The focus is on the foremost supply chains of staples to the capital cities: Dhaka, Bangladesh; Beijing, the PRC; and Delhi, India. Supplies to the capitals are more "commercial" than supplies in the average zone in each nation's economy, due to proximity to great cities.

However, while the rice and potato zones studied are not representative of all the rice and potato production zones in Bangladesh, the PRC, and India, they are representative of the main zones supplying the large cities. These tend to be within about 6–8 hours by truck from the big cities. Circles with a radius of 8 hours by truck or train around the 100 cities with more than 1 million people in the PRC or the 67 cities in India with more than 500,000 people cover a substantial part of the rural PRC and Indian populations. In India, that might be half the rural population—the half that, per information from wholesale markets, feeds the cities. Cities will hold 60% of the Asian population by 2025, from only 20% in 1960 (James et al. 2008). Understanding the supply chains from these dynamic, commercial, somewhat periurban zones is important to comprehending at least one major piece of the food security puzzle in Asia.

The questions addressed in the research for the book are summarized as follows:

(1) Are staples value chains transforming structurally? That is, how are value chains for staples (rice and potatoes) differentiated and differentiating over time from traditional long chains of small-scale actors to intermediate and modern shorter chains including medium- and large-scale actors?

(2) Is the conduct of staple value chains' actors transforming? That is, are value-chain finance, value-chain actors' procurement, and the production and marketing systems transforming? If so, how? Is the transformation broadly in the direction of "modernization" with capital intensification and technology upgrading, with quality differentiation, with contracting, and with disintermediation?

(3) Is the performance of staples value chains leading to the inclusion of small-scale farmers, small-scale midstream actors, and workers, and leading (all else being equal) to lower food costs for consumers?

The study examines the differentiation both over space (mainly comparing similar zones, except for the Gansu, PRC potato site) and through time (with three points of recall of information on the value chains: the one-year 2009/10 "snapshot," along with some mid- and early 2000s recall data for some key variables that describe transformation of the value chains.

Moreover, in Bangladesh, the PRC, and India, some situations continue to be traditional while others are more transformed, such as in the polar comparison of the Gansu potato zone with that in Agra, Uttar Pradesh, with the former remaining somewhat more "traditional" than the latter. This shows a cross section displaying a longitudinal story—a common device in the economics literature that uses a cross section to represent time series change by observing over space things that occur over time too.

In addition, a longer view of the evolution and differentiation of value chains is obtained by comparing the results from the 2000s with the descriptions of the traditional supply chains for rice in the older literature, such as Lele (1971) for India and Chowdhury (1992) for Bangladesh. In those works, state and private urban wholesalers bought from rural wholesalers, and rural wholesalers bought from field brokers and village traders; then state and rural or urban wholesalers milled the paddy and sold the rice to the cities or towns or local village markets.

For potato, a similar system had prevailed except that processors and the state were not present, and there were no modern cold stores (just traditional on-farm storage). The PRC had a similar traditional system but with a twist: prior to liberalization in the late 1970s, rice was supplied by collectives and farm groups/teams to state collection points. With liberalization, that was displaced by a system similar to India's traditional system for rice.

Then, to the degree the rice and potato value chains observed are not like the traditional systems, the presence of transformation is inferred. The transformation has two axes. First is the transformation of individual segments, such as change in farm technology, in the structure of the trading segment, in the structure and technology of mills and of storage, and in the evolution of retail from traditional toward modern. Second is the transformation of linkages between the segments: while little contracting takes place between actors in the segments, the shape and length of the chains change, as subsegments are suppressed (like the disintermediation), and occasionally segments are eliminated (such as Beijing supermarket chains buying directly from mills, eliminating the wholesaler between them).

## The Structure–Conduct–Performance Paradigm

The study's research questions can be grouped into the standard classification used in industrial organization studies to characterize subsectors or supply chains or value chains by their structure, conduct, and performance.

**Structure.** In terms of structure, the following questions were asked:

- How are rice and potato value chains structured?
- What is the distribution across the three segments (defined in the next paragraph) of the formation of costs and value added?
- What differentiation do value chains display in terms of restructuring from traditional into intermediate–transitional and modern supply chains?
- How concentrated are the chains across segments and, hence, what share of a chain's profits do farmers capture?
- How concentrated are the value chains within subsegments—that is, what role do medium- and large-scale actors such as large farms, mills, cold storage facilities, and supermarkets play, compared with marginal and small-scale actors?

Structure is then assessed in two ways. First, structure in the value chains is represented by the distribution of output, costs, and profits across segments of a value chain. The segments for the value chains studied are (1) upstream—the farmers, as well as suppliers of inputs such as land, water, labor, fertilizer, and chemicals; (2) midstream—the traders (village traders, rural wholesale market traders, and urban wholesale market traders) and storage and processors (rice mills and potato cold storages); and (3) downstream—the retailers. Knowing the structure can help determine, for example, whether the farmers' share of total profit generated by the value chain is higher in a particular country, product, or quality of product, than in another.

Second, structure in the value chains is represented by the distribution of output, costs, and profits across subsegments in each segment. The relevant subsegments per segment are large- and medium-scale actors versus small-scale actors, on the one hand, and rural versus urban on the other. Knowing this structure, and its differentiation for a given product in a given zone or country, can answer questions such as whether there are several forms or versions of the rice value chain in a given country where one is "more traditional" and another is "more modern."

Relative modernity can be measured in one or both of two ways.

- First, by length, as a proxy for transaction costs: a chain can be longer (with more actors) and thus more traditional; or shorter, with disintermediation, that is with fewer actors and more direct buying from suppliers.
- Second, by scale, in principal, as a proxy for efficiency or market power or both: a chain can have one or more segments dominated by large- or medium-scale actors.

These criteria comprise a spectrum of forms of a value chain, from most traditional to most modern, with various intermediate structures. An example of a modern value chain that satisfies both criteria would be where the retailers are supermarket chains, and they buy potatoes directly from farmers or rice from big mills that source directly from farmers. An intermediate level of modernity would be supermarkets buying from wholesale markets that then source from cold stores or from farmers at cold stores. A very traditional structure of the value chain would be where small-scale farmers sell to village traders who sell to rural wholesale markets who sell to semi-wholesalers (who both wholesale and retail) who sell to urban wholesale markets who sell via semi-wholesalers to small retailers in the city.

**Conduct.** In terms of conduct, a question is: What is the behavior of the actors in the value chains, differentiated into their segments and subsegments, and of the different kinds of value chains per product, including traditional, intermediate-transitional, and modern?

Conduct is assessed in four categories and three ways. The four categories of conduct correspond to how actors finance production, buy inputs, make their product, and sell it. The three ways each category is assessed are technical, physical, and/or geographical; institutional (such as standards and contracts); and organizational. The four categories and three ways are elaborated on below.

The first category is related to finance, specifically value-chain finance, and in particular, buyers' credit to suppliers and suppliers' credit to clients. A value chain may be financed from within the chain or from sources external to it. Finance from within the value chain is based on the value-chain relationships, such as a trader advancing funds to a farmer who buys inputs, produces a crop, and markets the crop to the trader. Finance from outside the value chain is predicated on value-chain relationships, such as a bank lending to a mill because it has a contract with a retailer, which contract substitutes for collateral.

This book focuses only on finance within the value chain: trader, miller, cold store, and retailer credit to suppliers and clients. Value-chain finance is one of many ways that value-chain actors can finance their production. Other examples include self-finance, which predominates, and credit, which is not always predicated on value-chain relationships, such as a straight bank loan or microcredit. All value-chain actors may also provide credit services to each other—farmers de facto lending to traders, traders advancing cash to farmers, retailers getting credit from mills, retailers allowing delayed payment by consumers, and so on.

Finance within the value chain is assessed in the three ways already noted: (1) technical and /or physical: assessing the quantitative importance of traders' credit to suppliers and buyers; (2) institutional: evaluating whether traders' credit is linked to contracts and/or specification of meeting certain standards such as of quality; and (3) organizational: whether the credit is funneled via organizations such as cooperatives.

The second category is related to input procurement. Farmers buy inputs; traders buy intermediate inputs such as paddy and potatoes and factor inputs such as trucks, petrol, and labor; mills buy intermediate inputs such as paddy and factor inputs (electricity, equipment, labor, and transport services); cold storage facilities buy factor inputs (electricity or diesel, labor, and equipment) and could buy intermediate inputs; and retailers buy intermediate inputs (potatoes and rice) and factor inputs (stalls, transport services, and labor).

Input procurement is assessed in the same three ways: (1) technical and/or physical: assessing the quantitative importance of the kinds of inputs such as purchased seeds and herbicides in farmers' costs, or transport services in traders' and retailers' costs, the geography and socioeconomics of their sourcing (such as whether the traders buy from small-scale farmers, whether retailers buy from small mills, and so on); (2) institutional: evaluating whether traders' credit is linked to contracts and/or specification of meeting certain standards such as of quality; and (3) organizational: determining whether the credit is funneled via organizations such as cooperatives.

The third category is related to output production technology. All actors in the value chain are considered to be producers, not just the farmers. Farmers grow paddy and potatoes; millers mill paddy and produce rice; cold storage facilities store potatoes; traders buy or broker potatoes and rice or paddy and perform a service of storing and transporting and selling; and retailers also buy, store, transport, and sell the produce.

Production technology is assessed in three ways: (1) technically, in terms of the inputs used, such as the intensity of labor use and capital per unit of output: for example, a supermarket may be more capital intensive than a traditional retailer; (2) technically, in terms of the scale of production and of farm, plant, or stall; and (3) economically, in terms of costs incurred (intermediate input and factor prices paid) by different actors.

The fourth category is related to selling and marketing output. Farmers sell paddy and potatoes; millers sell milling services; cold stores sell storage and other services; traders sell logistics, grading and sorting, and marketing services; and retailers sell the final product. This is assessed in the same three ways: (1) technical and/or physical: assessing the quantitative importance of the various kinds of products, such as varieties and qualities of rice; services such as providing delivery or credit along with the primary product or service; and the geography and socioeconomics of their marketing; (2) institutional: whether the marketing is done on contract or a spot market, and per standards or without; and (3) organizational: whether marketing is done in cooperatives or associations or individually, and off-market versus in clusters such as wholesale markets and wet markets.

**Performance.** In terms of performance, the value chains as a whole and their component parts or segments can be analyzed with respect to two outcomes: efficiency and equity. Of course there is a trade-off between them—for example, a cost in the system can be cut by disintermediation via eliminating village traders (a common trend), but that means an equity effect (employment) on small-scale traders. Efficiency measures the cost of food and resources that were used to move the crops from the farmers' fields to the retail shelves. This book does not present partial or total factor productivity analyses, but rather comparative cost estimates over actor types and study zones per product. The study also evaluates traditional versus modern retail prices for rice and potatoes. Equity measures the "inclusion" of poorer groups in the value chains and the effects on poor consumers. This is analyzed by comparing prices earned by different scales of farmers (i.e., small-, medium-, and large-scale), and their participation in different value chains. Implicitly, this issue is also addressed in the other segments by examining structural change, in particular, concentration within the trading, mills, cold storage, and retail segments. Food prices charged by different kinds of retailers are considered, but the study did not include consumer surveys.

## Structure of the Book

Chapter 2 presents selected background information for the study zones regarding rice and potato production, consumption, trade, and policies as well as the sampling framework. Chapters 3–6 (Part B) present the findings of the study's surveys on rice value chains—first on the upstream or farm segment, second on the midstream segments (domestic traders and rice mills), third on retail, and fourth on costs and margins across the value chain. In the same manner, Chapters 7–10 (Part C) present the findings from the study's surveys on potato value chains. Parts B and C are necessarily similar and often use the same language, given the subjects studied and the methods used. Part B is intended for readers interested in rice, and Part C for those interested in potatoes, who may not want to refer back to the rice section to understand the information fully. Parts A and D are relevant to both the potato and rice sections. Part D synthesizes the findings on the overall value chains and presents policy implications.

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* ADB recognizes this member by the name People's Republic of China.

# 2 | Sector Overview, Study Areas, and Sampling Framework

This chapter provides background information for the rest of the book. The first two sections lay out the key points about the rice and potato sectors;[1] their patterns and trends in the sample zones in the economies studied—Bangladesh, the People's Republic of China (PRC), and India—in terms of imports and exports, consumption, production, domestic marketing; and the key points of government policy on the two products. The last section briefly describes the study areas, and discusses the survey methods and sampling framework used in the study.

## Rice in Bangladesh, the People's Republic of China, and India

### Rice Imports and Exports

External rice trade was a very minor part of all three rice economies studied, which were basically self-sufficient in rice. With some modest yearly fluctuations, about 2% of rice consumption in Bangladesh was imported in the 2000s. Rice trade was relatively insignificant in the PRC, accounting for less than 1.5% of total consumption or production. The PRC was a very small net rice importer in 1995 but a net exporter in 2000, 2005, and 2009. In 2000 and 2009, the PRC exported 1.8 million tons of rice (less than 1% of its output). India exported on average 4.6% of its rice output during the crop years (CYs) 2001/02–2008/09. India's rice imports had been negligible (less than 1% of total rice consumption in any year since 1990).

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[1] For information about detailed trends and patterns in the staples sectors in Asia, see, for example, Dawe (2010), Pandey et al. (2010), and Sombilla, Hossain, and Hardy (2002), for broad information on the rice sector in Asia. Similar literature is not available for potatoes in Asia.

That very little rice was externally traded by any of the economies studied justifies the focus on the domestic market as the rice value chain's end point.

## Rice Consumption

Rice was important in the food consumption basket of all three economies for consumers of all income strata. Nearly all the food grain consumed in Bangladesh was rice, but rice comprised only about half the food grain consumed in the PRC and India. However, there are differences between rural and urban areas. For example, in the PRC, in 2004, urban residents consumed 51 kilograms (kg) of rice per capita, while rural residents consumed 93 kg.

The importance of rice as a share in the diet of most Asian consumers has been declining during the last several decades, as analyzed by Timmer and Dawe (2010). The share of rice in calories for all Asian countries in the Food and Agriculture Organization's food balance data sheets was at its highest in 1970 in the midst of the Green Revolution, at 38.2%, and then trended down to 29.3% by 2007 (FAOSTAT 2012). Among the economies studied for this book, that shift was greatest in the PRC (from rice being 38.7% of calories in 1970 to 26.8% in 2007) and Bangladesh (from 75.1% in 1970 to 69.8% in 2007), and least in India (from 32.4% in 1970 to 29.9% in 2007). The downward drift was very slow until 1990 and then much faster (as Asian incomes increased).

By 2007, only 30% of calories in Asian consumers' diets came from rice (comprising 5% of their food budget in money terms). The calories from rice changed in the PRC (from a low of 444 in 1961 to a high of 872 in 1990, then dropped to 799 by 2007) and India (from a low in the 600s in the 1960s–1970s to a high of 781 in 1990, then dropped to 703 in 2007). The calories from rice rose slightly in Bangladesh in absolute terms (from a high in the 1,500s in the 1960s–1970s, down to 1,311 in 1980 and 1,473 in 1990, and up to 1,591 in 2007), as Bangladesh rode through the Green Revolution, a prolonged crisis, and a long recovery.

This is part of a longer trend of decline in rice consumption in Asia in the last several decades. Timmer and Dawe (2010) noted that the decline had accelerated in the last decade and should be expected to continue for some time because (1) the income elasticity of rice demand is falling over time; (2) as rural-to-urban migration occurs and incomes rise, the elasticity trends downward; and (3) the income elasticity is lower in urban than in rural areas and among richer than poorer consumers. This general decline of course disguises heterogeneity among age groups, regions within countries, and across the economies themselves, but the overall trend is clear.

More broadly, the gradual decline in rice consumption is part of a trend of a declining share of cereals in Asian diets, which are diversifying (Pingali 2006)—part of the general phenomenon known as Bennett's Law (Bennett 1954). For example, the Government of India (2010) report shows that the share of cereals in the total food budget of Indians had decreased during 1997–2006, in the rural areas from 55% to 35% and in urban areas from 35% to 25%.

## Paddy Production

A few key observations on paddy production in the study countries follow.[2]

First, the extent of land under rice cultivation had not changed much in Bangladesh, the PRC, and India during the last several decades. In Bangladesh, almost three-quarters of total cropped land was devoted to paddy cultivation. That area had changed little over time, at roughly 10 million hectares (ha) of paddy from 1986 to 2008. In the PRC, the rice area rose from 27 million ha in 1961 to 35 million ha in 1980, then dropped to 30 million ha during the 2000s. In India, rice was planted in about 22% of all cropped areas in CY1989/90, but that dropped to 19% in CY2008/09.

Second, paddy production varied widely within zones. This was especially so in India and the PRC, large economies with substantial interregional differences.

In the PRC, Hunan, Jiangxi, and Heilongjiang were the three largest rice-producing provinces, accounting for about 14%, 11%, and 8% (respectively) of rice area and about 13%, 10%, and 8% of paddy output (CRRI 2009). The PRC has three major rice-producing regions. Region 1 (the northeast), including provinces such as Heilongjiang, Jilin, and Liaoning, produced japonica rice only. Region 2 (the east), including Fujian, Guangdong, Guangxi, Guizhou, Hainan, Hubei, Hunan, Jiangxi, Sichuan, and Yunan provinces, produced only indica. Region 3 (southeast), including Anhui, Jiangsu, Shanghai, and Zhejiang, produced indica and japonica. Heilongjiang (the province studied for this book) was the PRC's largest japonica rice-producing province and Hunan was the largest indica-producing province. Rice production in the PRC had been shifting from south to north since 1980. The rice area in Heilongjiang increased from 206 ha in 1980 to 2.25 million ha in 2008, while in Zhejiang, another major rice production area in the east, rice land declined from 2.5 million ha in 1980 to less than 1 million ha in 2008 as the province industrialized and agriculture diversified.

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2 "Paddy" refers in this book to unmilled rice and not to the field in which it is grown.

In India, rice production was somewhat geographically concentrated. India's top five rice-producing states were West Bengal, Andhra Pradesh, Uttar Pradesh (the state studied for this book), Punjab, and Orissa. In CY2007/08 they contributed 60% of rice production, with 15%, 14%, 12%, 11%, and 8%, respectively, of India's total rice production (Government of India 2009a). This geographical distribution of rice production had not changed much over time—the same five states produced 59% of India's rice in 1986.

Third, the average rice farm was small in the study zones. In Bangladesh, the average farm size in 2000 was 0.46 ha and in the PRC, the average farm size was 0.67 ha (Eastwood, Lipton, and Newell 2010). In India, the average size of operational holding (for all crops) in 1995–1997 was 1.41 ha (Eastwood, Lipton, and Newell 2010), and rice farms averaged 1.33 ha overall in India, while that in Uttar Pradesh was 0.83 ha (Government of India 2001). As will be discussed in Chapter 3 with the presentation of study results for rice farms, these national averages masked significant heterogeneity in rice farm sizes in each study zone and among the three (in Bangladesh, the PRC, and India).

Fourth, paddy output and yields had increased greatly over time in the three zones due to the diffusion of improved varieties and irrigation (which allowed multiple cropping).

In Bangladesh, due to the proliferation of shallow tube wells and the development of high-yielding varieties (HYVs) of dry season (*boro*) rice, rice yields had increased dramatically, and the share of dry season rice (irrigated) had increased from 10% of the country's rice production in CY1966/67 to 61% in 2008 (Asaduzzaman 2009). The consequence was that paddy yields rose from roughly 1.8 tons per hectare (t/ha) in 1990 to 2.5 t/ha in 2000 and to 3.0 t/ha in 2008. Output jumped from about 15 million tons to about 30 million tons during the same period, even though the area under rice changed little. With irrigation, seasonality in the rice market in Bangladesh had decreased. By allowing multiple seasons of cropping, irrigation had reduced seasonal fluctuations in rice prices. While the seasonal price spread was 15% between the peak and trough in the 1960s, the spread declined to less than 10% during 2000–2009.

The PRC, the world's top rice producer and consumer, produced about 190 million tons of paddy per year—close to one-third of the world's total output. The PRC's paddy yields had more than tripled since 1961, when they were roughly 2 t/ha, to 6.6 t/ha in 2010 (SSB 2010). The PRC's rice culture also had "deseasonalized" with the diffusion of irrigation. Commonly, the PRC rice crop has three seasons: (1) a planting in January (early indica planted in the southern PRC); (2) a mid-year planting (in May, such as indica in the south and japonica in the north); and (3) a late year crop of indica, planted in July in the south. From 1990 to 2009, statistics show a shift toward mid and late rice, reflecting a shift toward japonica and increased rice production in the north, and toward mid- and late-season rice in the south.

In India, yields had doubled since 1960, from roughly 1 t/ha to 2.2 t/ha in 2010, and production had risen by 41%, from roughly 70 million tons in CY1988/89 to 99 million tons in CY2008/09. Paddy production in India had also become less seasonal. The share of dry season (irrigated) paddy in total paddy production had increased from 37% in 1960 to 57% in 2008 (Government of India 2009a).

While yields had risen in all three economies, the South Asian zones lagged behind the PRC: Bangladesh and India yields were about 35%–45% of PRC yields. Hence, although the PRC had less rice land under cultivation than did India and Bangladesh combined, the PRC produced 190 million tons of paddy yearly versus 130 million tons for Bangladesh and India combined.

Fourth, the diffusion of HYVs occurred rapidly in all three economies, especially before 2000.

Bangladesh had widely adopted HYVs, as the expansion of irrigation facilities allowed planting in the dry (*boro*) season (Asaduzzaman 2009). Hossain (2009) noted that, from 1987 to 2000, Bangladesh's share of cultivated rice land under HYVs increased from 33% to 60%.

The PRC's rapid yield increase can largely be attributed to the adoption of hybrid rice. The PRC's hybrid rice program was started in 1963, and hybrid seed was released commercially in 1976 (Gulati, Chen, and Shreedhar 2010). Less than 1% of rice area was planted to hybrid rice in 1976, but this increased to about 54% in 1991 and about 63% in 2008 (Li, Xin, and Yuan 2009).

In India, HYVs were introduced during the Green Revolution. HYVs comprised only 7% of all rice in CY1968/69, but the share grew to 58% by CY1982/83 (Singh and Kaur 1990) and 74% by 1999 (Directorate of Rice Development 2002). As in Bangladesh, the adoption of HYV rice as a rainy season (*kharif*) crop in drier areas in the Indo-Gangetic plain (such as in Uttar Pradesh) increased quickly in the 1980s along with the widespread diffusion of private shallow tube wells. Rainy season rice is double cropped with irrigated wheat in the dry season (*rabi*). In higher rainfall areas, such as West Bengal (as in Bangladesh), the spread of tube wells and HYV rice allowed double cropping of rice (Fujita and Hossain 1995). Fujita and Hossain show that HYVs diffused most rapidly in the 1980s, coinciding with the most rapid increase of tube wells in the rice areas. In contrast with HYVs, hybrid rice had spread slowly in India, and only approximately 2% of rice production was from hybrid varieties. To encourage the spread of hybrid rice, India implemented a policy for subsidizing its seeds (*Economic Times* 2010).

Fifth, the diffusion of new varieties had been accompanied by a shift to higher quality rice (quality here refers to cosmetic attributes such as the length to width ratio of the milled kernel). In Bangladesh, high-quality rice varieties were rapidly adopted because of high yields, shorter maturity, and relatively good grain quality, causing a shift away from coarse varieties (Hossain, Bose, and Mustafi 2006; Minten, Murshid, and Reardon 2012). The PRC produced two main kinds of rice: japonica and indica. The area planted to japonica had expanded from 11% of the total rice area in 1980 to 29% by 2000 (Hansen et al. 2002) and about 29%–30% during the 2000s (Lee and Kim 2007). The expansion occurred mainly in the northeast, in three provinces, one of which (Heilongjiang) was used in the study for this book. The shift in quality in India had been least marked: while India is known on the world market for its high-quality rice, called "basmati," it comprised just 1%–2% of the country's total rice production (NBARD n.d.).

## Rice Value Chains and Markets

First, in general, the value chains can be grouped into four types that were found in the zones studied (from Noagoan to Dhaka, Heilongjiang to Beijing, and Shahjahanpur to Delhi):

(1) The most traditional rice value chain was "geographically short and intermediationally short"[3] and was the local supply chain of paddy grown by the farmer, dehusked in a local village mill, and consumed by the farm household or sold to the local village market for local consumption.

(2) The rural–urban traditional rice value chain was "geographically long and intermediationally long" and featured sale of paddy to local brokers (village traders) who then sold it as paddy or had it milled in village mills and then sold it to rural wholesale markets, where in turn

[3] The term "geographically short (or long)" refers to the relative distance between the farm and the retailer, and "intermediationally short (or long)" refers to the number of actors or steps the rice goes through from the farmer to the consumer.

the rice was bought by wholesalers from cities. The rice was then sold to semi-wholesalers (who sold to retailers) and/or traditional retailers.

(3) The intermediate (or transitional) rice value chain, which was "geographically long and intermediationally medium," entailed the rice farmer selling paddy directly to mills, which then (a) sold rice to city wholesale market traders, or (b) sold paddy to rural or city wholesale market traders who had it milled and then sold the rice on the city wholesale market. At the city wholesale market, traditional retailers bought the rice directly.

(4) The modern rice value chain was "geographically long and intermediationally short," with the rice farmer selling directly to mills, which then sold to supermarkets and/or urban wholesale markets to sell on to supermarkets and traditional urban retailers.

Part B of the book shows that in the Bangladesh study value chain (Noagoan to Dhaka), the rural–urban traditional value chain still dominated, but the intermediate (or transitional) value chain was emerging quickly, due to direct sales to mills. In the Heilongjiang study, the intermediate (or transitional) and modern value chains dominated. In the Shahjahanpur–Delhi study, the intermediate (or transitional) value chain strongly dominated, with the continued use of village traders and rural wholesale markets upstream, but direct sale from mills to urban traders downstream. The most traditional value chain no longer had a significant presence (in fact, it had a very minor presence) in any of the study zones. Only in the PRC had the modern value chain emerged in a significant way.

Second, rice farmers had a substantial marketed surplus rate in all three zones studied.[4] In Bangladesh, while paddy output had more than doubled since the 1960s, the marketed surplus rate had increased by a factor of six or more, from 12% in the 1960s to 49% in the 1990s (Chowdhury and Haggblade 2000). Nationally, while about one-third of rural households were net sellers of rice, a large number of farmers also sold paddy at harvest and then bought rice at some point of the year (Klytchnikova and Diop 2006).

In India in general and in the study state of Uttar Pradesh in particular, paddy was primarily a commercialized crop. Uttar Pradesh's marketed surplus rate was 63% in CY1988/89 and 80% in CY2006/07, with the latter similar to India as a whole (Government of India 2009a).

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[4] The marketed surplus rate is sales divided by output.

Third, market integration appeared to be advanced. In Bangladesh, since the 1980s, food grain markets had become well integrated over time and space (Ravallion 1985, Goletti 1993, Dawson and Dey 2002, and Murshid et al. 2009). The integration may have been driven by major investments in road infrastructure. Wider availability of mobile phones may have helped. There also seemed to be little collusion between traders to fix prices, except during short periods (Chowdhury and Haggblade 2000, Goodland 2001).

In the PRC, Huang and Wang (2001) showed that rice markets were increasingly integrated. The difference in prices among regions was much lower in the late 1990s than in the mid-1990s. Part of the decline in price differences among markets may also have been due to falling transaction costs resulting from improved infrastructure and an increasingly competitive transport industry (especially in trucking). The majority of the PRC's rice (in fact, about 70% or more) was moved by truck. This was a big change in the PRC's rice economy, where most rice used to be moved by train and ship or boat.

In India, there was evidence that rice markets were regionally integrated (Ghosh 2000), but also that integration was imperfect across regions (Jha, Murthy, and Sharma 2005), with the imperfection ascribed to heavy government intervention in the rice market. Yet Ghosh (2011) found that rice market integration had improved markedly between the premarket liberalization period (before 1991) and the reform period (after 1991 and into the 2000s).

Fourth, in the rice milling segment, there had been an expansion followed by technological change and concentration during the last several decades in the three economies studied. This change is indicated in several reports, although little research has been done on it.

In Bangladesh, the hitherto ubiquitous hand pounding of paddy was being displaced by milling. In the initial phase of change, from the 1960s through the 1990s, the number of mills increased rapidly, from 6,155 in the 1960s to 50,868 in the 1990s. The scale and technology of the mills changed somewhat during that period: In the 1960s, no paddy was milled in large mills, but by the 1990s, about 15% of it was processed in large mills (automatic and "major" mills) and the rest was milled by small huller mills (Chowdhury and Haggblade 2000). In the second phase, during the 2000s, the larger mills were beginning to displace the small ones. Murshid (2011) noted that from 1990 to 2009 the number of automatic and semi-automatic larger mills rose quickly, rapidly displacing small mills. In some districts, the process had proceeded far by 2009; for example, in Noakhali in Chittagong Division, large mills accounted for more than 90% of all milling.

In the PRC, most paddy used to be processed in its approximately 100,000 town-level mills (McKee 2010), but in the last decade in particular, paddy milling in large mills had increased rapidly. Examples of companies with large mills include the PRC's China Oil and Food Corporation (COFCO) and the Singaporean Wilmar International. In 2003, about 74% of mills were owned by the private sector and 26% by the public sector. By 2011, corporations with large mills milled an estimated 20%–25% of the PRC's rice.

Most village mills with capacities of 5–10 t/day had closed during 2003–2008. The remaining mills had a capacity of 50–200 t/day. In 2007, the PRC had about 7,600 milling companies, 5.1% fewer than in 2008, but the number of mills with capacities exceeding 400 t/day had increased from 81 in 2007 to 115 in 2008 (He and Wen 2009).

In India, the mill sector's trends were similar to those noted above. Rice milling was fully in the private sector domain. Until 1996, rice milling was reserved by law for small-scale operators. But in 1997, the Rice Milling Industry (Regulation) Act of 1958 and Rice Milling Industry (Regulation and Licensing) Rules of 1959 were repealed, thereby allowing medium and large companies to enter the business. This quickly led to substantial technological modernization in milling, as hand pounding was replaced by hulling and shelling machines, and small mills were displaced by medium and large ones.

By 2003, 50% of India's rice was milled using modern technology (i.e., hullers with disc shellers, equivalent to automatic, and rubber rollers, equivalent to "semi-automatic"); 40% was processed using single hullers (small mills, which produce for farmers' domestic consumption); and 10% was hand pounded, mainly for home consumption (Government of India 2003).

## Direct and Indirect Government Roles in the Rice Value Chain

The government's direct role in rice markets was in general limited, although it was greater in India than in Bangladesh or the PRC.

In Bangladesh, the public sector's role in food grain markets had declined significantly over time. Private food grain imports were legalized in 1993, and by 2007/08 the government had only a 9% share in grain imports. The share of government purchases in total rice output declined from 4% at the end of the 1980s to 2% in 2007/08 (Chowdhury 2010).

The PRC government discontinued its rice shops in the early 1990s and limited itself in the 2000s to purchases in order to stock public reserves. In 2008, the government purchased 7.5 million tons (4% of national output) of rice for public stockpiling for price stabilization; these stocks were then sold to private traders. The government set an indicative floor price but did not have strict enforcement mechanisms in place so that prices tended to fluctuate around the floor price.

In India, the government was much more involved directly in the rice market than in the other two economies, and, contrary to the trend elsewhere in Asia, that involvement was rising (Rashid, Cummings, and Gulati 2007). The Government of India bought 15.8% of rice output in CY1996/97, 25.1% in CY2000/01, and 29.5% in CY2007/08. The government undertook these purchases by mandating that mills in certain states (such as in the study state, Uttar Pradesh) sell part of their rice to the central government. The government then sold this rice to consumers, mostly via the Public Distribution System in rural and urban areas. Moreover, the government declared minimum support prices, but, as in the PRC, the government did not have a mechanism to strictly enforce the prices so de facto they were merely indicative, and there is evidence that traders frequently did not adhere to the required prices.

All three economies' governments had, however, a substantial role in the rice market. That role consisted of selling subsidized seed and fertilizer to farmers; providing some subsidized credit; providing public extension services; and, in the PRC, giving direct subsidies to farmers. The expenditures for these items were significant parts of government budgets for agriculture. However, the survey found in all zones that the share of subsidized inputs bought from government stores was in general a minor share of farmers' total input purchases.

## Potatoes in Bangladesh, the People's Republic of China, and India

This section presents the context of general trends in potato trade, consumption, and production in the economies studied.

### Potato Imports and Exports

In all three economies, very little potato was imported or exported. Bangladesh exported about 0.2% of its potato production, and it imported none; the PRC imported 2% of its consumption, and exported 1% of its output (Scott and Suarez 2012). India imported less than 1% of its potato consumption and exported less than 1% of its domestic output. For simplicity, the analysis in the study focused on the domestic market.

## Potato Consumption and Production

Potatoes are an important basic food, and the leading nongrain food in Bangladesh, the PRC, and India. The PRC consumed 32 kg of potatoes per capita per year; Bangladesh, 23 kg; and India, 15 kg. Potatoes attained their leading rank among vegetables only recently in South Asia, especially in the last several decades as incomes had been rising substantially. Potatoes were consumed mainly as a vegetable accompanying a rice or wheat base, and were generally considered a "luxury staple" (Bouis and Scott 1996), with fairly high income elasticities in South Asia and moderate but positive income elasticity in the PRC. Thus, potatoes were a "normal good" in all three economies (not an "inferior good" whose demand declines with income, as occurs with the potato in the United States and Western Europe). Moreover, the ratio of the potato to rice calorie price in 2010 was an estimated 4.0/1.0 in Bangladesh, 3.2/1.0 in the PRC, and 7.0/1.0 in India. Thus, it was thus much more expensive for consumers to obtain their energy needs from potatoes than from rice; instead potatoes served as a source of diet diversity, vitamins, and taste variety.

In Bangladesh, potatoes were also by far the leading vegetable and a main food product. While the country produced 49.0 million tons of rice in 2010, potatoes ranked second (among all crops), with 7.9 million tons; other fresh and/or leafy vegetables together were a distant third, at 1.4 million tons. This ascendance of potato was much more abrupt and recent than in the PRC (discussed below): potato output was only 0.3 million tons in Bangladesh in 1961; it edged up to 0.9, 1.1, and 2.9 million tons in 1980, 1990, and 2000, respectively, and then abruptly surged to 7.9 million in 2010—a 26-fold increase in total (and a 10-fold per capita increase) in 5 decades. Thus, much of the growth was only in the last decade.

In Bangladesh, moreover, potatoes had an elasticity of demand with respect to income, ranging from 0.87 among the wealthiest urban quartile to 1.17 among the poorest urban quartile, and 1.02 among the wealthiest rural quartile to 1.67 among the poorest rural quartile (Bouis and Scott 1996), based on 1973/74 data (not updated since). These high income elasticities (and high calorie prices relative to rice) led Bouis and Scott to call potatoes a "luxury staple" in Bangladesh. Ahmed and Shams (1994) used rural survey data from 1991/92 and found a total-expenditure elasticity for potato of 1.15, also very elastic (compared with 0.68 for rice). These figures again, as in the PRC, suggest that with growing incomes, potato consumption will continue to increase.

In the PRC, the world's leading producer of potatoes since 1993 (Wang and Zhang 2010), potatoes were by far the leading vegetable, and a main food product. In 2010, the PRC grew 75 million tons of potatoes on 5.1 million ha, well above any other single vegetable category (tomatoes ranked second at 42 million tons and cucumbers third at 41 million tons). Fresh leafy vegetables (apart from cabbage, which is reported separately by FAOSTAT) together constituted 133 million tons. The potato figures can be compared with the PRC's production of 197 million tons of rice and 115 million tons of wheat (FAOSTAT 2012). Potato output was only 13 million tons in 1961, growing to 26 million in 1970, 32 million in 1990, 66 million in 2000, and then soaring to 72 million in 2007—a sixfold increase in total (and a threefold increase in per capita terms) in 5 decades. The increase of the PRC's potato production was the motor of world potato production growth: 70% of the world's increase in potato output from the 1960s through the 2000s was because the PRC added 50 million tons to its annual output of potato.

In the PRC, only 11% of potatoes were consumed as processed (Scott and Suarez 2012), and merely 10% as feed, 4% as seed, and 6% as waste, so that fully 69% of potato output was consumed as fresh (not processed) potatoes. While potatoes are an important food and vitamin source, they constituted only 2.2% of calories consumed in the PRC, compared with 27% for rice and 20% for wheat (Scott and Suarez 2012). Moreover, potatoes had an elasticity of demand with respect to total expenditure (as a proxy for income) of 0.2 (higher than for sweet potatoes), using 2000 data (Wang and Zhang 2010). Thus, potatoes are a normal good, so that their consumption is slated to continue to increase as incomes continue to rise in the PRC (but at a slower rate than in Bangladesh).

In India, as in Bangladesh and the PRC, potatoes were the leading vegetable, at 38.6 million tons (half the PRC figure) in 2010, compared with 35.0 million tons of green vegetables taken as a group (a quarter of the PRC figure), and 120.0 million and 81.0 million for rice and wheat output, respectively. But the leading position of potatoes was very recent; potato output was only 2.7 million tons in 1961, 3.9 million tons in 1970, 8.0 million tons in 1980, 15.0 million tons in 1990, 25.0 million tons in 2000, and 38.6 million tons in 2010—a 14-fold increase in 5 decades (and a 5.6-fold increase in per capita terms).

As with Bangladesh, in India the surge in potato's position was recent—potato became the leading vegetable only in the mid-2000s, and much of the growth was in the last 20 years (adding 4 million t/year to the average during 1961–1980, and then adding 29 million t/year to the average during 1980–1961). Potatoes were a fifth of the tonnage of vegetables in 1961, and slightly more than that in 2010. In India, the increase of potato output and diversification of the diet roughly tracked income growth. Data from the

Household Income and Expenditure Surveys illustrate how per capita potato consumption was changing over time. During 1973/74–2004/05, the annual per capita consumption increased sixfold in rural areas, from 3.4 kg to 22.9 kg, and fourfold in urban areas, from 6.5 kg to 24.8 kg. Apart from use as seed, almost all (95% of) potatoes were consumed fresh, and the remaining 5% were processed (as chips, french fries, etc.). Potato consumption was ubiquitous in India—92% of people ate potatoes. During 1987/88–2004/05, per capita consumption rose by 7%, from 14 kg to 15 kg (Government of India 1988, 2005).

## Potato Yields and Production Geography

First, yields showed very strong growth in all three zones studied, but the volumes varied greatly. Potato is a seasonal crop, with one growing season in all three zones. According to FAOSTAT,[5] Bangladesh's average yields were 10 t/ha at the end of the 1980s and 15 t/ha by the end of the 2000s. During 1982–2009, the PRC's yields increased steadily, from 10 t/ha to 15 t/ha. In India, potato yields were 16 t/ha in 1989 and 19 t/ha in 2009 (CPRI Potato Statistics online).

Second, potato production varied significantly geographically across the three economies. In Bangladesh, potato production was distributed widely, but was concentrated in the northwest (including the area studied) and the center–east around Dhaka and in Comilla (World Food Programme n.d.). In the PRC, potatoes were primarily grown in the cool mountains and high altitude areas in Gansu (the study province), Guizhou, Heilongjiang, Inner Mongolia, Jilin, Shanxi, Sichuan, and Yunnan. In India, 87% of potatoes were grown in the northern Indo-Gangetic Plain; two states in the Plain accounted for the lion's share of India's potatoes, 35% from just Uttar Pradesh (the study state), a huge state with roughly 180 million people, and 24% from West Bengal.

## Potato Value Chains and Markets

First, in general, four types of potato value chains were evident in the studied areas (from Bogra to Dhaka, Gansu to Beijing, and Agra to Delhi):

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[5] The following FAOSTAT yield data are for a single season.

(1) The most traditional potato value chain, which was "geographically short and intermediationally short," was the local supply chain of potato from the farmer that was sold fresh at harvest or, within a few months and after traditional on-farm storage, to the local village market for local consumption.

(2) The rural–urban traditional potato value chain, which was "geographically long and intermediationally long," included selling potatoes fresh at harvest or, after a few months of traditional on-farm storage, to local brokers (village traders) who then sold the potatoes to rural wholesale markets where wholesalers from cities bought the potatoes, then resold them to semi-wholesalers (who in turn sold to retailers) and/or traditional retailers.

(3) The intermediate (or transitional) potato value chain, which was "geographically long," featured the potato farmer selling both fresh at harvest and after storage in modern cold storage facilities (CSFs) directly to city wholesale market traders.

(4) The modern potato value chain, which was "geographically long and intermediationally short," featured the potato farmer selling both fresh at harvest and after modern cold storage directly to processing firms or supermarkets.

Part C of the book shows that, in the Bangladesh study (Bogra to Dhaka), the rural–urban traditional value chain still predominated, but the intermediate or transitional value chain was emerging quickly (due to the increase of modern CSFs) and was already important. In the Gansu study, the rural–urban traditional value chain still dominated, with little modern cold storage. In the Agra–Delhi study, the intermediate (or transitional) value chain strongly predominated, after the rapid development of modern CSFs in the last decade. The most traditional value chain no longer had a significant presence (in fact it was very minor) in any of the study areas, nor had the fully modern value chain emerged in a significant way.

Second, in all the zones, potato was both a major food crop and a major cash crop. Potato farmers had a substantial marketed surplus rate (sales divided by output) in the study areas. In Bangladesh, this has been estimated at 85%–90% (in early studies, such as Scott 1988, and in later work, such as Huq, Alam, and Akhter 2005). In India, government statistics show the marketed surplus rate of potato was 78% in CY1988/89, averaged 72% during 1999–2002, and then rose to 82% in CY2008/09 (Government of India 1989, 2002, 2009a).

Third, cold storage had expanded in the last several decades in the study zones. In Bangladesh, CSFs had a total capacity of 3.6 million tons as of 2012 (*Financial Express* 2012), which could handle roughly 30% of the country's potato crop. Interestingly, this is the same share noted by Scott (1988) several decades earlier. Hence, cold storage capacity had kept pace with the rapid increase of potatoes grown. In India, CSFs had a capacity as of 2012 of 21 million tons (*Economics Times* 2012). In 2009, 91% of the CSFs were in the private sector (and together had 96% of total capacity of storage in tonnage); 7% of the CSFs were in the cooperative (government organized) sector (and these CSFs had 3% of the country's total capacity in tonnage terms); and 2% of the CSFs were in the public sector (with 1% of the country's total capacity). Of the country's total CSFs, 75% stored potatoes (Government of India 2009b).

Fourth, there is evidence of at least partial market integration in potato markets, although little research has been done on this in the zones studied for this book. For example in India, Basu and Dinda (2003) analyzed the market integration of wholesale and retail markets in a district in West Bengal during 1998–2000 and found cointegration. Shivaraya and Hugar (2002) studied the integration of onion and potato markets in northern Karnataka and found market integration for potatoes.

## Direct and Indirect Government Roles in the Potato Value Chain

The governments in the three economies studied had not directly intervened in the domestic potato markets, or set or recommended prices, in general. Occasional exceptions to this generality have occurred, such as recently when the state government of West Bengal declared that potatoes should not be exported from the state to foreign countries (mainly to Bangladesh), to quell a price surge (*Financial Express* 2012).

Governments were engaged indirectly through some direct subsidies and sale of subsidized inputs (as noted in the rice section), as well as partial subsidies for electricity and for cold storage construction. In India for example, during 2008–2011, the government spent $124 million on cold storage subsidies to increase capacity (*Economic Times* 2012).

# Study Areas, Survey Methods, and Sampling Framework

## Study Areas

All but one of the six study zones were major rice or potato production areas that were the closest to and main suppliers of capital cities; they were thus representative of the commercial agriculture zones in the market catchment areas of the three economies' large cities. Those catchment areas constitute an important share of the overall rural area; the authors estimate that share at roughly half of the rural areas in the study economies. Bogra and Noagoan districts in Bangladesh are both about 200 kilometers (km) from Dhaka and are major suppliers to Dhaka of potatoes (Bogra) and rice (Noagoan). Shahjahanpur District in central Uttar Pradesh, the rural starting point of a main rice value chain to Delhi, was a major supplier to Delhi and is among the closest rice areas (at 375 km from Delhi). Agra in western Uttar Pradesh was Delhi's closest major potato supplier (at 200 km), and produced a quarter of India's potatoes. In the PRC, Jiamusi in Heilongjiang was selected as the starting point for the rice value chain to Beijing. Jiamusi is 1,360 km from the capital. Heilongjiang is the closest and foremost supplier of rice to Beijing, and is representative of the northeast region, which supplies the great majority of rice to Beijing. The outlier among the six zones is Gansu, the potato production area studied in the PRC. Gansu is about 1,100 km from Beijing, which is further from Beijing than its other major potato-supplying areas (Hebei, Inner Mongolia, and Shanxi).

## Survey and Sampling Methods

First, "rapid reconnaissance" studies were done for each of the six value chains (one for rice and one for potato in each economy). This consisted of interviews with representative types of actors in each segment of each value chain, plus academics, policy makers, and private sector associations. The literature pertaining to rice and potatoes in each economy was also reviewed.

Moreover, and importantly, the survey data eventually were found to contradict many of the assertions of the key informants, whom the authors found were repeating "conventional wisdom" and partial perceptions. A striking example is that, although many experts and key informants noted that "tied credit" (trader's credit to farmers in return for a guarantee that the farmer would provide the crop to the trader) was still very common, the surveys showed it was actually very uncommon in the zones studied. Thus, surveys are essential to provide a good base for policy-making information.

Second, based on the broad picture emerging from the rapid reconnaissance, detailed structured questionnaires were formulated. These questionnaires were pretested and then modified about half a dozen times prior to the actual survey. They were then administered in surveys by enumerators who read the questions individually to respondents and noted the responses. No government officials or other people accompanied the interviewers, so no outside influence was introduced into the interviews.

Third, samples were tested in the rural and urban areas of each zone. This gave rise to a sample of about 3,500 farmers, traders, mills, CSFs, and traditional and modern retailers in the three economies on which this book focuses. The details of the sampling methods and samples are presented in the Appendix to this chapter. In general the study used a stratified random sampling method for every segment: the authors typically stratified by geographic area using reasoned sampling (based on the quantitative importance of the zone for supply to the capital cities, and then the choice of villages and markets in the zones based on their quantitative importance in supply). Then the authors generally sampled randomly within a given universe; in some cases, where there was a highly unequal set of actors, they were further stratified by category, such as smaller and larger farmers in the Indian and Bangladesh potato and rice areas; however, in the analysis, the shares of these groups were weighted in the population (as discerned by the study's census of each area) so that the reported figures are unbiased and representative.

The authors call the method used the "stacked survey method," as it entails a full sample survey at every level of the value chain. Thus, the method can be used to statistically study differences across actor scales for each segment (each stage being represented by sets of actors, such as farmers, processors, and traders) of the value chain. Some of the surveys of specific segments are unique or have rarely been done, such as the surveys of postharvest segments, mills, CSFs, traders, and (especially) of traditional retailers and supermarkets. No comparable survey-based study of staples value chains in Asia is evident in the literature.

In addition, the data were collected mainly in 2009 and the first half of 2010 using questionnaires that asked the interviewees to recall information over the year before the survey. For several key variables, a 5- or 10-year recall was also requested, but in general the survey's questions are for the year before the survey was administered. Thus the viewpoint is mainly a snapshot of short-term change and cross-section comparisons.

The survey questionnaires in general asked the actors four categories of questions:

(1) characteristics of the actor, in particular, the types of assets held (human capital such as education; social and organizational capital such as membership in associations and cooperatives; and physical capital such as holdings of equipment, land, and vehicles);

(2) purchase of factor inputs (labor and external nonlabor inputs such as fertilizer and fuel) and intermediate inputs (such as the inventory bought by a trader), in terms of costs, geographic origins, supplier types, value-chain finance, quality attributes, and any contractual relations;

(3) value addition using the inputs plus technology to produce outputs, such as production of rice and potatoes, delivery and marketing of products, cold storage, and so on; and

(4) marketing of the outputs (in terms of prices received, geographic destinations, and buyer types, as well as value-chain finance, quality attributes, contractual relations, and labeling/branding).

## Appendix: Details of the Sampling Framework

**Rice in Bangladesh.** The Bangladesh rice farmers and villages were surveyed in November–December 2009. Noagoan was selected for the survey in rural areas as it is an important rice-producing district. The district is about 200 kilometers (km) north of Dhaka.

The village and household survey was set up as follows. For rice farm households, the two most important rice-producing counties (*thana*) in Noagoan were selected. In each county, 5 villages were randomly selected from three village strata—2 from high-producing, 2 from medium-producing, and 1 from low-producing villages. In each selected village, a village questionnaire was implemented.

In each village, a census of households was conducted to enumerate the paddy producers. Using the census questionnaire, all the households in the village were listed. Each household was asked questions about its total land cultivated and about rice cultivation in particular. In each of 10 villages, 22 households were then randomly selected (for a total of 220), half from the largest farm group and half from the smallest, to reflect their relative importance in the rice value chain.

To sample the rural rice mills, a list of all the millers in Noagoan District was obtained. A stratified random selection of 20 millers was done, consisting of 8 automatic, 5 semi-automatic, and 7 small mills. Small mills typically first parboil paddy and then spread it to dry in the open air. After drying, the paddy is transferred to be milled by small Engleberg friction dehullers that remove the husk and polish the rice, all in one unit (Chowdhury and Haggblade 2000). Semi-automatic mills have larger huller and rubber rolls (Rahman 2004). Large-scale automatic mills emerged in the 1980s, financed largely by international financial institutions. These mills integrate steam-pressure parboiling, mechanical forced-air dryers, rubber roller shellers, and polishing machines in a single conveyer-driven, flow-through facility (Chowdhury and Haggblade 2000). In 2006/07, Bangladesh had 13,329 small, 109 semi-automatic, and 141 automatic rice mills, accounting for 550,204 tons, 8,595 tons, and 22,827 tons of milling capacity, respectively (FPMU 2009).

In the paddy and rice wholesaler survey, first the 17 village and other rural off-wholesale market traders that the households in that village or other traders sold to were interviewed. Second, 43 traders were interviewed from the local rural wholesale market in the selected district. Third, 30 urban wholesale traders were interviewed in Dhaka, half each in Badamtoli and Krishi markets, the city’s two most important rice wholesale markets.

A sample of traditional and modern rice retailers in urban Bangladesh (Dhaka) was surveyed in November–December 2009. First, 5 districts were randomly selected in different parts of Dhaka (north, east, west, south, and central). In each, a census was done of all markets, and two were randomly selected. At each market, a census of all rice retailers was taken, and 12 traders were then randomly selected and interviewed. A total of 120 traditional retailers were thus interviewed. Second, 20 modern retailers were surveyed. In each district selected for the traditional retail survey, a census of modern retail shops was conducted, and 4 were randomly selected and surveyed regarding their rice prices.

**Potato in Bangladesh.** Samples of potato farmers and traders in Bogra and of district retailers in Dhaka were used for the Bangladesh survey. Bogra district was selected for the rural areas as it is an important potato-producing district. Bogra is about 200 km north of Dhaka.

The village and household survey for potato was conducted in the same way as the village and household survey for rice. For the rural sample of potato cold storages, 20 cold storage facilities (CSFs) were selected from a list of all CSFs in Bogra.

For the wholesaler survey, first, 30 village traders and other rural off-wholesale market traders that the households in that village or other traders sold to were interviewed. Second, 30 traders were interviewed from the rural wholesale market in Bogra. Third, 30 urban wholesale traders were interviewed in Dhaka—15 in Shyam Bazar and 15 in Kawran Bazar, the two most important potato wholesale markets in the city.

The urban potato retail survey in Dhaka was conducted in the same manner as the urban rice retail survey.

**Rice in the People's Republic of China (PRC).** The PRC sample of rice farmers and villages was surveyed in May–June 2010. Heilongjiang was chosen as representative of the northeast provinces, which grow most of the rice that provisions Beijing. Jiamusi Prefecture in Heilongjiang was chosen because it is the largest japonica-producing district in the PRC (providing about 28% of the PRC's japonica) and the dominant source of japonica to Beijing. Moreover, wholesalers in Beijing indicated that Jiamusi is one of the main areas supplying rice to Beijing.

From Jiamusi Prefecture, a list of its 6 counties and their total rice area was obtained. From the 6 counties, 2 were randomly selected: Huachuan and Huanan. From the 12 townships in Huachuan and 19 in Huanan, 1 township was chosen randomly per county: Chuangye in Huachuan and Lishu in Huanan. From the 10 villages in Chuangye and 20 villages in Lishu, 5 were chosen at random in each township. With the help of each village government, all households in the village were listed. Then 25 households were randomly selected in each village, for a total sample of 250 households.

The village surveys indicated about 1–2 mills per village, and thus all 15 mills in the sampled villages were selected for the survey. They were small-scale mills. The 5 town or county mills chosen as representative were in the nearest town or county seat and were mainly medium- or large-scale mills.

As the village surveys indicated that there was about one trader per village, all 10 village traders were selected. However, Jiamusi Prefecture no longer had a wholesale market for rice. A key informant said this was because the mills tended to sell directly to wholesale markets in other cities and to retailers in their city (the study could not test this hypothesis). As a substitute, three of the four wholesalers in the area where the market used to be were surveyed.

For the Beijing trader survey, 30 traders were selected at the Shenghuahonglin and Jinxiudadi wholesale markets, the two largest rice wholesale markets in Beijing. Shenghuahonglin had about twice as many wholesalers as Jinxiudadi, so 20 wholesalers were chosen randomly from about 400 at Shenghuahonglin and 10 from about 200 at Jinxiudadi.

For the urban rice supermarket survey in Beijing, modern retailers from four selected districts (Chaoyang, Fengtai, Haidian, and "central" district) were sampled. In each of the four districts, 15 supermarkets were selected. In total, 60 supermarkets were sampled: 35 from lists of stores in the PRC's 20 leading chains and 25 from among other (smaller) chains and independent supermarkets. The list of 803 supermarkets in the Beijing metropolitan area in 2010 was supplied by the China Chain Store Association.

**Potato in the PRC.** The PRC sample of potato farmers and villages was surveyed in July 2010. For the sample, Dingxi Prefecture was chosen in Gansu Province. Gansu was chosen because it is the largest potato-producing province in the PRC (growing about 15% of the PRC's potatoes). Wholesalers in Beijing noted that Dingxi is a supplier to Beijing. The Dingxi government provided a list of the prefecture's 7 counties and their total potato areas. From the 7 counties, 2 were chosen at random: Anding and Weiyuan. Four townships were then randomly selected for the study: Chankou and Qinglanshanin from among Anding County's 19 townships, and Beizhai and Da'anin from among Weiyuan's 16 townships. Then, 2 villages were selected at random per township. Finally, based on a list of potato-growing households in each sample village, 40 households were chosen at random, giving a total of 320 households selected and surveyed.

Rural cold storages were not covered separately in Gansu, as they were either owned by traders and thus formed part of the trader interviews, or by the farm households.

As the village surveys showed that each village had about 2 traders, all 17 were selected for the survey. In addition, 10 traders on the Dingxi potato wholesale market were chosen from a list of the market's wholesalers.

For Beijing, Xinfadi and Jinxiudadi—the two top wholesale markets—were surveyed. As the number of potato wholesalers at Xinfadi was about twice that at Jinxiudadi, 20 potato wholesalers were surveyed at random from about 100 in Xinfadi and 10 wholesalers from about 50 in Jinxiudadi.

The PRC urban potato traditional and modern retail surveys used the same four districts as for rice. From district lists of wet markets, 22 were selected across the four districts. The number of wet markets varied among districts, so the number chosen was roughly proportional to wet markets in the district. In each wet market, five retailers, chosen randomly from the total, were surveyed. The modern retail outlets used in the potato retail survey were the same as those used in the rice survey.

**Rice in India.** The sample survey of Indian rice farmers and villages was conducted in September–October 2009. The state of Uttar Pradesh was chosen as a main rice-producing state supplying the Delhi market; the district of Shahjahanpur (in west–central Uttar Pradesh) was chosen because it was the nearest to Delhi and thus was comparable to the rice regions chosen in Bangladesh and the PRC in being a major rice-growing area near the capital city. The Uttar Pradesh Ministry of Agriculture provided a list of the four subdistricts (*tehsils*) and their total rice area. From the four subdistricts, the three with the largest rice area (Jalalabad, Powayan, and Tilhar) were chosen for the survey. The subdistricts' offices provided, for all their villages, data on cropping patterns and land use in the main rice season, the rainy or *kharif* season. On the basis of the data, the villages were categorized as high-, low-, and medium-density villages, depending on the share of area cultivated for rice in the subdistrict's total farmland. A subdistrict with less than 10% of its total farmland under rice cultivation was categorized as low density, 10%–20% as medium density, and more than 20% as high density. For each of the three subdistricts, 5 villages were chosen: 2 randomly from the high-density, 2 from the medium-density, and 1 from the low-density villages, for a total of 15 villages per subdistrict.

In each selected village, a census of households was conducted. Using the census questionnaire, all the farm households in the village were listed. Each household was questioned about its total land cultivated and land under rice cultivation. Eighteen households were selected in each village, giving a total of 270 households surveyed. To select households, first, they were ranked in descending order by their land size. Then, 7 households were randomly selected per village from farms that together cultivated more than 50% of the village's total cultivated area, and 8 households were chosen from the rest. The statistical results report both sample averages and population-weighted results, using the population weights from the census.

In Shahjahanpur District, 25 mills were sampled randomly by size (milling capacity) strata. The sample was drawn from a list of 65 registered mills (the district total) provided by the Uttar Pradesh government. The list showed the milling capacity of each mill and whether it was automatic or semi-automatic. The mills were ranked for the study in descending order by milling capacity. Then 8 were randomly selected (with some attrition due to mills that were not traceable or willing to respond) from the mills that constituted less than 50% of the total milling capacity in the district and 17 from those constituting more than 50% of the total. It turned out that the 8 mills in the lower stratum were automatic, while the 17 in the upper stratum were semi-automatic.

As the village surveys indicated that each village had about one paddy trader, all 15 villages' paddy traders were surveyed. To survey the rural wholesalers in the subdistricts, a list of wholesale markets for grains was obtained through information from farmers, village traders, and the subdistrict offices. Then, the subdistrict government provided the list of rice traders in each wholesale market. All 42 rice traders in the rural wholesale markets were surveyed—23 paddy and 19 milled-rice traders. Of the total, 13 paddy and 11 rice traders were in Shahjahanpur Mandi (the main wholesale market in Shahjahanpur District), 5 paddy and 4 rice traders were in Jalalabad Mandi, and the same numbers were in Tilhar Mandi.

For the rice traders in Delhi, the sample was taken in Naya Bazar wholesale market, the main rice market in Delhi. The sample included 23 wholesalers chosen randomly. (There was some attrition due to unwillingness to respond, but there was no discernible bias in trader size related to the unresponsiveness.) In addition, 10 semi-wholesalers (who bought rice from Naya Bazar wholesalers and sold to small shops elsewhere in Delhi) were surveyed. The names and addresses of the semi-wholesalers were collected from the traditional retailers surveyed.

For the India urban rice and potato traditional retail survey in Delhi, surveys were conducted in March 2009; the following distills the sampling method discussed in Minten, Reardon, and Sutradhar (2010). Delhi is divided into 12 zones and a total of 272 wards. Each ward contains several colonies (the smallest urban geographical unit). For this study's sample, one ward was randomly selected in each of Delhi's 12 zones.

Two types of surveys were implemented in each selected ward. First, a census of food retail outlets was conducted. If a ward had fewer than 10 colonies, all were covered in the census exercise; if a ward had more than 10 colonies, 10 were randomly selected within the chosen ward. A census was taken of all operating private modern retail outlets and wet markets where one of the two products was sold. Within the 10 colonies, 5 were then randomly selected. Within the 5, a census was conducted of all the other retail outlets—pushcarts, Safal outlets (a cooperative chain), Fair Price Shops, and small-scale (*kirana*) shops—that sold any of the two products covered.

The retailers were then surveyed—focusing on their retailing practices for the selected products, the prices they charged, and relevant quality questions. The survey focused on the only two types of rice retailers: private modern retailers and small shops. All modern retail outlets in the 10 colonies were surveyed for the two products. Four small shops and one retail outlet were randomly selected and interviewed in each of the five selected colonies. In all, per ward and per product, 20 traditional retailers, 10 consumers, 1 Safal outlet, and all private modern retailers were covered (for a maximum of 10 colonies). This survey was conducted from 16 February to 19 March 2009. At the end of March and the beginning of April, a second smaller survey was conducted in 6 of the 12 selected wards, wherein randomly selected retailers in each category were asked about their turnover the day before. During this second round, all Fair Price Shops were visited in the five selected colonies of each ward during regular opening hours. Whether the shop was open was noted, and, if it was, rice qualities were recorded. Additional information on the structural characteristics of the modern retail stores was also collected during this survey.

In all, for the retail survey for rice and potatoes, 561 pushcart retailers, 518 wet market retailers, and 650 small-scale (*kirana*) shop owners were interviewed, and 674 consumer exit interviews were conducted.

**Potato in India.** The sample of Indian potato farmers and villages was selected for a survey in September–October 2009. Uttar Pradesh was chosen as the main potato-producing state supplying the Delhi market. Agra district was chosen because it was the major potato district nearest Delhi, and the largest potato-producing district in India (supplying about 25% of the country's potatoes). Wholesalers in Delhi noted that Agra was a main supplier to Delhi. The Uttar Pradesh government provided a list of Agra's five subdistricts and their total potato-growing area. From the five, the three with the largest potato-growing area were selected—Etmadpur, Fatehabad, and Sadar. For each subdistrict, data for cropping patterns and land use for the winter–spring (*rabi*) season (when most of the potato crop is grown) were obtained from subdistrict offices for all their villages. Based on the data, villages were categorized as high, low, and medium density, depending on their share of potato-growing area in their total farmland (using the same area ratios as for the rice zone). From each of the 3 subdistricts, 6 villages were chosen: 3 randomly from the high-density, 2 from the medium, and 1 from the low-density strata of villages, for a total of 18.

In each selected village, a census of households was conducted. Using the census questionnaire, each household in the village was asked about its total land area under cultivation in general and under potato in particular. Then 15 households per village, for a total of 270 households, were selected and surveyed. To select households for the survey, they were first ranked in descending order by their land size. Then 7 households were randomly selected from farms that together cultivated more than 50% of the total area cultivated in the village, and 8 households from the rest. This was done to assure a sufficient sample to compare the medium- and small-scale farmers, as the medium-scale farmers were few in number but they grew and marketed a large share of the potatoes.

In the India potato zone, medium- to large-scale farms were disproportionately sampled to assure statistical significance in understanding their behavior in production and marketing in the potato value chain. Based on the study's census, a random sample would result in only 28% of the sample being medium and large farms, although they dominated the value chain with 65% of the farmland (correlated with their dominance in potato). Thus, 53% of the sample was selected to be medium or large farms (with more than 4 hectares [ha]); 19% to be semi-medium (2 to less than 4 ha), versus 33% in the census; and 28% to be marginal or small (less than 2 ha), versus 39% in the census. From the perspective of farmland distribution and thus volume incidence in the value chain, medium–large, and semi-medium farmers are somewhat underrepresented and marginal–small farmers are overrepresented. In the tables in the book, the sample averages are provided; in the base report, the population-weighted averages are also presented, correcting for the overrepresentation of larger farms from the sampling by calculating the average with weights for the strata calculated from each stratum's actual weights in the population. In the great majority of cases, the unweighted and weighted strata averages for the behaviors studied are very close; thus, for simplicity, the latter are not presented in addition to the former in this book.

For the rural sample of potato CSFs, in Agra District, size (capacity) strata were sampled from a list of 182 registered CSFs (the district total) provided by the Government of Uttar Pradesh. For the survey, 9 were selected randomly from the high capacity (more than 10,000 tons), 11 from the medium capacity (7,000–10,000 tons), and 11 from the low or small capacity (less than 7,000 tons) CSFs.

For the wholesaler samples, first, as the village surveys indicated about 1 trader per village, all 18 villages' traders were surveyed. For the 68 traders on the rural wholesale markets in the subdistricts, the list of wholesale markets was compiled from farmers, village traders, and the subdistrict offices. The governing body of the subdistrict provided the list of all traders, and potato sellers were selected from the list. As the number of traders in the rural wholesale markets was limited, they were all interviewed, for a total of 68 traders for the three subdistricts—37 in Sadar Bazar (the main wholesale market in Agra District, just outside Agra city), 4 in Fatehabad, 24 in Shamsabad, and 3 in Etmadpur wholesale markets.

In Delhi, 30 urban traders were sampled from the two top wholesale markets—Azadpur and Okhla. This included 20 wholesalers chosen randomly from the 50 at Azadpur and 10 wholesalers at Okhla.

The potato retail survey sample was discussed earlier, in the discussion of rice and potato retail sampling.

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# PART B
# RICE VALUE CHAIN

# 3 | Upstream—Rice Farm Transformation

In much of the policy discussion concerning food security in Asia, the reigning presumption is that, apart from a few dynamic pockets of rapid technology change and larger farms such as in the Punjab, staples farmers still essentially use traditional farming methods and are moving only gradually to modern methods. This assumes that the staples farm segment of value chains is barely engaged in factor markets, uses few inputs, sells a small portion of output, subsists on the rest, and makes few capital investments. Another assumption is that when the farmers turn to the market, they are facing at the farm gate a rapacious and exploitative rural broker—a "tied" output–credit market where the trader holds the farmers in thrall by providing credit at the start of the season and requiring that they sell their harvests to the trader at disadvantageous terms. This also assumes that the farmer sells the entire paddy crop at harvest without storing or "playing the market," leaving the gains to the trader.

In this chapter, the results of the farm household surveys of paddy in Bangladesh, the People's Republic of China (PRC), and India are assessed to ascertain the extent to which the rice farm segment still uses traditional methods, to what extent they have transformed to using new methods, and what are the key characteristics of that transformation.

## Structure of the Rice Farm Segment

### Rice Land Distribution

Regarding land size distribution, the study's findings partly support the view extant in policy circles of farm size and its distribution in Asia: that most farms are small in scale and homogeneous. Indeed, most rice farms are marginal or small: the average land area operated in the study zones was 1.1 hectares (ha) in Bangladesh (or 2.4 ha when accounting for multiple cropping on the land); 2.2 ha in the PRC (with only one season); and somewhat larger in India, at 5.4 ha (with only one season). Table 3.1 shows land area operated, including for rice and other purposes, and both rented and owned land.

### Table 3.1 Rice Farm Land: Distribution and Rental

| Land | Farm Size Strata (all arable land under any crop) | | | |
|---|---|---|---|---|
| **Bangladesh** | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **All** |
| Rice land (ha) | 0.59 | 1.63 | | 1.07 |
| Rice land (% of all arable land under any crop) | 86 | 90 | | 89 |
| Land rented-out (ha) | 0.06 | 0.24 | | 0.14 |
| Land rented-in (ha) | 0.13 | 0.16 | | 0.14 |
| Land rented-in (% of all operational land) | 19 | 9 | | 12 |
| All operational land (ha) | 0.69 | 1.81 | | 1.20 |
| **China, People's Rep. of** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Rice land (ha) | 0.87 | 1.51 | 1.59 | 1.20 |
| Rice land (% of all operational land) | 78 | 55 | 33 | 54 |
| Land rented-out (ha) | 0.07 | 0.01 | 0 | 0.04 |
| Land rented-in (ha) | 0.15 | 0.98 | 2.72 | 0.81 |
| Land rented-in (% of operational land) | 13 | 36 | 56 | 36 |
| All operational land (ha) | 1.12 | 2.73 | 4.85 | 2.23 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Rice land (ha) | 1.1 | 3.1 | 7.4 | 4.8 |
| Rice land (% of all operational land) | 92 | 89 | 88 | 89 |
| Land rented-in (ha) | 0.3 | 0.9 | 2.1 | 1.4 |
| Land rented-in (% of operational land) | 25 | 26 | 25 | 26 |
| All operational land (ha) | 1.2 | 3.5 | 8.4 | 5.4 |

ha = hectare.

However, several aspects of the current study's findings contradict the extant view, and instead show farmland size inequality and even concentration. First, while the average farm size in the study zones was small, Table 3.1 shows significant farm size variation across the zones in the three economies. Second, while all three had many marginal–small farms with less than 2 ha, the PRC and India had substantial variation in farm size across the households in the samples. Two aspects of this variation deserve emphasis.

On the one hand, there was an important jump in the farm size between the first and second strata. The second stratum was 2.3–2.9 times larger than the smallest stratum in all three economies. That means that there is substantial farm size heterogeneity among small-scale farmers, which may be underappreciated in the policy debate. In asset terms, in Bangladesh, marginal farmers (with less than 1 ha) were disadvantaged compared with even small-scale farmers (with 1 ha or more); and similarly for marginal–small farmers relative to semi-medium farmers in the PRC and India.

On the other hand, the farm size of the upper stratum in the PRC and India (at an average of 4.85 ha and 8.40 ha, respectively) exceeded the "small farm" image, especially given that they were irrigated farms. This shows that the general image of the study zones in those economies, as a set of "commercial small-scale farmers," actually included a subset of medium- and large-scale farmers. The ratios of the average total operational land size of the largest stratum to the smallest were 3:1, 4:1, and 7:1 for Bangladesh, the PRC, and India, respectively. For rice land, the ratios were approximately 3:1, 2:1, and 7:1, respectively. The rice land ratios are close to those of operational land for South Asia, because the surveyed farmers used, on average, 90% of the land for growing rice. In the PRC study zone, the inequality in land distribution was lower for rice land than for overall land, which implied that the rice land was more equally distributed than the land not used for rice. Indeed, in the PRC study zone, on average, farmers devoted only half their land area to rice—but the ratio descended steeply from 78% among the smallest to 33% in the large stratum, as larger farms were much more diversified than the smallest.

This inequality is even more interesting when viewed in output or land terms. For example, in central Uttar Pradesh, the marginal–small stratum had 49% of the farms, but generated only 25% of the paddy output. The semi-medium and medium–large strata strongly dominated paddy output, with 75% of the volume. While the zone studied had larger farms than the average in the state and in India overall (about 4 times larger, as in the PRC study zone), the same pattern of land concentration and output was seen in the rest of Uttar Pradesh (and perhaps in other rice-producing states in India). Across Uttar Pradesh, only 25% of the farms were medium- and large-scale, but they had about 66% of the land. Given that the survey showed that large rice farms had higher yields than small farms, at least two-thirds of the state's rice output came from the medium and large farms. The implication is that medium and large farms were important to urban food security and dominated food supply chains to Delhi and other cities in the catchment zone of these commercialized grain belts, although marginal–small farms were more numerous.

Moreover, although farm operational sizes differed by a factor of 4 across the strata, the number of plots rose only from an average of 1.66 to 2.89. This indicates larger plots among larger farmers, and may relate to the correlation of farm size and mechanization.

## Rental of Rice Land

Table 3.1 shows that a surprisingly large amount of rice land was rented and this had been increasing, especially in the PRC and India. In the PRC zone in 2009, 36% of the average operational holding was rented-in (versus only 27% in 2004); in the Indian zone, it was 26% in 2009 (versus only 8% in 2004); and in Bangladesh, it was 12% in 2009. Clearly, in the areas studied, the land market was transforming, with an increasing rental market in the commercial zones. The rental market was growing fast: for example in the PRC, land rented increased 60% in 5 years.

The relation between inequality in operational landholding and the rental market is interesting in the PRC. The PRC may lead the study cases in land rental development because land sales and purchases were not yet fully legal, although various forms of exchange were possible (Jin and Deininger 2009). In the PRC study zone, land rental differences explained about half of farm size inequality: while the ratio of land of the upper to lower stratum was 4:1 with rented-in land included, it was only 2:1 with rented-in land excluded.

The average shares of rented land in total land mask substantial differences across the strata in the PRC and India (but not in Bangladesh). In India, the share of rented-in land in total operated land was about the same across strata (26%–27%), but the absolute amount of rented-in land differed sevenfold between the smallest and largest land strata. In the PRC study zone, the share rose steeply with overall land size (from 13% to 36% to 56%), and the upper land stratum rented 18 times more land than in the lower stratum. These figures suggest that land rental markets were quite concentrated in the upper stratum.

Finally, in India, the average farm size in the study areas increased 32% in 5 years, and in the PRC, 20%, with nearly all of the increase due to rented-in land. The key informants believed that the increase in land rental was due to the rapid increase in rural nonfarm employment (employment outside of the farm sector) in local areas as well as in migration activities, resulting in a labor shortage.

## Rice Farmers' Nonland Assets

Table 3.2 indicates a lot of heterogeneity in small-scale farmers' nonland assets (education, livestock, and farm equipment) in each study zone and across the three economies studied. Several points stand out.

### Table 3.2 Farm Size and Nonland Assets

| Asset | Farm Size Strata (all arable land under any crop) | | | |
|---|---|---|---|---|
| **Bangladesh** | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **All** |
| Age of head of household (years) | 47 | 51 | | 49 |
| Head of household (% male) | 99 | 100 | | 100 |
| Household size (number of adults and children) | 4.1 | 5.0 | | 4.5 |
| Household heads with no schooling (%) | 25 | 15 | | 20 |
| Livestock holdings in 2009 ($) | 412 | 588 | | 500 |
| Farm assets other than livestock and land in 2009 ($) | 118 | 324 | | 221 |
| Mean value of power tiller owned in 2009 ($; parentheses show % of power tiller in total value of farm assets other than livestock and land) | 32 (28) | 82 (25) | | 57 (26) |
| Mean value of tractors owned in 2009 ($; parentheses show % of tractor in total value of farm assets other than livestock and land) | 0 | 65 (20) | | 33 (15) |
| Households owning power tillers (%) | 2 | 4 | | 3 |
| Households owning tractors (%) | 0 | 2 | | 1 |
| Households using machine traction (tractors/power tillers, %) | 92 | 94 | | 93 |
| Households using animal traction (%) | 7 | 5 | | 6 |
| **China, People's Rep. of** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Age of head of household (years) | 47 | 43 | 40 | 44 |
| Head of household (% male) | 80 | 75 | 83 | 79 |
| Household size (adults plus children) | 4 | 4 | 4 | 4 |
| Household heads with 0–6 years of education | 41 | 33 | 19 | 35 |
| Livestock holdings in 2009 ($) | 21.34 | 37.11 | 27.23 | 28.39 |
| Farm assets other than livestock and land in 2009 ($) | 2,330 | 4,330 | 5,650 | 3,560 |
| Farm assets other than livestock and land in 2004 ($) | 1,280 | 2,210 | 3,790 | 1,910 |
| Mean value of tractors owned in 2009 ($; parentheses show % of tractor in total value of farm assets other than livestock and land) | 818 (35) | 1,647 (38) | 1,900 (34) | 1,279 (36) |
| Mean value of animal traction owned in 2009 ($; parentheses show % of animal traction in total value of farm assets other than livestock and land) | 0 | 8 (0.2) | 0 | 3 (0.1) |

*continued on next page*

Table 3.2 *continued*

| **Asset** | **Farm Size Strata** (all arable land under any crop) | | | |
|---|---|---|---|---|
| Households owning tractors in 2009 (%) | 37 | 73 | 78 | 56 |
| Households owning tractors in 2004 (%) | 27 | 51 | 56 | 40 |
| Households owning animal traction in 2009 (%) | 0 | 1 | 0 | 0.4 |
| Households owning animal traction in 2004 (%) | 0 | 0 | 0 | 0 |
| Households using machine traction (tractors) in 2009 (%) | 100 | 100 | 100 | 100 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Age of head of household (years) | 57 | 54 | 55 | 55 |
| Head of household (% male) | 100 | 100 | 100 | 100 |
| Household size (adults and children) | 8 | 8 | 9 | 8 |
| Household heads who are illiterate (%) | 37 | 25 | 22 | 28 |
| Livestock holdings in 2009 ($) | 1,333 | 1,556 | 1,556 | 1,481 |
| Farm assets other than livestock and land in 2009 ($) | 222 | 667 | 889 | 592 |
| Mean value of tractors/tillers owned in 2009 ($; parentheses show % of tractor in total value of farm assets other than livestock and land) | 0 | 278 (42) | 353 (40) | 210 (36) |
| Households owning tractors (%) | 0 | 45 | 55 | 50 |
| Households using machine traction (tractors; %) | 88 | 83 | 85 | 86 |
| Households using animal traction (%) | 12 | 16 | 15 | 14 |

ha = hectare.

First, the larger the farm, the greater the holdings of livestock, but the correlation was partial. Examining Bangladesh, the PRC, and India, in that order, the data show that, while the ratio of the average farm size of the largest to the small stratum was 2.6:1, 4.3:1, and 7.0:1, the ratio for livestock holdings was only 1.4:1, 1.3:1, and 1.2:1. This implies that the livestock/land ratio declined with farm size.

Moreover, livestock/land ratios were far higher on rice farms in South Asia than in the PRC. This reflected the greater use of animal traction and production of milk on rice farms in South Asia. Moreover, on Bangladesh rice farms, the livestock/land ratio for smaller farms was 2 times that of larger farmers, and in India, the ratio was 6:1—thus, small-scale South Asian rice farmers depended more on dairy and on animal traction than did larger farmers. Also, the livestock/land ratio among the smallest farmers was 2 times higher in India than in Bangladesh.

Second, for farm assets (other than livestock), the ratios of asset holdings comparing the largest with the smallest farm strata were 2.7:1, 2.4:1, and 4.0:1 for Bangladesh, the PRC, and India, respectively. For the subset of farm traction machine assets (tractors, power tillers, and animal traction equipment), the ratio (upper land stratum divided by lower) of machine holdings was 4.6:1 for Bangladesh, 2.3:1 for the PRC, and very high for India (as no farms in the smallest stratum owned machines). This implies that the traction-machine/landholding ratio increased with farm size in South Asia but not in the PRC, where it even slightly declined. The difference between the regions may result from smaller farms in the PRC having more access to nonfarm earnings to buy machines, and higher inducement to reduce farm labor, given farm labor costs that are much higher than for their South Asian counterparts.

Moreover, the traction-machine/landholding ratios differed sharply across zones. With the caveat that nominal values for the assets were not strictly comparable across the study zones, rough ratios show that the traction machine/land ratio in Bangladesh was about \$90/2.4 ha, or \$38/ha;[1] and in India it was \$210/5.4, or \$39/ha; but in the PRC it was \$1,279/2.2, or \$581/ha. That is, by this very rough measure, comparing "commercial small holder" zones, the PRC rice farms were about 15 times more "traction-machine owning" in machine-traction/land terms than the South Asian rice farms. Moreover, farm equipment holdings nearly doubled (in all strata) in the PRC sample during 2004–2009. This reflects the advancing shift to machine ownership in rice farming under pressure of rising labor costs from migration and rural nonfarm employment in the PRC.

However, the differences across farm size strata in terms of traction-machine holdings mask an important point: while only a few farmers in the Bangladesh sample, and about half of the samples in the PRC and India owned tractors, power tillers, or animal traction equipment, nearly all farmers, regardless of size stratum, used farm traction machines. This points to a very well-developed market for farm machine rental in all three zones. The upshot is that the use rate of traction machines was actually similar across the average farms of the three zones, as will be shown in the subsection on farm technology.

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[1] Table 3.1 shows 1.2 ha as land size, and given two seasons, this is equivalent to 2.4 ha.

Third, some demographic differences were apparent across the study zones, but none were very striking. Households were larger and their heads older in the India rice zone, while PRC rice farms had more female heads (20%), due to migration. Most household heads were literate and had some education; education was moderately correlated with land size.

## Rice Farmers and Nonfarm and Farm Labor Markets

Table 3.3 shows shares of rice farm households participating in off-farm employment. Several results are striking.

### Table 3.3 Rice Farmers and Nonfarm Labor (%)

| Labor | Farm Size | | | |
|---|---|---|---|---|
| **Bangladesh** | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **All** |
| Households with off-farm employment in 2009 | 12 | 18 | | 15 |
| Households that received remittances in 2009 | 5 | 9 | | 7 |
| **China, People's Rep. of** | **Marginal–Small** (<2 ha) | **Semi–Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Households with member working off-farm in 2009 | 53 | 43 | 28 | 45 |
| Households with member working off-farm in 2004 | 32 | 32 | 14 | 29 |
| Local nonfarm workers in 2009 | 20 | 21 | 8 | 19 |
| Local nonfarm workers in 2004 | 14 | 12 | 3 | 12 |
| Local farm workers in 2009 | 8 | 14 | 8 | 10 |
| Local farm workers in 2004 | 6 | 11 | 6 | 7 |
| Migrants to other districts in HLJ Province in 2009 | 16 | 17 | 17 | 16 |
| Migrants to other districts in HLJ Province in 2004 | 6 | 13 | 6 | 9 |
| Migrants to other provinces in 2009 | 20 | 7 | 6 | 13 |
| Migrants to other provinces in 2004 | 13 | 5 | 0 | 9 |
| **India** | **Marginal–Small** (<2 ha) | **Semi–Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Households with nonfarm employment 2009 | 37 | 38 | 36 | 37 |
| Households reporting received remittances 2009 | 5 | 7 | 8 | 7 |

ha = hectare, HLJ = Heilongjiang.

First, farm households were substantially engaged in rural nonfarm employment, including 45% of households in the PRC and 37% in the India zones, but only 15% in Bangladesh. These findings converge with a stream of research on the importance of rural nonfarm employment and migration employment in Asia. Survey data for the PRC show a sharp jump in only 5 years in participating households—from 29% to 45%. The rapid increase in land rental and farm capital investment appears to be linked to this rise in nonfarm employment, per key local informants in the PRC and India study zones. This hypothesis requires further exploration; it has been investigated more broadly for farm capital investment in Davis et al. (2009).

Second, while public attention often focuses on migration to the cities for employment, the current study finds that, in the PRC study zone, local nonfarm employment was at least as important as migration for employment in cities, and was more important than migration to cities in the study zones in South Asia. The Bangladesh and India data showed few households receiving migrant remittances (although a third send out migrants); the great majority of the rural nonfarm employment was local. In the PRC study zone, about 50% of the households engaged in nonfarm activity were engaged locally, and about 29% of the off-farm employment was in migration beyond the province. This converges with other PRC research showing the rise of local nonfarm employment (Mohapatra, Rozelle, and Goodhue 2007).

Moreover, while the recent debate on the PRC focuses on rural areas being depleted of male working age adults and left to farm with elderly and female-headed households, the current study's data do not fully support this view. Only about a quarter of households in the Heilongjiang study zone had members who had migrated elsewhere to work, and only about a fifth of the households were headed by females. Especially for smaller farmers, perhaps the importance of rural nonfarm employment opportunities and intensive rice farming competed with migration opportunities. This finding appears to corroborate a similar study by Huang, Wu, and Rozelle (2009) on fruit farming and migration in Shandong in the PRC. However, unlike Hunan and Sichuan, provinces such as Heilongjiang and Shandong are not considered to be major "migrant exporters."

Third, interestingly, only about 10% of the PRC households engaged in farm wage labor, even in the study's commercial agricultural zone. This is commonly noted in the literature about off-farm employment, which generally finds that rural nonfarm employment is much more important than farm wage labor and migration employment (Haggblade, Hazell, and Reardon 2007).

# Conduct of the Rice Farm Segment

## Farm Technology

Table 3.4 shows paddy production technology as an average farm budget derived from the survey data. The survey included detailed questions that were asked for all the rice fields and related to the level of output; input use (seeds, fertilizer, chemicals, irrigation, and manure); use of family and hired labor for farm activities (including preparing the soil, planting, weeding, and harvesting); farm machine use; and land rental. Inputs were divided by the rice field area to provide a measure of the intensity of input use per hectare. The costs are for the winter season (*boro*, the main rice season) in Bangladesh, and for the single rice season in the PRC and India study zones. The main results of the cost analysis are as follows, from the most to the least numerically important input cost component.

First, labor was by far the largest cost component. The total labor expenditure (on own labor imputed at the farm labor wage, plus hired labor) was much higher in the PRC ($679/ha) than in Bangladesh ($371/ha) or India ($333/ha). But the daily wage rates differed: in 2009, the hired labor wage was about $2.0/day in India, $2.2/day in Bangladesh, and $9.0/day in the PRC, with labor use in days at 75/ha in the PRC, 217/ha in Bangladesh, and 167/ha in India. These differences are roughly in line with the study's finding that the PRC sample used more mechanization per hectare than the South Asian samples. Moreover, the share of hired labor in total labor differed sharply, with a high of 60% in Bangladesh, to 53% in India, and 40% in the PRC. Interestingly, this is the inverse of the rural nonfarm employment pattern and of mechanization, suggesting that nonfarm jobs were substitutes for farm wage labor, and that mechanization reduced the hired labor market.

Second, expenditures for own and rented machinery use were highest in the PRC (at 23% of total costs), dropping to 15%–17% in South Asia. The traction expenditure, however, was roughly similar, and the cost shares difference was partly because nontraction farm machine use is shown only for the PRC but not for the South Asian sites (due to data gap); however, farm asset data show that the PRC rice farms had larger holdings of nontraction machines (such as seeders and harvesters) than the South Asian farms.

**Table 3.4 Composition of Rice Farmers' Production Costs**
(value in $/ha and shares in % of total cost)

| Input | Bangladesh | | PRC | | India | |
|---|---|---|---|---|---|---|
| | $/ha | % | $/ha | % | $/ha | % |
| Own seeds | 15 | 2 | 17 | 1 | 3 | 0.003 |
| Purchased seeds | 5 | 1 | 59 | 3 | 11 | 1 |
| Chemical fertilizer | 124 | 16 | 288 | 14 | 83 | 11 |
| Crop chemicals | 53 | 7 | 109 | 5 | 21 | 3 |
| Water total | 30 | 4 | 134 | 7 | 126 | 17 |
| Water (irrigation costs purchased) | 30 | 4 | 134 | 7 | 76 | 10 |
| Own irrigation imputed at market rate | … | … | … | … | 50 | 7 |
| Manure | 12 | 2 | 2 | 0.11 | | |
| Labor total | 371 | 47 | 679 | 33 | 333 | 45 |
| Own labor imputed at wage rate | 147 | 19 | 405 | 20 | 157 | 21 |
| Hired labor | 224 | 28 | 274 | 13 | 177 | 24 |
| Animal traction | 4 | 1 | 0 | 0 | 7 | 1 |
| Machine use total | 119 | 15 | 467 | 23 | 123 | 17 |
| Hired tractor use | 112 | 14 | 40 | 2 | 53 | 8 |
| Own tractor use | 7 | 1 | 54 | 3 | 70 | 9 |
| Other hired farm machine use (hired harvester and hired paddy seeder) | … | … | 165 | 8 | … | … |
| Other own farm machine use (own harvester and own paddy seeder) | … | … | 208 | 10 | … | … |
| Land rental | 61 | 8 | 279 | 14 | 32 | 4 |
| Total (cash outlays plus imputed in-kind costs; 100% and total value) | 794 | 100 | 2,033 | 100 | 739 | 100 |
| Total monetary cost (value and share of total cost) | 625 | 79 | 1,350 | 66 | 428 | 58 |
| Total imputed in kind costs (value and share of total cost) | 169 | 21 | 683 | 34 | 311 | 42 |

… = no data available, ha = hectare, PRC = People's Republic of China.

Third, fertilizer costs were an interestingly consistent share of production costs across the sites—averaging about 15%—despite sharply different outlays. The most striking point is the much lower cost of fertilizer in India—where it is heavily subsidized (subsidies were 16% of the agricultural gross domestic product in India in 2008/09 [Grossman and Carlson 2011]). Behind the United States dollar totals in Table 3.4 are widely differing rice prices ($170/ton in

India, $400 in the PRC, and $500 in Bangladesh) and use rates (340 kilograms/ha in Bangladesh, 488 in India, and 720 in the PRC).

Fourth, land rental costs were about 14% in the PRC, compared with 4%–8% in South Asia, findings that corroborate the rented-in land shares noted above. Water costs were similar, but with a higher share (17%) in India, where many small farmers buy water from larger farmers who own the bulk of the tube wells; this is discussed further below.

Fifth, seeds and crop chemicals, while important for productivity, were a minor share of costs, about 4%–10%. The PRC farms' use of crop chemicals was 2 times that in Bangladesh and 5 times that in India (measured in value terms, which is a rough measure). This higher use of chemicals, especially herbicides, appears correlated with the higher opportunity cost of time because of the much greater participation in the nonfarm labor market in the PRC than in the South Asian zones.

The overall technology picture that emerges is that rice production in the PRC zone used more machines, fertilizer, and chemicals than the Bangladesh and India zones, which used much more labor, but still used substantial amounts of purchased seeds, fertilizer, and chemicals. Hence, Lele and Stone (1989) would term the PRC's production "capital-led intensification."

But this is a static picture. There is evidence (such as in *Business Standard* 2011) that as wages rise in India, mechanization is increasing rapidly (with the leading edge in Haryana and the Punjab, but it is also increasing in Uttar Pradesh).

## Access to Water

Table 3.5 shows farm households' access to agricultural water. Several points stand out.

First, despite a history of government programs subsidizing tube well irrigation in Bangladesh and India, only a third of the farms had their own wells. By contrast, fully two-thirds of the PRC farms owned tube wells. Moreover, while ownership was only slightly correlated with farm size in Bangladesh, it was highly related with farm size in India: about 20% of marginal–small and semi-medium farms had tube wells, but 71% of the medium–large farms had them. Given that the wells were subsidized, this means that the distribution of the tube well subsidy was highly skewed toward larger farmers in India.

**Table 3.5 Rice Farms' Access to Water** (% of farms)

| Water Source | Farm Size | | | |
|---|---|---|---|---|
| **Bangladesh** | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **All** |
| Own irrigation pump | 25 | 37 | | 31 |
| Bought from other farmers | 80 | 76 | | 77 |
| Sold to other farmers | 10 | 16 | | 13 |
| **China, People's Rep. of** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Own irrigation pump | 52 | 70 | 75 | 62 |
| Bought irrigation water from government | 86 | 71 | 69 | 78 |
| Bought irrigation water from other farmers | 0 | 0 | 0 | 0 |
| Sold irrigation water | 0 | 0 | 0 | 0 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | All |
| Own irrigation pump | 20 | 18 | 71 | 36 |
| Bought irrigation water from other farmers | 66 | 62 | 20 | 49 |
| Sold irrigation water to other farmers | 15 | 21 | 51 | 29 |

ha = hectare.

Second, most PRC farmers bought water from the government canal scheme. In Bangladesh and India, farmers did not purchase water from the government, but there was a well-developed private agricultural water market. In India, two-thirds of the small-scale and semi-medium farmers bought water, and half of the large farmers sold it; in Bangladesh, three-quarters of all farmers bought water, as their own irrigation was not enough for their needs, and only 13% sold water.

## Access to Seed

Several key findings concerning access to seed emerge from Table 3.6.

First, rice seed markets were widely and well developed: 91% of farmers in the India and 94% in the PRC samples reported purchasing rice seed in the 12 months prior to the survey. Bangladesh rice farmers relied the least on seed

## Table 3.6 Farmers' Acquisition of Rice Seed

(% of households declaring their main seed sources)

| Seed Source | Farm Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Lowest | | Middle | | Highest | | All | |
| **Bangladesh** | **1999** | **2009** | **1999** | **2009** | | | **1999** | **2009** |
| Government | 19 | 29 | 24 | 21 | | | 21 | 25 |
| Farmers association | 10 | 6 | 9 | 6 | | | 10 | 6 |
| Wholesale market trader | 19 | 24 | 14 | 27 | | | 17 | 26 |
| Small private seed retailer | 17 | 17 | 16 | 18 | | | 16 | 17 |
| Other farmers | 8 | 0 | 6 | 2 | | | 7 | 1 |
| Own seeds | 24 | 23 | 30 | 25 | | | 27 | 24 |
| Other | 3 | 1 | 1 | 1 | | | 2 | 1 |
| Total (with rounding error) | 100 | 100 | 100 | 100 | | | 100 | 100 |
| **China, People's Rep. of** | **2004** | **2009** | **2004** | **2009** | **2004** | **2009** | **2004** | **2009** |
| Government (rice institute) | 38 | 37 | 41 | 42 | 42 | 42 | 39 | 40 |
| Private input market | 10 | 7 | 14 | 14 | 6 | 8 | 11 | 10 |
| Traditional private retailers | 20 | 18 | 15 | 12 | 22 | 22 | 18 | 16 |
| Other farmers | 9 | 10 | 5 | 6 | 3 | 3 | 7 | 7 |
| Seed company distributor | 5 | 6 | 3 | 4 | 3 | 3 | 4 | 5 |
| Own seed | 3 | 4 | 1 | 2 | 3 | 0 | 2 | 3 |
| Others | 16 | 18 | 20 | 19 | 22 | 22 | 18 | 18 |
| Total (with rounding error) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **India** | **1999** | **2009** | **1999** | **2009** | **1999** | **2009** | **1999** | **2009** |
| Government cooperatives | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 |
| Government seed store | 0 | 0 | 0 | 0 | 3 | 10 | 1 | 5 |
| Traditional private retailers | 73 | 98 | 96 | 97 | 90 | 82 | 87 | 90 |
| Modern private sector rural business hubs | 0 | 2 | 0 | 3 | 0 | 8 | 0 | 5 |
| Other farmers | 27 | 0 | 4 | 0 | 3 | 0 | 10 | 0 |
| Total (with rounding error) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Note: "Lowest" = "marginal" for Bangladesh and "marginal–small" for the People's Republic of China (PRC) and India; "Middle" = "small" for Bangladesh and "semi-medium" for the PRC and India; "Highest" = "medium–large" for the PRC and India. See Table 3.1 for the equivalent hectare sizes.

markets, as only 48% of farm households purchased seeds in the 12 months before the survey; however, farmers in the lowest stratum bought seed an average of 5 times in the 5 years prior to the survey. Most farmers who did not buy seed in the year before the survey said that they did not need to do so (that is, they did not say they could not access seed on the market).

Second, Table 3.6 shows the main sources for seed as reported by farmers. When farmers evaluated their main seed sources, "own seed" was important only in Bangladesh, where it declined from 27% of farmers declaring it so for 1999 to 24% in 2009. In the PRC and India, own seed comprised only a few percent of the total. Table 3.4 examines own seed use from another angle—showing the share of "own seed" in total seed used in the average farm budget. This share was 75% in Bangladesh, but only 21%–22% in the PRC and India.

Third, "other farmers" were very minor as the local seed source by 2009 (at 1% in Bangladesh, 7% in the PRC, and 0% in India). In the PRC, this small share was mainly among smaller farmers; in India, the share of farmers reporting "other farmers" as a main source dropped from 10% in 1999 to 0% in 2009, including a sharp drop among the smallest farmers, from 27% to 0% during the same period.

Fourth, in all three economies, the state subsidized seed sales via government shops, but the incidence of those sales in farmers' purchase of seeds was very different: the government (and government cooperatives) were very minor "main sources" in India (at only 5%), but were more important in Bangladesh (at 25%, with the Bangladesh Agricultural Development Corporation as a main player) and the PRC (at 40% for state seed stores selling from Heilongjiang's rice research institute). In Bangladesh, the increase during 1999–2009 of the smallest farmers' access to seeds from the Bangladesh Agricultural Development Corporation is noteworthy. The governments' role in distributing rice in Bangladesh and the PRC had waned greatly, but had been maintained in seed provision, while the converse was true in India, where the government's role in seeds had waned but remained significant in rice distribution.

Fifth, traditional private seed suppliers had a predominant role as "main seed sources" in South Asia, and an important role in the PRC. In India, fully 90% of the farmers reported small private seed shops as their primary source; in the PRC, 26% of farmers mainly relied on traditional private retailers and the private input market. In Bangladesh, while private suppliers served 16% of farmers during 1999–2009, the role of wholesale market traders as main seed sources rose sharply, from supplying 17% of farms in 1999 to 26% in 2009.

Finally, in India, Table 3.6 shows that "modern seed channels" increased their share from nil to about 5% of farms during 1999–2009, and for the PRC the change was from 4% to 5%. The main source was the seed companies through direct retailing in the PRC and rural business hub companies in India (for the latter, see Reardon et al. 2012).

In the PRC sample, "Others" adds 18% of the total, with nearly twice the use rate among the highest farm stratum than in the lowest one. The "other" category comprises nontraditional sources of seed such as rice mills, seed stations, producer organizations, state input stores, paddy wholesalers, and provincial input stores. In fact, the PRC case is especially interesting as the sources of seed were very diversified, ranging from public to private to private cooperative, from traditional to modern, and from wholesalers to retailers to research field stations.

Table 3.7 shows shares of sample rice farmers planting traditional rice varieties, high-yielding rice such as semi-dwarf, and hybrid varieties. Three sets of points emerge.

First, in South Asia, use of traditional varieties dropped fast during 1999–2009. In the PRC, traditional varieties had been mostly replaced by high-yielding varieties (HYVs) in the 1970s and 1980s (Li, Xin, and Yuan 2009).

**Table 3.7 Shift to High-Yielding and Hybrid Varieties** (% of households)

| Type of Rice | Farm Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Lowest | | Middle | | Highest | | All | |
| **Bangladesh** | **1999** | **2009** | **1999** | **2009** | | | **1999** | **2009** |
| Local traditional | 53 | 14 | 59 | 15 | | | 56 | 14 |
| Local HYV | 37 | 18 | 31 | 25 | | | 34 | 21 |
| National HYV | 10 | 68 | 10 | 60 | | | 10 | 64 |
| Total | 100 | 100 | 100 | 100 | | | 100 | 100 |
| **China, People's Rep. of** | **2004** | **2009** | **2004** | **2009** | **2004** | **2009** | **2004** | **2009** |
| Hybrid | 38 | 45 | 38 | 52 | 47 | 53 | 39 | 49 |
| Other | 62 | 55 | 62 | 48 | 53 | 47 | 61 | 51 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **India** | **1999** | **2009** | **1999** | **2009** | **1999** | **2009** | **1999** | **2009** |
| Traditional | 44 | 0 | 39 | 0 | 39 | 0 | 41 | 0 |
| HYV | 54 | 80 | 61 | 78 | 61 | 86 | 59 | 83 |
| Hybrid | 2 | 20 | 0 | 23 | 0 | 14 | 1 | 18 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

HYV = high-yielding variety.

Note: "Lowest" = "marginal" for Bangladesh and "marginal–small" for the People's Republic of China (PRC) and India; "Middle" = "small" for Bangladesh and "semi-medium" for the PRC and India; "Highest" = "medium–large" for the PRC and India. See Table 3.1 for the equivalent hectare sizes.

Second, the importance of HYVs shot up in South Asia. In the PRC study zone, the share of farms growing HYVs edged down in the 5 years before the survey.

Third, hybrid rice was important in the PRC study zone but not in the South Asian cases. Hybrid rice was introduced in 1994 in India (Virmani 2003) and in 1998 in Bangladesh (Husain, Hossain, and Janaiah 2001); but at the national level, hybrids had reached only 4% of the rice area by 2011 in Bangladesh (Bhandari, Mohanty, and Hossain 2011) and 3% in India by 2007 (Tripp, Hu, and Pal 2010). This is compared with 53% by 2007 in the PRC (Tripp, Hu, and Pal 2010) or another estimate of 63% by 2008 (Li, Xin, and Yuan 2009). The table shows that hybrid rice did not have a foothold in the Bangladesh study zone by 2009. However, in contrast with India's 3% national rate of adoption, 18% of the Indian rice farms in the study zone had adopted hybrids by 2009, which is consistent with the study area being a commercial rice zone. The northeast PRC lagged behind the south in adopting hybrid rice, as hybridization spread from indica to japonica, with indica grown in the south and japonica grown in the northeast. Thus, during the 5 years before the survey, the share of farms using hybrids grew by 10 percentage points, converging toward the national average of 50%–60%.

In summary, the adoption of new varieties in the study areas during 1999–2009 ranged from a major shift toward HYVs in South Asia to incipient diffusion of hybrids in India and to a shift from HYVs to hybrids in the northeast PRC.

## Purchase of Fertilizer and Crop Chemicals

Table 3.8 shows widespread and substantial development of markets for fertilizer and crop chemicals (insecticides, fungicides, and herbicides), and even very small-scale farmers participated in them very actively. In all the study zones, 89% or more of the farmers purchased these inputs, except that only 69% of marginal and small-scale farmers in the India study zone purchased crop chemicals.

Of particular note is the rapid uptake of herbicides in the PRC, where 96% of the farmers used them, and the rest weeded by hand or mechanically. The adoption of herbicides may partly have been related to the rapid rise of off-farm employment, which competed for labor. By contrast, only 9% of rice farms in the India study zone used herbicides—a much lower share than among potato growers in the same state (see Chapter 7).

**Table 3.8 Share of Farms Buying Chemical Fertilizers and Crop Chemicals (%)**

| Input | Farm Size | | | |
|---|---|---|---|---|
| **Bangladesh** | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **All** |
| Fertilizer | 100 | 100 | | 100 |
| Crop chemicals[a] | 98 | 98 | | 98 |
| **China, People's Rep. of** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Fertilizer | 98 | 95 | 92 | 96 |
| Crop chemicals[a] | 98 | 95 | 94 | 96 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Fertilizer | 100 | 100 | 100 | 100 |
| Crop chemicals[a] | 69 | 90 | 97 | 89 |

ha = hectare.

[a] Insecticides, fungicides, and herbicides.

Finally, the survey showed some important surprises concerning farmers' sources of fertilizer and chemicals. In all three study zones, the government had only a minor role in selling fertilizer, and nearly no role in selling crop chemicals. The government share was very low in Bangladesh (in contrast with the finding for seeds): only 3% of the farmers bought fertilizer and only 1% bought chemicals from the state (Bangladesh Agricultural Development Corporation). In the PRC, the figures were 9% for fertilizer and 8% for crop chemicals. India is the most interesting case: About 28% bought fertilizer from the primary agricultural credit societies (the state-organized cooperatives)—but the purchasers were mainly the larger and semi-medium farmers, while very few were small or marginal farmers. This finding runs contrary to the conventional wisdom that small-scale farmers rely on the primary agricultural credit societies and are their main customers. Thus (as with the finding for tube wells), the input subsidy actually assists the larger, not the smaller, farmers. This is contrary to the purpose of the subsidies.

By contrast, the great bulk of fertilizer and crop chemicals was purchased from small private input retailers or wholesale market input traders in all three zones. However, where modern input retailers had arisen in India, their market shares were still small: Less than 1% of the farmers in the study area bought fertilizer, and only 10% bought crop chemicals from these hubs.

Finally, while few farmers bought crop chemicals directly from the manufacturers, the companies promoted their products through their extension activities. For example, in India, the study found that 33% of all rice farmers received some extension services in the year before the survey—but 85% of this was from input companies, only 14% was from government extension, and only 5% of farmers saw a state extension agent. This implies a very minor presence of the government extension services.

## Marketing

Table 3.9 shows farmers' marketed surplus rates (sales divided by output). The zones studied were highly commercialized, with high marketed surplus rates among both small and medium farms. The marginal and small farmers in these zones were really small-scale commercial farmers—with staples as cash crops. Only the marginal farmers in Bangladesh had a substantial home consumption rate (43%), and thus could be termed semi-subsistence.

The study areas tended to be more commercialized than the national averages. For example, in India, the Ministry of Agriculture, in its *Agricultural Statistics at a Glance, 2009*, estimated that the marketed surplus rate in Uttar Pradesh was 63.0% in 1988/89 and 1999/2000, and 78.7% in 2008/09, close to

**Table 3.9 Rice Farmers' Marketed Surplus Rates**

| Production and Surplus | Farm Size | | | |
|---|---|---|---|---|
| **Bangladesh** | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **All** |
| Production (tons/farm) | 7 | 17 | | 11 |
| Marketed surplus rate (%) | 57 | 71 | | 68 |
| **China, People's Rep. of** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Production (tons/farm) | 7 | 17 | 25 | 13 |
| Marketed surplus rate (%) | 100 | 94 | 92 | 95 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Production (in tons/farm) | 4.8 | 10.8 | 28.1 | 18.1 |
| Marketed surplus rate (%) | 77 | 89 | 94 | 92 |

ha = hectare.

India's overall rates of 62.0% in 1999/2000 and 75.5% in 2008/09 (Ministry of Agriculture 2010).

Table 3.10 shows shares of farmers selling to the various buyers, and Table 3.11 shows the shares of sales to the types of buyers. The overall picture that emerges is that the role of the traditional village broker was much diminished, and shorter value chains (from farmer to rural wholesale market and farmer to mill) were evolving. Several specific items are noteworthy.

**Table 3.10 Composition of Rice Farmers' Clients**
(% of farmers selling to buyer types; totals do not have to equal 100%)

| Buyer | Farm Size | | | |
|---|---|---|---|---|
| **Bangladesh** | **Marginal** (>1 ha) | **Small** (≥1 ha) | | **All** |
| Village trader | 6 | 19 | | 7 |
| Wholesaler on wholesale market | 34 | 38 | | 35 |
| Miller | 33 | 24 | | 32 |
| Wholesaler at mill | 33 | 29 | | 32 |
| Other | 1 | 0 | | 1 |
| **China, People's Rep. of** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Village trader | 32 | 24 | 31 | 28 |
| Wholesaler on wholesale market | 0.83 | 2 | 3 | 2 |
| Miller | 63 | 67 | 60 | 64 |
| Government buyer | 0.83 | 0 | 0 | 0.41 |
| Cooperative association | 0 | 0 | 0 | 0 |
| Private grain warehouse | 0 | 1 | 0 | 0.41 |
| Village government paddy purchasing center | 0 | 2 | 0 | 0.81 |
| Seed company | 2 | 0 | 3 | 1 |
| Traders from outside the farmer's village | 0.83 | 1 | 3 | 1 |
| Heilongjiang rice research institute | 0 | 0 | 0 | 0 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Village traders | 34 | 33 | 46 | 38 |
| Wholesaler on wholesale market | 59 | 65 | 67 | 64 |
| Wholesaler at mill | 8 | 9 | 12 | 9 |
| Government agency | 4 | 4 | 9 | 6 |
| Miller | 4 | 7 | 3 | 5 |
| Other farmer | 6 | 0 | 3 | 3 |

ha = hectare.

First, current conventional wisdom sees rice supply chains as "long," with "many hands," starting usually from the village trader–broker as an oligopsonist or even local monopsonist. However, the current study found that the role of the village trader had become minor, with only 7% of farms and sales in Bangladesh, 29% of farms and 28% of sales in the PRC, and 38% of farms and 18% of sales in India (Tables 3.10 and 3.11). The marked difference between shares of farms and sales in India is because smaller farmers tended to use village traders much more than did the larger farmers. (Due to their small lots, the small-scale farmers sold to local traders who collected the produce, rather than having to deliver to the larger traders.)

Second, by contrast, in South Asia, the wholesaler's role (mainly at the wholesale market but also, in a minor way, at the mill) was far greater, buying directly from the farmer. In both Bangladesh and India, farmers sold about two-thirds of their paddy to wholesalers whether at the wholesale market or the mill. However, in the PRC, the role of the rural wholesale market was a tiny 2%. Subsequent text shows what has displaced it (Table 3.11).

Third, especially in the PRC, incipiently in Bangladesh, but not yet in India, farmers were bypassing middlemen and selling directly to mills. Of all paddy sold, 63% was sold directly to mills in the PRC, 30% in Bangladesh, and 5% in India.

Fourth, the government was nearly absent as a direct buyer of paddy from farmers. It had no role in Bangladesh and bought only 1% of the produce in the PRC and 14% in India. Yet the government has had an important indirect role in providing the infrastructure improvements that appear to have facilitated restructuring the market.

The picture that emerges is one of "disintermediation." That term is usually reserved for modern supply chains, such as where large-scale retailers buy directly from producers through a collection center. But the rice value chains showed similar disintermediation. In South Asia, the disintermediation mainly entailed substituting a larger and more distant trader for the village broker. In the PRC, disintermediation entailed a nearby mill buying directly from the farmer rather than through a village trader or rural wholesale market. This appears to be a development continuum—from long value chains, to wholesaler-dominated chains, to processor-dominated chains in the rural areas—in the rural equivalent of a more macro trend where supermarket chains and large processors gradually buy increasingly directly from processors and farmers.

**Table 3.11 Composition of Rice Farmers' Sales to their Clients**
(% of farmers' total sales by type of buyer)

| Buyer | Farm Size | | | |
|---|---|---|---|---|
| **Bangladesh** | **Marginal** (<1 ha) | **Small** (>1 ha) | | **All** |
| Village trader | 5.5 | 19 | | 7 |
| Wholesaler on wholesale market | 32 | 36 | | 33 |
| Miller | 31 | 24 | | 30 |
| Trader at mill | 31 | 21 | | 30 |
| Other | 0.3 | 0 | | 0.3 |
| Total (tons in parenthesis) | 100 (3.34) | 100 (11.17) | | 100 (6.94) |
| **China, People's Rep. of** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Village trader | 33 | 27 | 24 | 29 |
| Wholesaler on wholesale market | 0.86 | 2 | 1 | 2 |
| Miller | 61 | 65 | 64 | 63 |
| Private grain warehouses | ... | 1 | ... | 1 |
| Cooperative associations | ... | ... | ... | 0 |
| Paddy rice retailers | ... | ... | ... | 0 |
| Heilongjiang rice research institute | ... | ... | ... | 0 |
| Government | 1 | 2 | ... | 1.13 |
| Relatives/acquaintances | 0.72 | ... | ... | 0.72 |
| Traders from other villages | 0.74 | 1 | 5 | 0.91 |
| Seed company | 2 | ... | 6 | 2.32 |
| Others | 0.86 | 2 | ... | 1.08 |
| Total (with rounding error; tons in parenthesis) | 100 (7.01) | 100 (16.33) | 100 (22.68) | 100 (12.63) |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Village trader | 26 | 27 | 15 | 18 |
| Trader on wholesale market | 41 | 59 | 64 | 61 |
| Trader at mill | 7 | 3 | 1 | 2 |
| Government agency | 14 | 7 | 15 | 14 |
| Miller | 6 | 5 | 5 | 5 |
| Other farmers | 6 | 0 | 0 | 1 |
| Total (with rounding error; tons in parenthesis) | 100 (3.7) | 100 (9.6) | 100 (26.5) | 100 (16.7) |

... = no data available, ha = hectare.

Three developments have been important for this change in the market structure in the study areas: the proliferation of rural wholesale markets; better road links to cities; and the spread of mobile (cellular) phones, giving farmers information about options (Fan, Hazell, and Thorat 2000; Fan and Hazell 2001; ADB 2012;

Reardon and Minten 2012). Moreover, as Table 3.12 shows, most paddy was still sold in the farmers' villages or nearby. Mills and wholesale market traders had made major investments in buying or renting trucks, third party logistics companies had emerged, and these trends had helped the wholesaler and mill cut out the village traders. The result was that the farmers could choose among several types of traders apparently competing for their products—which is a far cry from the traditional image of farmers waiting passively on their farms, bereft of intermediation choice, while traders prey on them.

**Table 3.12 Paddy Sales: Time and Location** (% of farmers)

| Sales Time and Location | Farm Size | | | |
|---|---|---|---|---|
| **Bangladesh** | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **All** |
| Time to, at, and from sales location (hours) | 1.7 | 3.0 | | 2.5 |
| Called the buyer before the transaction (%) | 36 | 53 | | 47 |
| If called, made the price deal on phone (%) | 24 | 39 | | 34 |
| Sales location | | | | |
| Same village (%) | 38 | 43 | | 41 |
| Wholesale market/mill within the district (%) | 53 | 52 | | 53 |
| Local retail market (%) | 10 | 5 | | 8 |
| **China, People's Rep. of** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Time to, at, and from sales location (hours) | 5.3 | 7.0 | 4.4 | 5.8 |
| Sales location | | | | |
| Own field or own village (%) | 80 | 74 | 81 | 78 |
| Wholesale market in this village (%) | 0 | 1 | 0 | 0.4 |
| Wholesale market in other villages in the county (%) | 0.80 | 4 | 0 | 2 |
| Wholesale market in other counties in the district (%) | 0 | 0 | 0 | 0 |
| Wholesale markets in other districts (%) | 0 | 0 | 3 | 0.4 |
| Local retail market for paddy rice (%) | 0 | 0 | 0 | 0 |
| Purchasing center for retailers (%) | 0 | 1 | 0 | 0.4 |
| Others (%) | 14 | 14 | 11 | 14 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Time to, at, and from sales location (hours) | 8 | 8 | 8 | 8 |
| Sales location | | | | |
| Own field or village (%) | 42 | 48 | 34 | 41 |
| Wholesale market in district (%) | 19 | 12 | 20 | 17 |
| Wholesale market elsewhere in Uttar Pradesh (%) | 0 | 0 | 5 | 2 |
| Wholesale market in Delhi (%) | 0 | 0 | 0 | 0 |
| Wholesale market at block level (%) | 59 | 64 | 74 | 66 |

ha = hectare.

Table 3.12 shows shares of farmers selling to various locations. The great majority of sales were made in the villages or (except in the PRC) at a wholesale market in the block or district. The transaction times were just a morning to a full day, once or twice per season. Very little was sold on the local retail market, in contrast with the importance given to these local retail markets in the 1960s and 1970s literature (Lele 1971).

The role of the mobile phone is assessed through the survey data and discussions with key informants in the field. Most of the farmers had acquired their mobile phone in the 5 years before the survey. Table 3.13 shows their cellular phone use. Most of them owned a cellular phone, and many used it to contact traders before a transaction and agree to the price on the phone. The farmers' ownership and use of cellular phones in the rice area was most widespread in Bangladesh, followed by the PRC, and then (in a somewhat distant third) India.

Marketing costs differed somewhat across the study sites, but, as the transactions were local, the costs were small (compared with traders' costs, as discussed in Chapter 4). In the PRC, the marketing cost was $3.07/ton. About half of the cost was for bags and a quarter was for the milling. In India, total marketing costs were just $1.55/ton.

**Table 3.13 Rice Farmers' Ownership and Use of Cellular Phones**

| Ownership and Use | Bangladesh | PRC | India |
|---|---|---|---|
| **Share** | | | |
| Share of farmers owning a cell phone (%) | 80 | 97 | 73 |
| Year phone first owned | | | |
| 2008 or later (%) | 18 | 21 | 16 |
| 2006 or 2007 (%) | 37 | 21 | 38 |
| 2004 or 2005 (%) | 29 | 36 | 32 |
| Before 2004 (%) | 16 | 22 | 14 |
| Share of all calls made related to rice business (%) | … | … | 6 |
| **Use of phone in last transaction** | | | |
| Farmers who used their phone to contact the buyer (%) | 71 | 47 | 19 |
| If used, … | | | |
| Farmers agreed upon price on the phone (%) | 58 | 34 | 51 |
| Other buyers contacted (%) | 90 | 95 | 50 |
| Calls concerning this transaction (no.) | 2.5 | 2.5 | 2.5 |

… = no data available, PRC = People's Republic of China.

## Rice Farmers' Accessing Value Chain Credit

Table 3.14 shows credit transactions in terms of shares of farmers getting advances from buyers, or de facto giving credit to buyers (by the buyers paying with a delay after receiving the paddy). Two surprising conclusions emerge from the data.

**Table 3.14 Credit from and to Buyers** (% of farmers)

| Payment Terms | Farm Size | | | |
|---|---|---|---|---|
| **Bangladesh** | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **All** |
| Buyer paid cash | 100 | 100 | | 100 |
| Buyer provided advance | 0 | 0 | | 0 |
| Buyer payment delayed (de facto credit) | 0 | 0 | | 0 |
| **China, People's Rep. of** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Buyer paid cash | 96 | 96 | 97 | 96 |
| Buyer provided advance | 0 | 0 | 0 | 0 |
| Buyer payment delayed (de facto credit) | 4 | 4 | 3 | 4 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Buyer paid cash | 96 | 89 | 93 | 92 |
| Buyer provided advance | 0 | 5 | 3 | 3 |
| Buyer payment delayed (de facto credit) | 15 | 11 | 10 | 12 |

ha = hectare.

First, the traditional image is of farmers as creditors through advances from traders. Key informants surveyed indicated that these relations are nearly universal and represent an exploitation of the farmer by the trader. In sharp contrast, however, the survey data showed that traders provided very little credit to rice farmers—none in Bangladesh and the PRC and a mere 3% in India, mainly to larger farmers.

Second, in Bangladesh and the PRC, farmers were paid immediately at delivery. But in India, 12% (with a slight inverse correlation with farm size) were paid later—and thus essentially gave credit to traders. The delay was often not long, usually a week to a few weeks while the trader sold the crop and returned to pay the farmer. Nearly all the transactions in all three zones were paid in cash, not check or barter.

# Performance of the Rice Farm Segment

## Farm Productivity

Table 3.15 shows yields of "common" grade rice, a group of rice varieties whose shape (length and width) correspond to the medium grade. (Finer grades are longer and narrower; coarser grades are stubbier. Other characteristics of quality, such as degree of whiteness or taste or smell, are not considered here.) Despite the changes in input use and capital intensity previously noted, there were no striking changes during 1999–2009 in Bangladesh or 2004–2009 in the PRC. Most of the farmers reported increased yields, of 5%–17%. Some, however, reported declines, which seem often related to climate problems (for example, cold in the PRC).

**Table 3.15 Rice Farm Productivity, Main Rice Season** (tons/hectare)

| Economy and Rice Type | Farm Size and Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Lowest | | Middle | | Highest | | All | |
| **Bangladesh** | **1999** | **2009** | **1999** | **2009** | | | **1999** | **2009** |
| Medium/common | 6.7 | 6.7 | 5.2 | 5.9 | | | 6.0 | 6.3 |
| **China, People's Rep. of** | **2004** | **2009** | **2004** | **2009** | **2004** | **2009** | **2004** | **2009** |
| Regular-common | 10 | 8 | 8 | 7 | 8 | 7 | 9 | 7 |
| **India** | **1999** | **2009** | **1999** | **2009** | **1999** | **2009** | **1999** | **2009** |
| Common | … | 4.4 | … | 3.5 | … | 3.8 | … | 3.8 |

… = no data available.
Note: "Lowest" = "marginal" for Bangladesh and "marginal–small" for the People's Republic of China (PRC) and India; "Middle" = "small" for Bangladesh and "semi-medium" for the PRC and India; "Highest" = "medium–large" for the PRC and India. See Table 3.1 for the equivalent hectare sizes.

Controlling for quality, yields in Bangladesh (6.3 tons/ha) and the PRC (7.0 tons/ha) were close despite the differences between the capital versus labor intensity. By contrast, India's yield of 3.8 tons/ha (the study zone had a higher yield than the Indian overall average of only 2.2 tons/ha) was only about 50%–60% of the Bangladesh and PRC averages. Interestingly, these yield differences line up with the technology differences: the PRC had a high capital/land and capital/labor ratio; Bangladesh had a very high labor/land ratio; and India was in between, with lower capital use than the PRC, and lower labor use than Bangladesh. Hence, the PRC and Bangladesh had somewhat more intensified rice systems, in terms of use of machines (the PRC) or labor (Bangladesh), and external inputs (in particular in the PRC) compared with India, and this contributed to the differences in yields.

In India, yields had declined slightly in the shift between common and fine grades, but yields of medium and fine grades were similar in Bangladesh. In Bangladesh, coarse rice had a modestly lower yield than common and fine grades. As the technologies used (in terms of input ratios) were similar in all the grades of rice, the yield gains in medium rice may have been because government rice research had concentrated on introducing new varieties in the medium (rather than the coarse) quality category during the last decade.

Finally, in Bangladesh and India (but not in the PRC), the yields of the smallest farms were about 15% above those of the larger farms. This small advantage coincided with the slightly more intense use of labor and fertilizer per hectare. However, the yields across farm strata were not very different in any of the three economies; this appears to be because fertilizer and crop chemicals were easily accessible across the strata and, to a certain extent, the larger farms compensated for less labor intensity with more capital intensity. But the technology differences were greater between zones than between the strata within them.

## Quality Differentiation and Evolution among Rice Farmers

Table 3.16 shows the differentiation of paddy at the South Asian sites. Rather than major growth in yield, the study found growth in the quality of output (proxied by the shape of the grain). This is part of a broader quality differentiation story of the staples value chains throughout this book.

**Table 3.16 Shift to Higher Quality Rice** (% of average output)

| Rice Quality | Year and Farm Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1999 | 2009 | 1999 | 2009 | 1999 | 2009 | 1999 | 2009 |
| **Bangladesh** | **Marginal** (<1 ha) | | **Small** (≥1 ha) | | | | **All** | |
| Fine | 20 | 23 | 19 | 20 | | | 19 | 22 |
| Medium/common | 44 | 63 | 46 | 62 | | | 45 | 62 |
| Coarse | 37 | 15 | 36 | 19 | | | 36 | 17 |
| Total | 100 | 100 | 100 | 100 | | | 100 | 100 |
| **India** | **Marginal–Small** (<2 ha) | | **Semi-Medium** (≥2 ha <4) | | **Medium–Large** (≥4 ha) | | **All** | |
| Common | 96 | 85 | 96 | 86 | 96 | 80 | 96 | 83 |
| Fine | 4 | 15 | 4 | 14 | 5 | 20 | 4 | 17 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

ha = hectare.

Varieties were changed and quality was upgraded, such as the shift into fine rice and partly away from common rice in India, and the rapid shift to medium from coarse grade rice in Bangladesh. Interestingly, the study found no significant technology (or farm gate price) difference between coarse and common rice production in Bangladesh; this suggests there may be no capital or scale entry barrier for the production of medium and fine rice. The study also found that the production costs of the grades did not differ much, nor did the farm gate prices. Minten, Murshid, and Reardon (2012) argue that this quality change at the farm level has been driven by national and international agriculture centers' introduction of varieties (for agronomic reasons) that happen to be the higher (market) grades of rice.

## Farmers' Total Costs

Table 3.17 reproduces the last three rows of Table 3.4, to bring out the performance-related points in this section. The costs in Table 3.17, divided by average yields from the second to the last column of Table 3.15, can be compared with the prices per ton of common paddy ($175, $317, and $169 in Bangladesh, the PRC, and India, respectively) and are $126, $209, and $294 per ton. Thus, only in the India case did prices not cover total costs. Monetary costs per ton were $99 for Bangladesh, $192 for the PRC, and $112 for India—well above inputed in-kind costs in all three cases.

**Table 3.17 Farmers' Production Cost**
(total from Table 3.4 on technology/cost composition)

| Cost | Bangladesh | | PRC | | India | |
|---|---|---|---|---|---|---|
| | $/ha | % | $/ha | % | $/ha | % |
| Total cost (cash outlays plus imputed in-kind costs, 100% and total value) | 794 | 100 | 2,033 | 100 | 739 | 100 |
| Total monetary cost (value and share) | 625 | 79 | 1,350 | 66 | 428 | 58 |
| Total imputed in-kind costs (value and share of total cost) | 169 | 21 | 683 | 34 | 311 | 42 |

ha = hectare, PRC = People's Republic of China.

## Price Rice Farmers Received

Table 3.18 shows prices farmers received for their paddy: about $170/ton in Bangladesh and India but $371 in the PRC. Several factors may explain the difference: (1) the "official" (in reality, benchmark, price, given no strict enforcement mechanisms) was about 30% higher in the PRC than in India in 2009; (2) farm costs per hectare were about twice as high in the PRC, and in

**Table 3.18 Farm Size and Paddy Prices** ($/ton)

| Economy | Farm Size | | | |
|---|---|---|---|---|
| | Lowest | Middle | Highest | All |
| **Bangladesh** | 174 | 175 | | 175 |
| **China, People's Rep. of** | 356 | 398 | 364 | 371 |
| **India** | 163 | 165 | 173 | 169 |

Note: "Lowest" = "marginal" for Bangladesh and "marginal–small" for the People's Republic of China (PRC) and India; "Middle" = "small" for Bangladesh and "semi-medium" for the PRC and India; "Highest" = "medium–large" for the PRC and India. See Table 3.1 for the equivalent hectare sizes.

per ton terms, 1.3 times that in India and 1.6 times that in Bangladesh; and (3) the northeast PRC produces japonica, which in Beijing fetched twice the retail price of indica, the rice type produced in the southern PRC and South Asia.

## Conclusions Regarding the Rice Farm Segment

The study's key findings punch significant holes in the general view of Asia's staple farmers as "traditional," and of input and output markets as underdeveloped and static. Instead, the findings paint a picture of change and development in rice farming and the input and output markets that serve it. The key points are as follows:

(1) Contrary to the extant image of Asian farmers on millions of tiny farms, farm land sizes varied substantially, and there was evidence of land concentration (that is, in the larger farms) in a number of the study zones. Moreover, land rental markets were developing rapidly in all three economies, but were most advanced in the PRC and India zones.

(2) Within and across zones, farmers' possession of nonland assets (livestock, farm equipment, and irrigation) was substantially heterogeneous. Larger farms typically had more farm equipment (a substitute for labor), but somewhat less livestock (which is closely related to the livelihoods of the smaller, poor farmers, who rely somewhat more on dairy). Farmers in the PRC study zone were investing rapidly in farm equipment, resulting in an eightfold difference with the South Asian sites in capital intensity (perhaps compensating for a fivefold greater rural wage in the PRC).

(3) A surprising finding is that, in Bangladesh and India, tube well owners (larger farmers) sold a lot of water to small farmers who did not own tube wells. Tube well ownership was especially skewed toward medium and large farmers in India, and thus so is the distribution of subsidies supporting that ownership.

(4) The farmers were engaged in substantial amounts of rural nonfarm employment. In the South Asian study zones, local employment was far more common than migration for employment. In the PRC, local employment was also evident, but migration for employment dominated. That rural nonfarm employment was a major source of cash may help to explain why credit and output markets were no longer "tied" in these areas.

(5) The study found very broad participation in seed, fertilizer, and pesticide and herbicide markets among the farmers in all the zones. In nearly all cases, the smallest farmers were participating as fully as, and sometimes more than, the larger farmers. The state played a minor role in these markets in terms of direct sale of inputs. The new modern outlets, the rural business hubs in India, were currently a minor but emerging player.

(6) The input market stories for rice farming showed increased capital infusion in the PRC and greater use of labor in Bangladesh. However, the study did not find evidence of rapid yield growth, which was quite variable over study sites.

(7) Rather than major yield growth, the study found an increased quality of output, with variety change and quality upgrading, such as the rapid shift to medium from coarse grade rice in Bangladesh.

(8) Rice value chains in most of the study zones appeared to be shifting from traditional to an intermediate stage, with a decline in the role of the traditional rural middleman or village trader and the rise of direct sales from farmers to mills and wholesale markets. This means an incipient disintermediation of the value chain.

(9) Whereas the traditional literature on grain markets in Asia emphasizes (rightly, in a historical context) the linkage between credit and output markets, in which traders "tie" output transactions to their advancing credit to farmers, the study found this is currently rare. Nonfarm income, mobile phones, multiple trading sites, better roads, and other forms of credit had undermined this tie over time.

(10) While the authors expected small-scale farmers to receive lower prices than medium and larger farmers, the study found this to be rare. The hypothesized superior bargaining and social capital power of medium and larger farmers was not evident, at least not in the prices they received.

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# 4 Midstream—Transformation of the Rice Mill and Trader Segments

The "conventional wisdom" in policy circles is that staples value chains are still essentially dominated by "traditional" players and structures, except for a few modernizing pockets of changing technology and marketing practices with the advent of a small number of modern mills, cold storage companies, and logistics firms. That view appears to carry with it assumptions of characteristics of the midstream segment of staples value chains. These assumptions, as voiced by many of the study's key informants and in many policy forums, are as follows:

(1) Rice mills are still mainly small in scale and village based.

(2) The government plays a major role in the midstream of the value chain by procuring and distributing rice.

(3) The wholesale system has remained a "long chain of many hands"—where urban wholesalers buy from traders who bring rice from rural wholesale markets, which in turn depend on a web of rural brokers or village traders who are the main interface between the farmer and the market. (The off-market local traders are mostly based in villages or rural towns, and henceforth are referred to in this chapter as "village traders" for simplicity.)

The idea that the midstream is or could be a motor for capital investment and labor employment in the staples food economy has not arisen in the policy debate; nor has the idea that transformation is occurring in the midstream and can drive lower costs, better quality, and even improved "traceability" (the ability to trace a given bag of rice back through the value chain to its source in the production area). Where the midstream does enter the policy debate, it tends to pertain to fears of speculation, such as during India's recent onion crisis, or discussions termed the "traditional trader role" whereby traders capture farmers' profits by providing them with credit tied to the harvest. Yet few hard data are brought to the debate.

This chapter marshals the evidence from the midstream surveys in Bangladesh, the People's Republic of China (PRC), and India to assess the extent to which the staples midstream segment had retained the traditional trader–farmer role, the extent that this segment had changed, and the key characteristics of the change. The chapter first previews the main findings and then provides the details.

# Structure, Conduct, and Performance of Rice Mills

## Structure of the Rice Mill Segment of the Value Chain

**Characteristics of Rice Mills.** Table 4.1 shows characteristics of the rice mills. Several points stand out. The Bangladesh and PRC rice mills sampled started operating about a decade prior to the study, while the Indian mills started in the mid-1990s. Moreover, within each economy, the difference between the sizes of the large and small mills varied widely. In Bangladesh, large mills were twice as large as small ones, and in the PRC, the large mills were 10 times larger than the small ones.

**Table 4.1 Structure of the Rice Mill Segment**
(all figures are means unless otherwise stated)

| Mill Characteristics | Mill Type/Size | | | |
|---|---|---|---|---|
| | Small | Semi-Automatic/Medium | Automatic/Large | All |
| **Bangladesh** | | | | |
| Average start-up year | 1998 | 2000 | 1998 | 1999 |
| Capacity in 2009 (tons/day) | 33 | 42 | 73 | 51 |
| Capacity at start-up (tons/day) | 22 | 21 | 34 | 26 |
| Mill value (2009, $ '000) | 10 | 650 | 1,710 | 840 |
| **China, People's Rep. of** | | | | |
| Average start-up year | 1999 | 2001 | 2001 | 2001 |
| Capacity in 2009 (tons/day) | 32 | 133 | 350 | 94 |
| Capacity at start-up (tons/day) | 18 | 76 | 170 | 50 |
| Mill value (2009, $ '000) | 94 | 744 | 3,692 | 649 |
| **India** | | | | |
| Average start-up year | | 1995 | 1995 | 1995 |
| Capacity (high season) (tons/day) | | 100 | 68 | 92 |
| Milling capacity (off-season) | | 40 | 27 | 37 |
| Capacity (high season) at start-up | | 84 | 64 | 78 |
| Mill value (2009, $ '000) | | 169 | 127 | 149 |

Also, the PRC mills were larger (measured by capacity or worth) than the South Asian mills, whether on average or comparing the largest mills. Mills in the PRC's "large" category were 3–4 times larger than the large mills in the South Asian sample. But in all three economies, the investment required for the large and medium mills was very large, averaging $1.7 million for a large mill in Bangladesh and $3.6 million in the PRC. Even the small mills (in the villages) were not cheap relative to villagers' incomes: A small mill in a PRC village cost nearly $100,000; in Bangladesh, the cost was about $10,000. The large and medium mills are major business sector investments. Interestingly, major investment in rice by multinationals (such as Wilmar of Singapore) or large state-owned enterprises (such as the PRC's Zhong Liang) was evident only in the PRC.

Furthermore, the Bangladesh and PRC mills doubled in capacity from the start of their operations through 2009, while the Indian mills expanded only modestly. Interestingly, in Bangladesh and the PRC, the largest mill category added capacity (adding machines and/or time using the machines) fastest. Controlling for the number of mills, the survey data appear to suggest concentration in the mill sector (with the share of larger mills increasing).

Scale differences also show in the mills' storage of paddy before milling and rice after. In Bangladesh, an average mill owned about 2,000 tons of storage capacity, but the difference between automatic and small mills was a huge 36-fold: 3,165 tons for the automatic versus 86 tons for the small mills. In the PRC study zone (in Heilongjiang), the largest mill category could store 40,000 tons (much more than could the largest Bangladesh mill) and the smallest, 400 tons (versus 86 tons for the village mill in Bangladesh). In India, the two medium–large mill types surveyed stored 1,400–2,200 tons, similar to the Bangladesh sample, but smaller than in the PRC.

The study's evidence of concentration in the mill sector is corroborated by some descriptive literature concerning concentration and technological change in the mill sector in the countries, as follows:

In the PRC, most paddy was processed in town- or county-level mills (as opposed to village-level mills), of which there were an estimated 100,000 (McKee 2010). During 1999–2009, corporations with large-scale mills (about 25 firms) invested heavily and appear to have milled 20%–25% of the PRC's rice in 2009. Among them are large agribusiness firms in the PRC—Zhong Liang and Singapore's Wilmar ("Jia Li" in the PRC). He and Wen (2009) reported that the large mills in which large agribusiness firms invest in the PRC had capacities of 88–1,200 tons/day (the latter being three times the size of the large mills in the current study). He and Wen also noted that village mills with 5–10 tons/day capacities mostly disappeared in the second half of the 2000s. The remaining mills had capacities of 50–200 tons/day (roughly the range of the small to medium mills in the sample used for this book). In 2007, the PRC had about 7,600 milling companies; this had decreased 5% to 7,220 by 2008, and the number of mills with capacities of more than 400 tons/day had increased 42%, from 81 in 2007 to 115 in 2008. All these patterns point to an overall trend of concentration of milling in medium and larger mills.

The South Asian story further illuminates the tendency toward concentration in the milling segment, showing its link with technological change. In India, during the 1960s through the 1980s, huller mills gradually displaced manual milling. The first modernization initiative started in the early 1970s with policies promoting the adoption of shellers and hullers with shellers by subsidizing the existing mills' purchase of mechanical dryers, silos, mechanical handling, and conveyors. That meant the mills were being converted from "hullers" to "modern" mills. This first modernization drive had partial results: by the 1980s, only 1% of the mills in Bihar, 9% in West Bengal, 16%–60% in the rice zones of South India, 30% in Punjab, and 55% in Haryana had converted to modern mills (Harris-White 2005).

A second modernization initiative began in the early 1980s with a quest for modernization of metallic hullers (only those built after July 1984) by adding rubber rollers, shellers, centrifugal dehuskers, paddy cleaners, and separators. A central sector huller subsidy scheme was launched in the early 1990s, paying for half the conversion cost. The mills emerging from this second wave are called "modern mini mills" locally. The policy had some impact: by 1987 India had 124,347 registered rice mills: 63% were single hullers; 4%, shellers; 8%, hullers with shellers disk sellers; and 25%, modern mini mills (Nayak 1996). But scale was still limited, due to the "reservation" policy that kept large-scale mills out by reserving the processing section in general to small-scale firms.

A third initiative was launched in India in 1997 with the "dereservation" of rice milling, thus allowing large-scale plants to be established such as mills with hourly capacities of 3 tons or more. At the same time, major investments in mills were made, often exceeding $1 million per mill, with the introduction of fully automatic milling equipment such as automatic cleaners, graders, dryers, separators, destoners, and computerized packaging and sorting units. These are the fully and semi-automatic one-line processing units that figured in the current survey results (the survey did not cover the mini mills or the remaining few small hullers in the villages). From 1987 to 1999, the number of mills increased by 12% to 138,898. Of these, 25% were modern mills; 6% were huller-cum-disk shellers, or rubber rollers; 3% were shellers; and 66% were single hullers (Government of India 2003). While the number of single hullers and modern mills increased by 17% and 12%, respectively, from 1987 to 1999, the hullers-cum-disk shellers decreased by almost 19%.

**Capacity Utilization and Seasonality in Rice Mills.** Table 4.2 shows the seasonality of the mills' capacity utilization in the PRC and India. Seasonality was very pronounced and the utilization rate was rather low even in the peak seasons, at only 30% in the PRC and 42% in India. Storage was sharply seasonal. In India, the mills essentially did not store and release in the months far from the harvest season. During and right after the main harvest months (October to December), the mills' average storage was about 1,700 tons/month; it dropped to 1,000 tons in January and then waned to very low amounts until the next harvest. The rice storage mirrored seasonal harvest patterns.

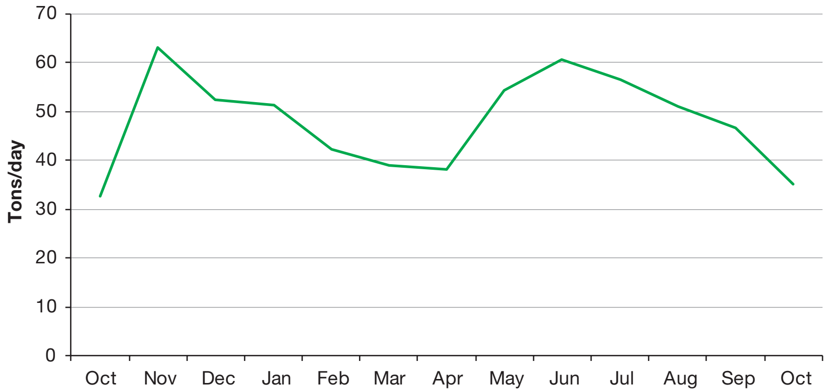
Moreover, the smaller the mill, the lower was the capacity utilization rate. This factor could have been driving concentration of the mill sector into larger strata if smaller mills were less competitive.

Also, the mills worked much longer periods each year in the PRC (102, 198, and 332 days for small, medium, and large mills) than in India, where they ran for about 3 months straight (96 days) during the harvest season, and then only 25 days in the rest of the year. During the off-season, the mills were cleaned and repaired and then lay idle until the next harvest season. Figure 4.1 shows the seasonality of milling in Bangladesh. As with the PRC case, the utilization rate dropped sharply between harvest seasons.

**Table 4.2 Capacity Utilization Rate of Rice Mills by Season**
(sample-weighted averages, %)

| Zone and Season | Mill Type/Size | | | |
|---|---|---|---|---|
| | Small | Semi-Automatic/ Medium | Automatic/ Large | All |
| **China, People's Rep. of** | | | | |
| Harvest season | 27 | 27 | 58 | 30 |
| Slack time | 3 | 37 | 38 | 17 |
| **India** | | | | |
| Harvest season | | 35 | 61 | 42 |
| Slack time | | 6 | 0 | 4 |

**Figure 4.1 Bangladesh Rice Mill Capacity Utilization**
(average tons/day)




## Rice Mill Segment: Procurement, Sales, Finance, and Other Services

**Paddy Procurement.** Table 4.3 shows the mills' paddy sources. The patterns differed sharply between Bangladesh and the PRC on the one hand and India on the other. The PRC's medium mills at the township level and small mills at the village level acquired nearly all their paddy directly from farmers, eschewing village traders, and the large mills sourced from traders who collected in the local villages and delivered to the county-level mill. Only in the PRC were farmers contracted by large and medium mills to sell their rice, and contracting was still uncommon. Bangladesh's small village mills directly purchased 63% of their paddy from farmers, and the medium mills directly purchased 38% of their paddy. The district-level traders (*bepari*) acted primarily as collectors for the large district-level mills, as in the PRC.

Thus, Bangladesh and PRC mills can be said to have disintermediated paddy acquisition by mainly buying directly from the farmers. However, as the largest mills must depend on a large catchment area to fill their huge capacities, they relied more on collectors. As milling is increasingly concentrated in the larger scale operators in the sector, the long-term trend may be greater use of traders serving the increasingly important large mills, with perhaps an eventual concentration in the trader segment, or direct purchase programs put in place by the larger mills.

**Table 4.3 Rice Mills' Procurement of Paddy (%)**

| Procurement Channel | Mill Type/Size | | | |
|---|---|---|---|---|
| | Small | Semi-Automatic/ Medium | Automatic/ Large | All |
| **Bangladesh** | | | | |
| Directly from farmers | 63 | 38 | 15 | 38 |
| Traders (district-level only) | 37 | 62 | 85 | 62 |
| Total | 100 | 100 | 100 | 100 |
| **China, People's Rep. of** | | | | |
| Directly from farmers | 98 | 78 | 0 | 83 |
| Farmers (contracted) | 0 | 8 | 13 | 4 |
| Traders | 2 | 10 | 70 | 11 |
| Government | 0 | 3 | 0 | 1 |
| Cooperative | 0 | 0 | 18 | 2 |
| Total | 100 | 100 | 100 | 100 |
| **India** | | | | |
| Directly from farmers | | 26 | 21 | 25 |
| Traders on wholesale market | | 21 | 24 | 22 |
| Village traders | | 10 | 11 | 10 |
| PACS | | 44 | 43 | 43 |
| Total | | 100 | 100 | 100 |

PACS = primary agricultural credit societies.

By contrast, India's mills procured paddy from a wider array of sources, including 25% from farmers directly, but the mills' main source (43%) was the government. The mills purchased paddy through the government cooperatives—primary agricultural cooperative societies—and/or Food Corporation of India (FCI) stalls at wholesale markets. In some years, FCI used mills for custom milling, but in the survey year in the study zone, the mills interviewed did not custom mill for the government; rather, the portion of paddy they acquired from the government was bought from the primary agricultural credit societies and/or FCI stalls in the wholesale market. The mills noted that this share (43%) was roughly the magnitude of paddy they had sourced from the government over the years, whether by buying, custom milling, or both. The magnitude of the Indian government engagement in the paddy market was unique in most of Asia (Rashid, Cummings, and Gulati 2007).

**Rice Mills' Sales.** Table 4.4 shows rice mills' sales to types of buyers. Several points stand out.

First, as with paddy sourcing, the importance of the government as a rice buyer from Indian mills was sharply different from the Bangladesh and PRC

**Table 4.4 Rice Mills' Sales by Source and Mill Size**
(averages of mills in each stratum of shares of all rice sold by the mills, %)

| Buyer | Mill Type/Size | | | |
|---|---|---|---|---|
| | Small | Semi-Automatic/ Medium | Automatic/ Large | All |
| **Bangladesh** | | | | |
| Government | 11 | 7 | 3 | 7 |
| Village traders | 0 | 16 | 6 | 7 |
| Traders on rural wholesale markets | 77 | 44 | 36 | 53 |
| Traders on wholesale markets in Dhaka | 0 | 17 | 15 | 10 |
| Traders on urban wholesale markets other than Dhaka | 11 | 12 | 33 | 20 |
| Traditional retailers | 0 | 4 | 6 | 3 |
| Modern retailers | 0 | 0 | 0 | 0 |
| Total | 100 | 100 | 100 | 100 |
| **China, People's Rep. of** | | | | |
| Government | 0 | 3 | 0 | 1 |
| Village traders | 11 | 17 | 4 | 12 |
| Other mills in rural district | 23 | 22 | 0 | 21 |
| Rural wholesale markets in production area | 10 | 3 | 1 | 7 |
| Wholesale market in Beijing | 15 | 2 | 5 | 10 |
| Wholesale markets in other cities | 39 | 47 | 90 | 46 |
| Directly to traditional retailers in Beijing | 0 | 0 | 0 | 0 |
| Directly to traditional retailers in other places | 2 | 7 | 0 | 3 |
| Directly to supermarkets | 0 | 0 | 0 | 0 |
| Total | 100 | 100 | 100 | 100 |
| **India** | | | | |
| Government | | 58 | 60 | 59 |
| Village traders | | 17 | 14 | 16 |
| Traders on wholesale markets | | 24 | 24 | 24 |
| Traditional retailers | | 1 | 2 | 1 |
| Supermarkets | | 0 | 0 | 0 |
| Directly to consumers | | 0 | 0 | 0 |
| Total | | 100 | 100 | 100 |

cases. Mills in Shahjahanpur sold fully 59% of their rice to the government; this is close to the 60% of the official requirement, with the rice moving into the Public Distribution System managed by the parastatal, FCI. The share to the government (7%) reported by the mill sample in Bangladesh can be compared with the government's nationwide target in the survey year, which was to procure 1% of rice output (Mondal 2010). In the PRC, the share was even smaller; the mills reported that only 1% of their rice was sold to the government. While the PRC government nationwide intervened much less in the rice market as a buyer than did the Indian government, its purchases were primarily of indica in the southern PRC in the early spring, to release stocks later in the year to smooth prices.

Second, large mills in Bangladesh and the PRC tended to sell directly to urban wholesale markets, as did (to a lesser degree) small mills in the PRC. The urban rice wholesale section showed that an important part of the mills' rice was sold via agents representing one or two mills.

Third, small mills in Bangladesh tended to sell to rural wholesale markets. Interestingly, small mills in the PRC also sold to large mills, presumably to allow them to complete orders and further polish the husked rice.

Fourth, in all the study zones, only a very small share of the mills' rice was sold directly to traditional retailers, and none to supermarkets. In the Beijing rice retail study, retailers noted that they sourced from both urban wholesale markets and from mills, but mainly from the very large mills.

The overall picture in the three economies is of a tight relation among farmers, mills, and wholesale markets—with a very minor role for traditional rural brokers among these segments. This could be part of shortening the value chains, of disintermediation.

**Rice Mills and Value-Chain Finance.** Table 4.5 shows how rice mills received value-chain finance from clients and suppliers and provided it to them. The following points show active value-chain financing in various directions.

First, mills provided value-chain finance in two ways. On the one hand, mills provided finance to paddy suppliers and rice buyers. Bangladesh and PRC mills were more apt to make advances to paddy suppliers (at 34% and 45% of their mills, respectively) than were Indian mills (at 13%). In Bangladesh, 18%[1] of the paddy suppliers received advances, while only 13% did so in India. Moreover, mills provided de facto credit to rice clients by allowing them to pay with a delay after receiving the rice shipment: this was most common in South Asia (with 41% of Bangladesh and 48% of Indian mills allowing delayed payment), but less so in the PRC (with 17% of mills).

On the other hand, mills received finance from suppliers and buyers. They got de facto credit from farmers and other suppliers by paying them with a delay

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[1] The share is derived from the share of mills giving advances times the average share of suppliers given advances by mills that give advances.

**Table 4.5 Rice Mills: Timing and Source of Payments (%)**

| Credit Flow | Mill Type/Size | | | |
|---|---|---|---|---|
| | Small | Semi-Automatic/ Medium | Automatic/ Large | All |
| **Bangladesh** | | | | |
| Mills that paid advances to suppliers | 43 | 43 | 25 | 34 |
| Mills' suppliers paid with delay | 34 | 40 | 31 | 34 |
| Mill clients that paid with delay to mills | 40 | 33 | 47 | 41 |
| Mills that got advances from clients | 0 | 40 | 25 | 20 |
| Clients of all mills that gave advances to mills | 0 | 14 | 10 | 7 |
| **China, People's Rep. of** | | | | |
| Mills that paid advances to suppliers | 50 | 33 | 50 | 45 |
| Mills that paid with delay to suppliers | 58 | 67 | 0 | 55 |
| Mills' suppliers paid with delay | 14 | 22 | 0 | 13 |
| Clients that paid with delay to mills | 22 | 11 | 0 | 17 |
| Mills that got advances from clients | 50 | 83 | 50 | 60 |
| Clients of all mills that gave advances to mills | 17 | 17 | 25 | 18 |
| **India** | | | | |
| Mills that paid advances to suppliers | | 14 | 10 | 13 |
| Mills' suppliers paid with delay | | 19 | 23 | 20 |
| Clients that paid with delay to mills | | 41 | 67 | 48 |
| Mills that got advances from clients | | 6 | 14 | 8 |
| Clients of all mills that gave advances to mills | | 10 | 10 | 10 |

after receiving the paddy. This was most common in the PRC (55% of the mills) and least common in India (only 20% of the mills). Moreover, mills received advances from the clients (20% of mills in Bangladesh, 60% in the PRC, and 8% in India). However, the share of the clients providing this credit was small—only 7%–18%.[2]

To get a rough idea of the importance of mill credit relations in the value chain, add the shares in the last column in Table 4.5. The result is that the PRC scores higher than the South Asian sites. For the four kinds of value-chain finance relations, the PRC averaged 44% of mills, versus 32% for Bangladesh and 22% for India. The reasons for the pattern require further investigation.

Finally, value-chain finance had limited reach. Only 18% of the paddy suppliers in Bangladesh and 13% in India actually had advances from the mills, and only 7%–18% of mills received credit from their clients across the three economies.

[2] Further exploration is needed as to what types of clients interact with the mills in value-chain finance relations.

**Other Services.** Table 4.6 shows services other than value-chain finance that the mills provided to suppliers and clients. Mills rarely provided farm production support. Only a few larger mills in the PRC sold seed or chemicals or provided extension services to farmers. However, most of the Bangladesh mills, the large PRC mills, and a few Indian mills provided bags to their suppliers.

**Table 4.6 Rice Mills' Provision of Services Other than Credit** (% of farmers)

| Service | Mill Type/Size | | | |
|---|---|---|---|---|
| | Small | Semi-Automatic/ Medium | Automatic/ Large | All |
| **Bangladesh** | | | | |
| Arranged farmers' access to seed | 0 | 0 | 0 | 0 |
| Share of farmers who got seed via mills | 0 | 0 | 0 | 0 |
| Arranged farmers' access to crop chemicals | 0 | 0 | 0 | 0 |
| Share of farmers who got crop chemicals via mills | 0 | 0 | 0 | 0 |
| Agricultural extension to farmers | 0 | 0 | 0 | 0 |
| Provided bags to suppliers | 85 | 80 | 75 | 80 |
| Provided bags to clients | 85 | 60 | 62 | 70 |
| Transport from farm to mill | 100 | 100 | 62 | 85 |
| Transport from mill to buyer | 100 | 100 | 100 | 100 |
| **China, People's Rep. of** | | | | |
| Arranged farmers' access to seed | 8 | 33 | 50 | 20 |
| Share of farmers who got seed via mills | 2 | 17 | 10 | 8 |
| Arranged farmers access to crop chemicals | 0 | 0 | 50 | 5 |
| Share of farmers who got crop chemicals via mills | 0 | 0 | 10 | 1 |
| Agricultural extension to farmers | 25 | 17 | 100 | 30 |
| Provided bags to their suppliers | 33 | 66 | 100 | 40 |
| Provided bags to their clients | 100 | 100 | 50 | 95 |
| Transport from farm to mill | 100 | 83 | 100 | 85 |
| Transport from mill to buyer | 67 | 100 | 50 | 75 |
| **India** | | | | |
| Arranged farmers' access to seed | | 0 | 0 | 0 |
| Share of farmers who got seed via mills | | 0 | 0 | 0 |
| Arranged farmers access to crop chemicals | | 0 | 0 | 0 |
| Farmers who got chemicals via mills | | 0 | 0 | 0 |
| Agricultural extension to farmers | | 6 | 14 | 8 |
| Provided bags to suppliers | | 17 | 0 | 12 |
| Provided bags to clients | | 83 | 100 | 88 |
| Transport from farm to mill | | 56 | 100 | 68 |
| Transport from mill to buyer | | 83 | 100 | 88 |

Mills were increasingly bagging and packaging the rice they sold. In Bangladesh, in 1999, 5% of all rice sold by the mills was bagged, but by 2009 this had risen to 36%. In the PRC, this trend had gone much further, with mills increasingly packaging and branding their rice, not just niche rice but the broad range of rice types as well.

Finally, in all the economies, mills commonly provided transport for the paddy to the mills and the rice to the clients. This was important for the mills to sidestep intermediaries.

## Performance of the Rice Mill Segment: Quality, Costs, and Profits

**Rice Quality and Rice Mill.** Table 4.7 shows changes in quality over time and differences across mill sizes. Quality is defined by the size and shape of the grain (usually a longer, thinner grain is considered higher quality); other attributes that factor into quality include the degree of polishing (whiteness), taste, cleanliness (degree of foreign matter), amount of broken rice, and age of the grain. Quality can be conferred by the variety of rice, when and where it is harvested, and how it is milled (including degree of polishing and shaping, for example, to upgrade the rice's appearance by thinning it). For simplicity, the mills were surveyed about quality using only the three general categories used in trading, which relate mainly to the shape of the kernel—coarse, common, and fine. Several points emerged from the data.

**Table 4.7 Rice Quality and Rice Mills** (% of types)

| Rice Quality | Mill Type/Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Small | | Semi-Automatic/ Medium | | Automatic/ Large | | All | |
| **Bangladesh** | **1999** | **2009** | **1999** | **2009** | **1999** | **2009** | **1999** | **2009** |
| Coarse | 52 | 33 | 30 | 25 | 55 | 42 | 49 | 34 |
| Medium | 34 | 59 | 20 | 33 | 25 | 29 | 27 | 40 |
| Fine | 14 | 9 | 50 | 42 | 20 | 29 | 24 | 25 |
| Total | 100 | 101 | 100 | 100 | 100 | 100 | 100 | 99 |
| **China, People's Rep. of** | **2004** | **2009** | **2004** | **2009** | **2004** | **2009** | **2004** | **2009** |
| Common regular | 7 | 9 | 38 | 19 | 50 | 20 | 21 | 13 |
| Fine regular | 57 | 45 | 62 | 81 | 50 | 80 | 58 | 59 |
| Sticky | 36 | 46 | 0 | 0 | 0 | 0 | 21 | 28 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **India** | | | **1999** | **2009** | **1999** | **2009** | **1999** | **2009** |
| Common | | | 86 | 87 | 99 | 95 | 89 | 90 |
| Fine | | | 14 | 13 | 1 | 5 | 11 | 11 |
| Total | | | 100 | 100 | 100 | 100 | 100 | 100 |

The amount of coarse rice produced in Bangladesh had decreased by 15 percentage points from 1999 to 2009. Concurrently, the share of medium (common) quality rice increased by 13 percentage points, and of fine rice, by 1 percentage point. The larger mills made a greater shift in quality than the smallest mills. In the PRC, the mills made smaller shifts (and the period of recall was shorter—2004–2009). During that period, the share of common rice in the study zone's mills declined by 8 percentage points, and the share of fine edged up by 1 percentage point. There were pronounced differences between the mill scales: the larger mills made a major shift from common to fine, while the small mills made little shift between these types, but moved more into sticky rice (which is their niche, as the larger mills did not deal in sticky rice). India showed the least change in quality, with common rice remaining at about 89% of their volume, and fine at about 11%.

In summary, the fastest shift in quality was in Bangladesh, followed by the PRC, with little shift at the mill level in India. The shift was much greater, controlling for economy, among larger mills, which could be fueling the observed concentration in the mill segment.

**Rice Mill Costs.** Table 4.8 details milling costs. As expected, due to the scale difference, yearly costs of PRC mills were roughly double those of the South Asia sample. However, on a daily basis, the PRC costs were a third higher than India's (measured in the same year and hence with no inflation effect). This could be due to the substantially higher labor wage in the PRC than in India. Interestingly, there was some evidence of economies of scale in the PRC: While capacity increased 10-fold between the smallest and largest mill strata, costs increased only 6.5 times.

The labor share was important for all, forming more than 40% of the costs for the Bangladesh and PRC mills and 33% for the India mills; while modern mills are by definition more capital intensive than the manual milling they displaced, they nevertheless were important employment sources. Electricity was a substantial item, at 11% in Bangladesh and 13% in the PRC, but was only 1% in India. However, in India the diesel that the mills used to generate their own electricity consumed 51% of their costs. Costs of mills are thus sensitive to energy costs, both directly in electricity costs and indirectly in fuel costs. Finally, most mills transported paddy to the mill and rice to the client; transport costs are especially high in Bangladesh at 45%, versus 14% in the PRC and India. Fuel is a major part of mills' costs, and thus is indirectly an important element in consumer rice prices.

**Table 4.8 Average Annual Costs per Mill**
($ '000; figures in parentheses are % of total costs)

| Cost Component | Mill Type/Size | | | |
|---|---|---|---|---|
| | Small | Semi-Automatic/ Medium | Automatic/ Large | All |
| **Bangladesh** | | | | |
| Labor (permanent plus casual) | 8 (57) | 82 (47) | 204 (39) | 105 (41) |
| Electricity | 1.5 (11) | 19 (11) | 56 (11) | 28 (11) |
| Own truck operation | 0 (0) | 13 (7) | 15 (3) | 9 (3) |
| Rental truck operation | 2.6 (19) | 55 (31) | 235 (44) | 109 (42) |
| Taxes | 0.2 (1) | 3 (2) | 3 (1) | 2 (1) |
| Other costs | 1.4 (10) | 3 (2) | 12 (2) | 6 (2) |
| Total yearly operating costs | 14 (100) | 175 (100) | 524 (100) | 258 (100) |
| **China, People's Rep. of** | | | | |
| Labor (permanent plus casual) | 12 (23) | 184 (28) | 494 (44) | 224 (43) |
| Electricity | 11 (21) | 76 (12) | 360 (32) | 65 (13) |
| Warehouse rental | 0.15 (.2) | 185 (28) | 31 (3) | 57 (11) |
| Own truck operation | 6 (14) | 23 (4) | 0 (0) | 11 (2) |
| Rental truck operation | 23 (43) | 162 (25) | 31 (3) | 64 (12) |
| Taxes | 1 (2) | 27 (4) | 14 (1) | 10 (2) |
| Other costs | 0 (0) | 0 (0) | 185 (17) | 91 (17) |
| Total yearly cost | 53 (100) | 656 (100) | 1,114 (100) | 521 (100) |
| Total days in operation during year | 102 | 198 | 332 | 154 |
| Daily costs ($ '000) | 0.51 | 3.31 | 3.35 | 3.38 |
| **India** | | | | |
| Labor (permanent plus casual) | | 85 (31) | 85 (36) | 85 (33) |
| Electricity | | 2 (1) | 2 (1) | 2 (1) |
| Diesel | | 142 (51) | 120 (51) | 133 (51) |
| Rental truck operation | | 44 (16) | 27 (11) | 36 (14) |
| Taxes | | 0 (0) | 0 (0) | 0 (0) |
| Others | | 4 (1) | 3 (1) | 4 (2) |
| Total yearly cost | | 278 (100) | 237 (100) | 259 (100) |
| Total days in operation during year | | 119 | 124 | 121 |
| Daily cost ($ '000) | | 2.34 | 1.90 | 2.14 |

Note: Numbers may not add to totals due to rounding.

**Rice Mill Profits.** Table 4.9 shows that the mills' profit rates and internal rates of return were appreciable but varied across mill strata. The rates are gross of amortization of capital, due to the difficulties of costing out capital and its rate of being used up and replaced. The profit rates shown do not differ much from the few other studies on mill profits examined; for example, Chowdhury (1992), using mill survey data collected by the International Food Policy Research Institute in 1989/90, found mill profit rates of 24%–42%, depending on the type of mill.

**Table 4.9 Rice Mill Profit Rates and Internal Rates of Return (%)**

| Zone | Profit Rates by Mill Type/Size | | | | Internal Rates of Return |
|---|---|---|---|---|---|
| | Small | Semi-Automatic/ Medium | Automatic/ Large | All | |
| **Bangladesh** | 32 | 56 | -0.5 | 28 | 10 |
| **China, People's Rep. of** | | 34 | | 34 | 7 |
| **India** | | 32 | 13 | 24 | 13 |

# Structure, Conduct, and Performance of Rice Traders

## Structure: Characteristics and Seasonality in Paddy and Rice Trading

Table 4.10 shows characteristics of rural traders based off-market (outside the rural wholesale market, with a base in either a rural town or a village), of traders in rural wholesale markets, and of traders in Dhaka and Delhi wholesale markets. The traders were middle-aged, male, and fairly educated: 64% in Bangladesh and 89% in India had more than 9th grade education. Most had started their trade in the early 1990s.

Trading requires substantial capital. Traders in Bangladesh commanded assets valued at $15,000 and those in India averaged $7,000 (with more assets being positively correlated with trading in urban areas). However, there was striking concentration in the assets. In Bangladesh, while the average was $15,000, the median was only $715, showing the skewed distribution that was common internationally in the wholesale sector. The upper end of the distribution was mainly traders in urban areas who owned several trucks. Working capital was also substantial (more than $35,000 in Bangladesh and $11,000 in India, again, increasing from village trader to rural wholesaler to urban wholesaler). In India, about 69% of traders owned or rented a warehouse, averaging 2 tons, a modest storage.

Table 4.11 shows characteristics of Beijing rice wholesalers. Of great interest is the finding that 37% of the wholesalers were actually agents of single mills; 84% of the mills they represented were large mills, and 16% were medium scale; no agent represented a small mill. One example is the son of a family that owned a mill in Heilongjiang. He set up shop in the wholesale market in Beijing and had posters of the family mill and the branded bags in his stall. Another is a woman who had one of the largest stalls in Jinxiadadi and was the mother of a man who ran a mill in Heilongjiang. In the markets surveyed, agents displayed their brand as a poster, and their bags were all branded. Indeed, most rice was sold bagged and branded, usually with a colorful and distinctive label that provided information on the type, quality, and geographic origin of the rice, plus the name and brand of the mill.

**Table 4.10 Characteristics of Paddy and Rice Traders in Bangladesh and India**

| Characteristics | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
| **Bangladesh** | | | | |
| Age (years) | 45 | 44 | 44 | 44 |
| Gender (% male) | 100 | 100 | 100 | 100 |
| Education (%): | | | | |
| 6–9 years | 24 | 27 | 17 | 23 |
| 10 or more years | 58 | 57 | 76 | 64 |
| Current working capital ($ '000) | 6.8 | 47.5 | 35.7 | 35.8 |
| Share from own funds (%) | 92 | 97 | 100 | 97 |
| Value of food trade assets owned ($ '000) | 2.81 | 3.21 | 39.00 | 15.19 |
| Year started trading | 1992 | 1990 | 1988 | 1990 |
| Trades rice seed (% yes) | 0 | 7 | 3 | 4 |
| **India** | | | | |
| Age (years) | 49 | 45 | 43 | 47 |
| Gender (% male) | 100 | 100 | 100 | 100 |
| Education (%) | | | | |
| 6–9 years | 34 | 9 | 3 | 11 |
| 10–12 years | 52 | 76 | 64 | 69 |
| Postsecondary | 14 | 15 | 33 | 20 |
| Retailers (%) who trade in | | | | |
| Paddy only | 100 | 55 | 0 | 42 |
| Rice only | 0 | 45 | 100 | 58 |
| Year started trading | 2000 | 1993 | 1990 | 1993 |
| Traders who also sold other products (%) | 87 | 100 | 36 | 74 |
| Rice in total volume of sales per trader (%) | 37 | 43 | 72 | 50 |
| Traders (%) with | | | | |
| Own warehouses | 40 | 48 | 45 | 45 |
| Rented warehouses | 7 | 29 | 27 | 24 |
| Average warehouse capacity (tons) | 0.4 | 1.0 | 3.1 | 1.7 |
| Average number of trucks owned per trader | 1 | 1 | 1 | 1 |
| Working capital and business assets | | | | |
| Current working capital per trader ($) | 6,667 | 11,110 | 15,556 | 11,111 |
| Share of own funds in current working capital (%) | 66 | 72 | 59 | 69 |
| Food trade business assets owned ($'000) | 1.3 | 4.4 | 8.9 | 6.7 |
| Staff members per trader | 3 | 4 | 7 | 6 |

**Table 4.11 Characteristics of Rice Traders and Wholesalers in Beijing**

| Characteristic | Share or Amount |
|---|---|
| Type of trader/wholesalers (one trader can have multiple answers, %) | |
| Wholesaler at wholesale market | 87 |
| Broker based in Beijing, selling on commission for rice mills | 0 |
| Agent/representative based in Beijing, working with/for one rice mill | 37 |
| Wholesaler based in production area bringing rice to Beijing | 7 |
| Type of mill wholesaler-traders bought from (one wholesaler can have multiple answers, %) | |
| Small mill | 0 |
| Semi-automatic mill | 16 |
| Automatic mill | 84 |
| Paddy and rice in wholesaler's total volume traded (%) | 97 |
| Wholesalers who also owned rice mills (%) | 13 |
| Traders' warehouses (%) | |
| Traders who owned no warehouse | 80 |
| Traders who owned 1 warehouse | 13 |
| Traders who owned more than 1 warehouse | 7 |
| Traders who only rented warehousing | 100 |
| Average warehouse capacity (tons; simple average over traders) | 176 |
| Traders' use of trucks or vans (%) | |
| No truck or van | 27 |
| 1 truck or van | 47 |
| More than 1 truck or van | 27 |
| Of traders operating van/truck, share that only rented | 82 |

The majority of the traders rented warehouses, and about 20% owned them. The average warehouse could contain 176 tons, and was thus much larger than the average warehouse in urban South Asia (at 3 tons). About 74% of the traders operated trucks, but only 18% of them owned their vehicles; the others rented. About 20%–25% of the Beijing traders had more assets and scale than the other traders, as in the South Asia case.

Table 4.12 shows the seasonality of the traders' sales. In urban wholesale markets, seasonality was low, as they were working from reserves and sourcing from diverse production zones. In the peak season, sales per trader per day in urban wholesale markets were about twice as high in Delhi and Beijing (about 14 tons) as in Dhaka (7 tons), showing sharply different operational scales.

Sales per trader in India's rural wholesale markets were smaller (about 7 tons of paddy and 9 tons of rice at peak times) than in the urban markets, but in Bangladesh the rural wholesaler sold more than double his urban counterpart in peak season. In fact, the rural wholesale market trader in Bangladesh moved twice the volume per day that the Indian counterpart did. But for all rural traders in both countries, seasonality was pronounced, with the peak season's volume roughly double that in the slack season.

**Table 4.12 Rice Traders' Seasonality** (average tons/day)

| Season | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
| **Bangladesh**[a] | | | | |
| Aman (Dec/Jan 2009) | 7 | 12 | 6 | 9 |
| Boro harvest (Apr–May 2009) | 10 | 19 | 6 | 13 |
| Aus harvest (Aug–Sep 2009) | 10 | 13 | 6 | 11 |
| Slack season (Oct–Dec 2009) | 11 | 9 | 6 | 8 |
| **China, People's Rep. of** | | | | |
| Start of harvest Aug–Oct 2009 | | | 12 | 11 |
| End of harvest plus main sales Nov 2009–Jan 2010 | | | 13 | 13 |
| Feb–Apr 2010 | | | 8 | 8 |
| May–Jul 2010 | | | 8 | 8 |
| **India** | | | | |
| Paddy, tons sold per day | | | | |
| Jan–Mar 2009 | 2 | 2 | | 2 |
| Apr–Jun 2009 | 3 | 5 | | 5 |
| Jul–Sep 2009 | 2 | 3 | | 3 |
| Oct–Dec 2009 | 3 | 7 | | 5 |
| Rice, tons sold per day | | | | |
| Jan–Mar 2009 | | 4 | 14 | 10 |
| Apr–Jun 2009 | | 5 | 16 | 13 |
| Jul–Sep 2009 | | 6 | 15 | 13 |
| Jan–Mar 2010 | | 9 | 15 | 13 |

[a] Aman, aus, and boro are the three seasons of rice production in Bangladesh.

## Conduct: Procurement and Sales, Value-Chain Financing, and Other Services of the Rice and Paddy Traders

**Procurement and Sales.** Table 4.13 shows the traders' sources. The village traders procured nearly all their paddy directly from farmers.

Rural wholesale market traders in the South Asian sites procured a surprising amount directly from farmers rather than from village traders; this contradicts the historical information noted in the next paragraph, and is thus evidence of transformation of markets in these zones. In the Bangladesh study zone, village traders had no role in supplying the rural wholesale markets directly with paddy; the rural wholesale markets procured all their paddy from the farmers (and that is all of the farmers' paddy) and their rice from small mills. In India, the rural wholesale markets bought 83% of their paddy from farmers.

Of that, the markets bought half from the farms and transported it to the market and the farmers brought the other half to the market for sale. Only the remaining 15% was procured from village traders.

The authors did not collect historic information from the study district about the share of rural brokers in distribution. But other studies in like places point to a preponderance of the rural broker's role (and of direct sale to consumers). The

**Table 4.13 Rice and Paddy Traders' Sources**
(% of volumes traders bought)

| Source | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
| **Bangladesh** (paddy and rice) | | | | |
| Farmers | 71 | 47 | 0 | 39 |
| Village and town traders | 11 | 3 | 0 | 3 |
| Small mills | 0 | 49 | 38 | 36 |
| Semi-automatic mills | 2 | 0 | 0 | 0 |
| Automatic mills | 2 | 0 | 0 | 0 |
| Wholesale markets | 0 | 1 | 60 | 20 |
| Other sources | 0 | 0 | 3 | 1 |
| Total | 100 | 100 | 100 | 100 |
| **China, People's Rep. of** (rice only) | | | | |
| Farmers | … | … | 2 | 2 |
| Wholesalers in production area | … | … | 10 | 10 |
| Mill | … | … | 87 | 87 |
| Broker from production area | … | … | 0 | 0 |
| Other wholesalers in Beijing | … | … | 0 | 0 |
| Other sources | … | … | 2 | 2 |
| Total | … | … | 100 | 100 |
| **India** (paddy only) | | | | |
| Farmers in villages | 100 | 38 | na | 61 |
| Village traders | 0 | 14 | na | 9 |
| Farmers in wholesale markets | 0 | 45 | na | 29 |
| Wholesale market traders | 0 | 2 | na | 2 |
| Total | 100 | 100 | na | 100 |
| **India** (rice only) | | | | |
| Government | 0 | 0 | 0 | 0 |
| Small mills | 0 | 0 | 0 | 0 |
| Semi-automatic mills | 0 | 0 | 16 | 9 |
| Automatic mills | 0 | 0 | 49 | 30 |
| Village traders | 0 | 0 | 0 | 0 |
| Wholesale market traders | 0 | 100 | 35 | 61 |
| Total | 0 | 100 | 100 | 100 |

… = no data collected due to small sample, as mills bought mainly directly from farmers; na = not applicable.

reliance on local traders was correlated with small- and medium-scale farmers (see, for example, Sarkar [1981] using a large data set collected by Rudra and Bardhan in West Bengal). Lele (1971) cites evidence of the preponderance of village traders in the rice trade in Orissa, Tamil Nadu, and Uttar Pradesh during the late 1960s, while Maharashtra wholesalers from the wholesale markets were buying rice directly from the villages.

The current study results for rural markets in South Asia are similar to those found in the PRC—that the mills sourced the great majority of their paddy directly from farmers (except for the largest mills, which still relied to some extent on local traders).

Regarding urban wholesale traders' procurement of rice, the surprising findings are that the survey data overturn the presumption of extensive intermediation from the mills to the urban markets. In the PRC, urban wholesalers sourced 87% of the rice they sold directly from rural mills, with only 10% coming from rural-based wholesalers. In India, 65% was sourced direct from medium and large rural mills (not small mills); only 35% was from rurally based wholesalers. While Bangladesh presented the most traditional case, a substantial share (38%) of its rice went directly from small mills to Dhaka markets, with the rest coming from rural wholesalers moving the rice to the urban markets. These findings show substantial disintermediation of the rural–urban rice supply chain.

Table 4.14 shows sales destinations of traders. Village traders in Bangladesh sold only 28% of their paddy to rural wholesale markets; the great majority (63%) was sold directly to large and medium—not small—mills. The small mills were buying directly from farmers; as in the PRC, the larger mills combined sourcing from village traders and directly from farmers. In India, village traders sold 53% of their paddy to mills—again, large and medium, not small, mills. Key informants emphasized that the remaining small village mills mainly did custom milling for farm households' home consumption.

Traders on rural wholesale markets sold most of their paddy to mills—in particular large and medium mills: In Bangladesh, wholesalers sold 29% of their paddy to large and medium mills, and only 14% to small mills; in India, fully 84% was sold to large and medium mills, and none to small mills. In Bangladesh, rural wholesalers' sold their rice to wholesale markets in Dhaka and other districts' cities, not directly to urban retailers. In India, by contrast, rural wholesalers sold 72% of their rice directly to local traditional retailers. Another 2% was sold to government (as traders were not under the levy system). The rest was sold to other traders, but mainly within the study zone; they sold only 2% of their rice to Delhi, 1% to other states, and all the rest to Uttar Pradesh.

**Table 4.14 Rice and Paddy Traders' Sales Destinations**
(% of volumes of traders' sales)

| Direct Clients | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
| **Bangladesh** (paddy and rice) | | | | |
| Traders in rural wholesale market in same district | 28 | 13 | 2 | 12 |
| Traders in Dhaka | 2 | 13 | 6 | 13 |
| Traders in other districts | 6 | 22 | 0 | 12 |
| Small mills | 1 | 14 | 0 | 7 |
| Semi-automatic mills | 31 | 11 | 1 | 11 |
| Automatic mills | 32 | 18 | 0.5 | 15 |
| Traditional retailers outside Dhaka | 0 | 0 | 6 | 2 |
| Traditional retailers in Dhaka | 0 | 0 | 85 | 29 |
| Supermarkets | 0.25 | 0 | 0 | 0 |
| Total | 100 | 100 | 100 | 100 |
| **China, People's Rep. of** (rice only) | | | | |
| Other wholesalers | | | 24 | 24 |
| Government buyers | | | 1 | 1 |
| Traditional retailers | | | 62 | 62 |
| Modern retailers | | | 3 | 3 |
| Restaurants, hotels, hospitals | | | 10 | 10 |
| Total | | | 100 | 100 |
| **India** (paddy only) | | | | |
| Government | 4 | 2 | | 1 |
| Other wholesalers | 43 | 8 | | 22 |
| Small mills | 0 | 0 | | 0 |
| Semi-automatic mills | 19 | 52 | | 39 |
| Automatic mills | 34 | 32 | | 33 |
| Traditional retailers | 0 | 4 | | 2 |
| Modern retailers | 0 | 0 | | 0 |
| Others | 0 | 2 | | 1 |
| Total | 100 | 100 | | 100 |
| **India** (rice only) | | | | |
| Government | | 2 | 0 | 1 |
| Other wholesalers/traders | | 25 | 17 | 21 |
| Traditional retailers | | 72 | 78 | 75 |
| Modern retailers | | 0 | 5 | 3 |
| Other destinations | | 1 | 0 | 0.5 |
| Total | | 100 | 100 | 100 |

Traders on urban wholesale markets sold the great majority of their rice directly to traditional retailers. Only in the PRC and India did the traders sell a small share (at most 5%) to supermarkets and, in the PRC, 10% went to institutional buyers such as restaurants, hotels, and hospitals. The Indian result for the sales to supermarkets is similar to the finding in Chapter 5 on the retail segment, on the share of rice in Delhi that was sold via supermarkets. But in Beijing, a much larger share of rice was sold via supermarkets. Interviews with 10 supermarket chains in the PRC showed that most of them sourced rice mainly directly from large mills, rather than from urban wholesale markets.

Moreover, about 88% of Beijing wholesalers sourced rice from the northeast (of which 50% is from Heilongjiang and 39% from other northeast areas). Only 8% of the wholesalers sourced rice from other provinces in the north, and only 4% from the south. This reflected the preference for japonica rice for consumption in Beijing. By contrast, the Delhi traders procured 14% of their product from Shahjahanpur, showing its importance, and 3% more from elsewhere in Uttar Pradesh. The rest was from other states. This means that the sourcing of rice for Delhi was less geographically concentrated than in the case of Beijing. Also, Delhi traders sold 86% of their rice in Delhi, and 12% of it to other states. Thus, Delhi was somewhat of a distribution hub for rice to other states, collected from a number of states. This was not the case for Beijing traders, who sold all their rice in Beijing.

**Rice and Paddy Traders and Value-Chain Finance.** Table 4.15 shows value-chain finance in which the traders participated. As with mills, the findings point to active value-chain finance in the midstream segment, but not in the way that conventional wisdom emphasizes. The main results follow.

First, historical studies such as Lele (1971) show that the traditional rice supply chain had interlinkages between credit and output markets. But the present surveys indicate that the traditional system had nearly disappeared by 2010. In Bangladesh, while 24% of traders still provided advances to farmers and other suppliers, the actual share of suppliers of all traders that received such credit was only 9% overall, with the share being somewhat more but still minor in rural areas (10% of village traders' and 16% of rural wholesalers' suppliers provided credit). In the PRC, only 7% of the urban wholesalers gave advances to clients. In India, none of the traders gave advances to their suppliers.

After calculating the results from the survey data, the authors asked a number of traders in India about the finding. They said that 10–20 years ago, they used to provide advances to many of their suppliers, but that this practice had indeed disappeared. The traders no longer found it profitable to offer advances to farmers, as they no longer had sufficient bargaining power or could control the product. They said this is due to better roads; mobile phones; more traders

**Table 4.15 Rice and Paddy Traders and Credit (%)**

| Credit Flows | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
| **Bangladesh** | | | | |
| Traders who paid advances to suppliers | 23 | 43 | 6 | 24 |
| Suppliers of traders who received advances | 10 | 16 | 2 | 9 |
| Traders' suppliers paid with delay | 6 | 17 | 65 | 29 |
| Clients who paid with delay to traders | 12 | 34 | 30 | 37 |
| Traders who received advances from clients | 13 | 30 | 0 | 14 |
| **China, People's Rep. of** | | | | |
| Traders who paid advances to suppliers | … | … | 7 | 7 |
| Traders' suppliers paid with delay | … | … | 20 | 20 |
| Clients who paid with delay to traders | … | … | 30 | 30 |
| Traders who received advances from clients | … | … | 17 | 17 |
| **India** | | | | |
| Traders who paid advances to suppliers | … | 0 | 0 | 0 |
| Traders' suppliers paid with delay | … | 29 | 66 | 52 |
| Clients who paid with delay to traders | … | 45 | 83 | 67 |
| Traders who received advances from clients | … | 0 | 6 | 3 |

… = no data available.

competing and providing more options to farmers; and more sources of cash for farmers (off-farm employment, employment schemes, and other sources of credit),

Second, traders did, however, commonly provide value-chain finance to the clients who bought from them, by allowing such clients to pay at a later date. This consignment practice was common—it occurred among 37% of traders in Bangladesh, 30% in the PRC, and 67% in India; however, it was more common among urban wholesalers working with retailers as clients than among rural traders. The delayed payment was not long, usually about a week, according to the client's transaction cycle.

Third, traders also received value-chain finance from their own suppliers, by paying them at a later date. For example, an urban wholesaler may take a shipment of rice from a mill and then sell that to retailers, await their payment, and then pay the mill, typically after several weeks. This practice was documented among 29% of the traders in Bangladesh, 20% in the PRC, and 52% in India.

Finally, some traders received advances from clients—but only 14% of them did so in Bangladesh, 17% in the PRC, and 3% in India.

**Traders' Other Services.** Table 4.16 shows other services that traders provided, beyond intermediating exchanges and providing value-chain finance. There was great variation in these services across trader types and zones studied, but a few general patterns emerge.

**Table 4.16 Rice and Paddy Traders' Provision of Other Services** (% of traders)

| Service | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
| **Bangladesh** | | | | |
| Product picked up and delivered in own truck | 6 | 9 | 0 | 6 |
| Product labeled | 53 | 65 | 0 | 41 |
| Provided packing boxes/crates/bags to suppliers | 82 | 86 | 0 | 57 |
| Delivered products to buyers' location | 65 | 35 | 0 | 29 |
| Graded and sorted to sell to clients | 35 | 37 | 27 | 33 |
| Product weighed when bought | 76 | 100 | 87 | 91 |
| If weighed, by electronic scale | 6 | 0 | 3 | 2 |
| Sampled rice for quality when bought | 100 | 100 | 97 | 99 |
| Rice weighed when sold | 94 | 42 | 97 | 70 |
| If yes, weighed by electronic scale | 12 | 0 | 0 | 3 |
| Sampled rice for quality by clients when bought | 100 | 100 | 100 | 100 |
| **China, People's Rep. of** | | | | |
| Product picked up and delivered in own truck | ir | ir | 10 | |
| Product labeled | ir | ir | 97 | |
| Provided packing boxes/crates/bags to suppliers | ir | ir | 90 | |
| Delivered products to buyers' location | ir | ir | 10 | |
| Graded and sorted to sell to clients | ir | ir | 100 | |
| Product weighed when bought | ir | ir | 30 | |
| If weighed when bought, by electronic scale | ir | ir | 100 | |
| Sampled rice for quality when bought | ir | ir | 67 | |
| Rice weighed when sold | ir | ir | 47 | |
| If weighed when sold, by electronic scale | ir | ir | 100 | |
| Sampled rice for quality by clients when bought | ir | ir | 97 | |

*continued on next page*

Table 4.16 *continued*

| Service | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
| **India** | | | | |
| Product picked up and delivered in own truck | 0 | 0 | 3 | 1 |
| Product labeled | 0 | 0 | 21 | 9 |
| Provided packing boxes/crates/bags to suppliers | 0 | 0 | 12 | 6 |
| Delivered paddy/rice to buyers' locations | 24 | 0 | 12 | 15 |
| Graded and sorted product to sell to clients | 17 | 0 | 9 | 5 |
| Product weighed when bought | 48 | 13 | 88 | 59 |
| If weighed when bought, by electronic scale | 5 | 0 | 100 | 52 |
| Sampled product for quality while buying | 48 | 13 | 82 | 59 |
| Weighed paddy/rice when selling | 48 | 13 | 88 | 59 |
| If weighed when sold, used electronic scale | 5 | 0 | 100 | 52 |
| Allowed clients to sample product for quality | 43 | 13 | 88 | 59 |
| Sold rice seeds | 100 | 93 | 91 | 93 |
| If sold rice seeds, share of traders with certificate of authenticity from the government | 95 | 0 | 98 | 74 |
| Traders who exported rice | 0 | 0 | 3 | 1 |
| Had registered company and rice brand | 0 | 0 | 18 | 9 |

ir = insufficient rural trader sample.

First, traders in Bangladesh and the PRC commonly labeled the bags they delivered to wholesalers with the name of the mill, but traders in India did not. Labeling with the mill's name and brand was very common in the PRC's urban wholesale markets but was far less common in South Asia.

Second, across all the zones and whether in rural or urban areas, suppliers were expected to deliver the product at their expense. Mainly in rural Bangladesh and rarely in the other zones, traders sometimes delivered to their buyers.

Third, traders in South Asia did not usually grade the paddy and rice, but all the traders in the PRC did so. Usually the grade and type were identified on the bags. In all the zones, customers commonly sampled the product to determine its quality before buying. In South Asia, customers checked the bags' weight, but not in the PRC, where bag weights were considered standard. Few South Asian traders had electronic scales, but nearly all the PRC traders did.

## Performance of the Trader Segment

**Quality Differentiation and the Rise of Rice Branding.** Table 4.17 shows the shares of the qualities of rice handled by types of traders. In both Bangladesh and India, the share of higher quality rice being traded increased, with fine quality rice being traded predominantly in urban rice wholesale markets. As noted in the milling section, this could be due to a difference in (1) varieties (as the urban traders may have drawn rice from areas with higher shares of fine rice varieties); and (2) quality. Some informants contended that mills also altered the shape of kernels by polishing, so that the rice was a given a higher grade, but the study did not test this hypothesis. For example, rice handled by traders in Delhi was about half common and half fine rice (with about 2% of the rice being "superfine"). In contrast, the rural rice traders reported handling only common rice. This could have been because Delhi traders drew from across states, and may have received fine rice that was not destined for the local rural market.

Not shown in the table, but evident in the survey data, is a sharp change in rice quality over time in the study countries. In Bangladesh, the share of coarse rice in total trader turnover was declining. Traders estimated that coarse rice was 50% of their turnover 11 years earlier, but only 31% by 2009. The composition of sales had shifted toward common and fine rice. Traders also reported that the share of rice handled by small mills declined during 1999–2009. The milling especially of fine rice was increasingly the purview of the large mills. Two-thirds of rice was processed in small mills in 1999, and this had fallen to 40% of coarse rice and 26% of fine rice by 2009. The same degree of quality change was not evident in the PRC during 2004–2009. The shift from indica to japonica had taken place in the previous decade and japonica's quality had not changed much since.

However, the PRC case stood out in that all the rice sold in wholesale markets surveyed was labeled and branded. The survey showed that 13% of the traders sold fine japonica: 10% of it came from Heilongjiang, all with mill brands and labels. And 17% of traders were selling fine rice labeled with a rice company name. Moreover, fully 77% were selling common grade japonica, and at prices

**Table 4.17 Quality of Rice Traders' Supply** (% of sales)

| Type/Quality | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
| **Bangladesh** | | | | |
| Coarse | 34 | 36 | 28 | 33 |
| Medium | 52 | 39 | 44 | 43 |
| Fine | 15 | 26 | 29 | 24 |
| Total | 100 | 100 | 100 | 100 |
| **China, People's Rep. of** | | | | |
| Regular common | ... | ... | 80 | 80 |
| Regular fine | ... | ... | 11 | 11 |
| Sticky | ... | ... | 5 | 5 |
| Fragrant | ... | ... | 0 | 0 |
| Indica | ... | ... | 3 | 3 |
| Total | ... | ... | 100 | 100 |
| **India** | | | | |
| Common | ... | 100 | 48 | 74 |
| Fine | ... | 0 | 50 | 25 |
| Superfine | ... | 0 | 2 | 1 |
| Total | ... | 100 | 100 | 100 |

... = data not available. In the People's Republic of China case, the rural sample of traders was insufficient because mills mainly buy rice directly from farmers. In the India case, the village traders did not report grading of rice.

28% below that of fine rice. Even common grade rice was sold branded: 90% of traders sold common rice in bags with the label and brand of the miller (rice company). This is important for communicating rice origins and quality to the consumer, and thus the advent of traceability in the rice market.

**Traders' Costs.** Table 4.18 shows yearly "fixed" costs (not varying with the transaction) for labor (permanent and casual laborers) and nonlabor (trucks, fuel, stall, and so on) categories. The South Asian costs were somewhat clustered, with the only striking difference being significantly higher outlays in Dhaka. By contrast, and as expected from higher labor, transport, and real estate costs (reflected in various costs), the Beijing costs were about twice as high as those in South Asia.

Table 4.19 shows variable costs in the last transaction. The most striking difference is that the traders were buying and selling locally (within a 10–15 kilometer radius) in the South Asian cases, whereas in the PRC case, transaction distances averaged 1,351 kilometers. That difference is reflected in the variable cost per ton, which was only about $2–$3 for Bangladesh and India versus $127 for the PRC and factors into the latter's higher consumer prices for rice.

Transport plus loading and unloading was, as expected, a large share of the costs—as much as 99% in the PRC, 87% in India, and 72% in Bangladesh. While market fees were a major part of the debate in South Asia concerning the price of rice to the consumer, the survey shows that the market fees were only 1% of the consumer's total cost.

**Table 4.18 Traders' Yearly Operating Costs ($)**

| Economy | Village Traders | Rural Wholesale Market Traders | Urban Wholesale Market Traders | All |
|---|---|---|---|---|
| **Bangladesh** | 2,347 | 2,780 | 7,900 | 4,405 |
| **China, People's Rep. of** | | | 13,939 | 13,939 |
| **India** | 3,192 | 3,732 | 3,996 | 3,732 |

**Table 4.19 Variable Costs of Rice and Paddy Wholesalers in the Last Transaction ($/ton; % in parentheses)**

| Variable Cost | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
| **Bangladesh** | | | | |
| Distance between sales and purchase (km) | 4 | 19 | 14 | 15 |
| Cost composition (%) | | | | |
| Bagging | 24 | 17 | 0 | 9 |
| Loading and unloading | 29 | 33 | 57 | 36 |
| Transport of rice | 41 | 33 | 36 | 36 |
| Payments at checkpoints | 0 | 0 | 0 | 0 |
| Personal transport | 6 | 0 | 7 | 9 |
| Fee at market | 6 | 17 | 0 | |
| Weighing fees | 6 | 0 | 0 | |
| Total (in $/ton; share in paretheses) | 2.50 (100) | 0.88 (100) | 2.06 (100) | 1.62 (100) |
| **China, People's Rep. of** | | | | |
| Distance between sales and purchase (km) | | | 1,351 | |
| Size of lot (kg) | | | 1,290 | |
| Cost composition (%) | | | | |
| Bagging and stitching | | | 0.4 | |
| Loading and unloading | | | 0.6 | |

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Table 4.19 *continued*

| Variable Cost | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
| Transport | | | 95 | |
| Personal transport | | | 4 | |
| Milling | | | 0 | |
| Fee for this transaction at the market | | | 0 | |
| Other expenses | | | 0 | |
| Total ($/ton; share in parentheses) | | | 127 (100) | |
| **India** | | | | |
| **Variable costs in last paddy transaction** | | | | |
| Distance from trader to supplier (km) | 10 | 9 | | 9 |
| Cost composition (%) | | | | |
| Bagging | 0 | 0 | | 0 |
| Loading and unloading | 7 | 6 | | 7 |
| Transport | 80 | 88 | | 82 |
| Personal transport | 4 | 0 | | 3 |
| Fee at market | 1 | 0 | | 1 |
| Milling | 0 | 0 | | 0 |
| Weighing fees | 7 | 6 | | 7 |
| Other expenses | 1 | 0 | | 0 |
| Total variable cost ($/ton; share in parentheses) | 3.07 (100) | 3.78 (100) | | 3.27 (100) |
| **Variable costs in last rice transaction** | | | | |
| Distance for last transaction (km) | 18 | | 5 | 11 |
| Cost composition (%) | | | | |
| Bagging | 0 | | 0 | 0 |
| Loading and unloading | 6 | | 7 | 7 |
| Transport | 88 | | 73 | 80 |
| Personal transport | 0 | | 7 | 3 |
| Fee at market | 1 | | 1 | 1 |
| Milling | 0 | | 0 | 0 |
| Weighing fees | 6 | | 7 | 7 |
| Other expenses | 0 | | 7 | 3 |
| Total variable cost ($/ton; share in parentheses) | 3.80 (100) | | 3.36 (100) | 3.33 (100) |

kg = kilogram, km = kilometer.

**Rice and Paddy Traders' Profits.** Table 4.20 shows traders' profit rates. The discussion focuses on the common grade of rice as it provides the most comparable case.

**Table 4.20 Rice and Paddy Traders' Profits (%)**

| Variety and Season | Village Traders | Rural Wholesalers | Urban Wholesalers |
|---|---|---|---|
| **Bangladesh** | | | |
| Coarse | | | |
| On-season | 56 | 55 | 5 |
| Off-season | 69 | 5 | 16 |
| Common | | | |
| On-season | 59 | 78 | 17 |
| Off-season | 35 | 76 | 26 |
| Fine | | | |
| On-season | 51 | 72 | 28 |
| Off-season | 37 | 73 | 25 |
| Total on-season | 55 | 68 | 17 |
| Total off-season | 47 | 51 | 22 |
| **China, People's Rep. of** | | | |
| Common | | | 24 |
| Fine | | | 50 |
| Total | | | 37 |
| **India** | | | |
| Common | | | |
| On-season | 40 | 55 | 72 |
| Off-season | 10 | 55 | 66 |
| Fine | | | |
| On-season | 50 | 25 | 81 |
| Off-season | 45 | 20 | 83 |
| Total on-season | 45 | 40 | 77 |
| Total off-season | 28 | 38 | 75 |

The urban wholesale market profit rates were 17%–26% in Dhaka, 24% in the PRC, and 66%–72% in Delhi, with the range showing peak and low seasons. The rural profit rates in Bangladesh were 2–3 times higher than those in Dhaka; in India the rural rates were about half the urban ones. Several caveats should be noted. The rates were gross of amortization of capital (as with the mill profit rates presented earlier), and thus were overstatements of the long-term profit rate that traders earned. Moreover, they are static measures, and profit rates may vary considerably over years. With those caveats in mind, the profit rates shown do not differ much from rates shown in other studies. For example, Chowdhury (1992), using mill survey data collected by the International Food Policy Research Institute in 1989/90, found trader profit rates of 35%–61%, depending on the type of zone. The lower profit rates were for the more dynamic commercial zones, and the higher rates were for the hinterlands. This fits the findings in the present survey, with the Dhaka wholesale profit rates lower than those in the rural areas, and comparable to the competitive Beijing case. The anomaly is the Indian case, where the rural trader's profit rates averaged somewhat less than those in Bangladesh, but the profit rates in Delhi were higher than those in Beijing and Dhaka. India's market regulations (requiring traders to have licenses and limiting the number of licenses) might have facilitated the especially high profit rates; this hypothesis is commonly proposed in the Indian literature, and the current survey's data appear to support the hypothesis, which requires further exploration.

## Summary

First, there had been significant structural and organizational changes in the mill and trader segments. Rice milling was becoming more concentrated in the medium and large mills, and the technology was changing in the three study zones—with the fastest and greatest change in the PRC. The use of the mills was highly seasonal.

There was evidence of disintermediation upstream, with the traditional role of the village trader being reduced, wholesale markets sourcing paddy directly from farmers, and increased direct sourcing by the mills from farmers. Disintermediation was also evident downstream, especially in Bangladesh and the PRC, with mills selling directly to wholesale markets and retailers in big cities. In the PRC, a third of wholesalers were agents representing single large mills. Mills were also selling directly to supermarket chains.

Second, the conduct of the rice value chain was changing quickly, especially in Bangladesh and the PRC, where mills and wholesalers representing them were selling branded, labeled bags to retailers. This was introducing traceability in the rice value chain.

Whereas in South Asia the traders used to provide advances to farmers in the form of "tied credit," this practice had nearly disappeared in all three zones. The change appears to be due to farmers' improved options for selecting buyers, taking credit, and accessing other forms of cash.

Third, the government played only a small direct role as supplier to or buyer from mills, except in India, where it remained a major player. The government was not a significant client of the trader sector in any of the zones. The improvements in the midstream segments of the rice value chain were largely private sector initiatives. Private milling and trading firms had made large investments in capacity expansion, new technology, logistics, and services to farmers.

Yet the findings and the reasons behind them suggest that the government had played an important enabling role. Some of the measures included removing impediments to change, such as when the Indian government deregulated the mill sector in 1998, allowing investments by large- and medium-scale mills, or when the PRC government relaxed restrictions on foreign companies investing in mills. Other measures directly facilitated change, such as the major improvements in roads and other infrastructure in all three economies during the last 10–15 years.

Finally, profits were found to be fairly high, although in line with some prior research findings. The high profit rates can reflect the risky nature of the trading enterprise, and possibly some local market power. An outlier was the case of rice trading in Delhi, with especially high profits. The high profits in general may have been related to the high investment required to be in rice milling and trading. In particular instances, the profits may have been related to policies such as the market licensing and entry restrictions in India.

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# 5 | Downstream—Rice Retail Transformation

For the very little that retailing is discussed in the Asian policy debate on food security in staples, the conventional image of the retail sector for staples is that it is fully dominated by traditional shops or by government "fair price stores." That is, it is seen as mainly in the "early stage" of retail evolution, as discussed in the next section, and somewhat in the "intermediate stage," where the public sector is directly involved. As a group, retailers and traders are often accused of price gouging, that is, charging higher prices to consumers than costs warrant, and retailing is often seen as offering little quality differentiation among staple products.

The food retail sector is certainly not held up as a champion of food security by finding ways to cut costs in the supply chain through inducing supply chain modernization. For example, in the Indian debate, while retailing is accused of being inefficient and "traditional" and adding costs to food consumers, it is nevertheless seen as a key source of employment and slow to change its performance or its importance. On the very edge of the debate is the recognition of the emergence of supermarkets, but these appear to be seen as marginal both in terms of importance to retail per se and to food security in particular.

Results of this study's survey indicate that the conventional images are outmoded, and point to the transformation of the downstream segment of the food value chain, as is the case for the upstream and midstream segments of the rice value chain. The transformation was taking place in two ways: an intermediate stage, where the traditional shops adjusted their behavior such as by differentiating rice quality and selling packaged and branded rather than just loose rice; and an advanced stage where supermarket chains are arising. The study shows the two stages coexisted and competed. This chapter discusses in detail the survey findings regarding the nature and evolution of rice retail in the study locations in Asia.

# Structure of Rice Retail

## Structure of Traditional Rice Retail

Table 5.1 shows characteristics of traditional retailers in the study. They were nearly all owned by middle-aged males, and started business on average only about a decade ago (about 6–12 years prior to the study in 2009–2010). They did not appear to be long-standing family businesses such as small grocery stores. Moreover, when compared with wholesalers, the retailers had relatively little education (across the three study zones, retailers were generally less educated in South Asia and more educated in the People's Republic of China [PRC]). In the PRC, only about 50% of the retailers' sales, and in India only 10%, came from rice; only in Bangladesh were the shops specialized in rice. Some of the PRC retailers also acted as "semi-wholesalers," who bought rice from the wholesale market and wholesaled it to other retailers.

**Table 5.1 Characteristics of Traditional Rice Retailers**

| Characteristic | Dhaka, Bangladesh | Beijing, the PRC | Delhi, India |
|---|---|---|---|
| Gender (% male) | 100 | … | 95 |
| Age (mean years) | 41 | … | 40 |
| Education | | | 11 years |
| No schooling (%) | 7 | … | … |
| Grade 5 or less (%) | 18 | … | … |
| Grade 6–9 (%) | 54 | … | … |
| More than grade 9 (%) | 21 | … | … |
| Year started retailing food products | 1999 | 2003 | 1998 |
| Year started retailing rice | 1999 | 2003 | 1998 |
| Also sell other food products (%) | 7 | 100 | 98 |
| Share of rice in total retail sales (%) | 97 | 51 | 10 |
| Also wholesale to other retailers (%) | … | 30 | … |

… = no data available, PRC = People's Republic of China.

Table 5.2 shows rice sales transactions. Daily sales were limited but differed widely between the three zones, due to the modest differences in the average scale of the small- and medium-size retailers and the major differences in the degree of product specialization between study zones. In Beijing, rice shops averaged daily sales of 344 kilograms (kg) of rice. In Delhi, the *kirana* shops (small-scale retailers that sell numerous products) averaged only 36 kg, but the Indian government's Fair Price Shops sold about 100 kg/day. Dhaka rice shops sold only 18 kg/day, despite specializing in rice—they were very small operations selling small bags of rice from small stalls. The South Asian stores served about 40–50 clients, most of them regular customers.

**Table 5.2 Transactions of Traditional Rice Retailers** (averages)

| Transaction | Dhaka, Bangladesh | Beijing, the PRC | Delhi, India |
|---|---|---|---|
| Sales per day (kg) | 18 | 344 | 36 |
| Last transaction (full lot bought and then retailed, kg) | 994 | 1,795 | 247 |
| Number of buyers sold to per day | 53 | ... | 40 |
| Number of regular customers | 37 | ... | 45 |

... = no data available, kg = kilogram, PRC = People's Republic of China.

Moreover, traditional rice retailers appeared to be in close competition with each other (thus apparently not in a situation of monopolistic competition by dominating a neighborhood). In Beijing, an average rice retailer competed with 6.0 others in the same market, up from 5.8 five years ago; rice-selling kirana shops in Delhi reported competing with 6.0 other small shops nearby.

Table 5.3 shows measures of retail scale in labor used, working capital, and value of retail assets. The interzone differences in these scale measures roughly correlate with the rice turnover differences. The PRC and India operations averaged two people (such as in the traditional "mom and pop stores" in the United States), while the Dhaka rice shops were operated by a single person, again reflecting their very small scale. The Beijing and Delhi retail operations had more assets and working capital than did the retailers in Dhaka. Retailers in Beijing spent about twice as much for hired labor as retailers in Delhi; this again aligns with the turnover differences noted above.

**Table 5.3 Labor and Capital per Traditional Rice Retailer**

| Labor and Capital | Dhaka, Bangladesh | Beijing, the PRC | Delhi, India |
|---|---|---|---|
| Average number of people working in the business | 1.30 | 2.02 | 2.00 |
| Average spent on hired labor (mean $/per month) | 10.91 | 156.92 | 66.67 |
| Current working capital ($) | 2,291 | 3,444 | 4,444 |
| Retail assets ($) | 1,179 | 1,555 | 8,876 |

PRC = People's Republic of China.

However, all the measures of scale for traditional retailers were well below those of urban rice traders and even further below those of rice mills. The traditional value chain in rice is thus configured as many small- and medium-scale farmers on one end, larger (than farmers) wholesalers and millers in the midstream, and many small retailers at the other end. Presumably, barriers for new entrants roughly reflect scale in each segment.

## Background: The Rise of Modern Retailers in Asia

Before examining the survey's findings concerning modern retail sales of rice in the three cities studied, the rapid growth in modern food retail in Asia is discussed. The term "modern retail" is applied to supermarkets, hypermarkets, convenience store chains, neighborhood chain stores, and discount and club stores. Table 5.4 is drawn from Reardon, Timmer, and Minten (2012) and presents data for 2001, 2005, and 2009 from Planet Retail.[1] The table tracks in each economy the leading retailers at a national level (and is thus an underestimate of the overall modern retail sector). The table is based on Planet Retail's set of 195 chains in nine economies.[2] The Republic of Korea and Taipei,China represent the "first wave," as the earliest adopters of modern retail, in the 1980s and 1990s (Reardon et al. 2003). Indonesia, Malaysia, the Philippines, and Thailand represent the second wave; and the PRC, India, and Viet Nam represent the third wave, as the most recent adopters of modern food retail.

**Table 5.4 Sales of Leading Modern Retail Chains that Sell Food and Growth of Gross Domestic Product** (selected Asian economies, 2001–2009)

| **Wave, Economy** | **2001 Sales** ($ billion) | **2005 Sales** ($ billion) | **2001–2005 Annual Compound Growth** (%) | **2009 Sales** ($ billion) | **2005-2009 Annual Compound Growth** (%) | **2001-2009 Annual Compound Sales Growth Rate** (%) | **2000–2008 Real GDP Compound Growth Rate** (%) | **Leading Chains Followed** (No.) |
|---|---|---|---|---|---|---|---|---|
| **First wave** | | | | | | | | |
| Korea, Rep. of | 19.1 | 38.5 | 19.2 | 41.7 | 2.0 | 10.3 | 4.5 | 18.0 |
| Taipei,China | 7.1 | 13.9 | 18.3 | 17.6 | 6.1 | 12.0 | … | 17.0 |
| **Second wave** | | | | | | | | |
| Indonesia | 1.8 | 4.0 | 22.1 | 7.3 | 16.2 | 19.1 | 5.2 | 14.0 |
| Malaysia | 2.0 | 3.6 | 15.8 | 7.1 | 18.5 | 17.2 | 5.5 | 16.0 |
| Philippines | 1.9 | 3.5 | 16.5 | 6.8 | 18.1 | 17.3 | 5.1 | 13.0 |
| Thailand | 5.4 | 10.9 | 19.2 | 17.7 | 12.9 | 16.0 | 5.2 | 21.0 |
| **Third wave** | | | | | | | | |
| China, People's Rep. of | 13.1 | 40.2 | 32.4 | 91.5 | 22.8 | 27.5 | 10.4 | 47.0 |
| India | 0.2 | 0.9 | 45.6 | 5.1 | 54.3 | 49.9 | 7.5 | 33.0 |
| Viet Nam | 0.1 | 0.7 | 62.7 | 2.0 | 30.0 | 45.4 | 7.7 | 16.0 |

… = data not available, GDP = gross domestic product.

Source: Reardon, Timmer, and Minten (2012).

1 Planet Retail is one of the world's leading retail data services, tracking 7,000 retail companies in 211 countries.

2 The 195 chains comprise part of the data set of chains that sell food.

Table 5.4 shows two key results, as noted in Reardon, Timmer, and Minten (2012). First, during 2001–2009, the chains' sales quadrupled, from $50 billion to $200 billion. The third-wave economies (including, two of this study's survey zones) had the highest modern retail growth rate (40.9% annual compound growth rate), because the most recent starters advanced fastest, and the earliest were relatively saturated. Growth of modern retailers in the third-wave economies varied, with a sevenfold growth in sales in the PRC and 25-fold in India. The sales growth, particularly in India and Viet Nam, rose quickly from about 2005. For India, 22 of the 33 chains followed had not yet started business in 2001, and 17 of the 22 had still not started in 2005. Planet Retail data show that chains formed only during 2007–2010 had 75% of modern retail sales in India; this is corroborated by the current survey's findings for Delhi and Dhaka. The sales growth comprised an increased number of chains and expansion of the individual chains. Individual chains grew very rapidly; for example, the sales of the top five PRC chains grew more than 10-fold during 2001–2009.

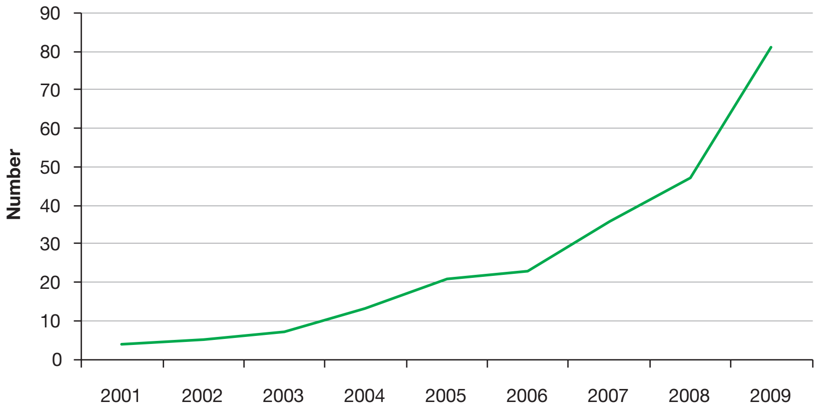
Second, although gross domestic products in Asia grew fast and those in the third-wave economies grew the fastest in the world, the growth rates in the sales of the modern retail chains were much more rapid, as shown in Table 5.4. Thus, modern retail continued to gain share in overall retail, displacing traditional retail.

## The Rise of Modern Food Retail in Beijing, Delhi, and Dhaka

Modern retailing had started in the 2000s and grown quickly in Bangladesh, the PRC, and India. Similar to other commercial transformations discussed in the book, Bangladesh was just starting its transformation to modern retailing (Bayes 2007). India had reached a point where supermarket development had begun in a significant way (Reardon and Minten 2011), but was intermediate between the PRC and Bangladesh, and the PRC was the first to start the transformation and had proceeded furthest (Hu et al. 2004; Reardon, Timmer, and Minten 2012).

Figure 5.1 shows the study's census of supermarkets in Dhaka at the end of 2009, with the net of modern retail stores opening, existent, and closing during the 2001–2009 period. Growth rates in stores were high but started from a low base. At the end of 2009, an estimated 80 supermarkets were active in Bangladesh, concentrated in Dhaka, from only four of them in 2001. For comparison, the population of Dhaka proper and that of Beijing inside its 5th ring road were each approximately 7 million, but that part of Beijing had about 800 supermarkets in 2009—or about 10 times more than in Dhaka. Most of Dhaka's modern outlets were of recent origin—85% had started operating in the 3 years prior to the survey (similar to Delhi, see Figure 5.2), and 50% of Dhaka's supermarkets had started operating only in 2009.

**Figure 5.1 Number of Supermarket Stores in Dhaka**

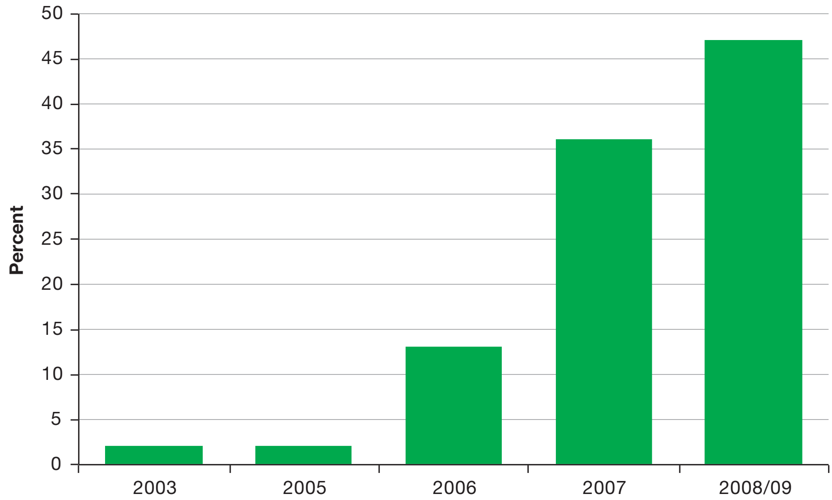



The rise of modern food retailers in Delhi has been a leading edge in the general rapid growth of modern retailing in India since 2001. The rise of modern private retailing from 2005 through 2009 has been among the fastest in the world, increasing at 54% a year on average during that period, and bouncing back to growth after a dip from the recent recession (Reardon and Minten 2011) .

Figure 5.2, which is adapted from Minten, Reardon, and Sutradhar (2010), provides data from the census of modern retail outlets in the study districts in Delhi in 2009. The start-up dates of the private modern retail outlets in the sample illustrate the extent to which modern retailing was a recent phenomenon in Delhi: 83% of the functioning outlets were started in the 2 years before the survey, and almost 50% began operations within 18 months before the survey. These results demonstrate the speed at which modern retail had obtained market share, as the number of modern food retail outlets had on average more than doubled annually during 2007–2009, though from a low base. The speed of the rollout in Delhi even came down significantly in the months prior to the survey due to the closure of Subhiksha shops, which was one of the biggest modern retailers in Delhi. Delhi might also have shown high growth rates because its move to modern retailing was later than that in some major southern Indian cities such as Bangalore and Hyderabad, where the diffusion of modern retailing had started in India.

Reardon and Minten (2011) discuss the following reasons for the sudden take-off of modern retailing in India: (1) Incomes grew quickly and the middle class emergence accelerated in the 2000s. (2) India's urbanization continued but there

**Figure 5.2 Start-up Years of Modern Retail in Delhi**




Source: Adapted from Minten, Reardon, and Sutradhar (2010).

was an especially fast growth below the top tier of cities.[3] (3) Public investment in infrastructure (especially roads and airports) increased in the 2000s in urban and rural areas. (4) Interest rates fell and conglomerates (such as Reliance) arose, fueling retail investment funds; and remittances increased, fueling demand. Due to continued restrictions on foreign direct investment in multibrand retailing, large and medium Indian companies were responsible for the great majority of modern retail investment until the restrictions were lifted in September 2012. This investment appears to have been spurred by domestic companies' expectations that foreign direct investment was likely to be liberalized and the domestic firms must invest fast to compete with domestic rivals, and either to prepare to compete with multinationals or to be attractive to them as partners for joint ventures or as acquisitions. To that inducement was added the intense competition among chains jockeying for position in the retail real estate market,

[3] There is no standard categorization of Indian cities and towns, but they are typically divided into four tiers. Ablett et al. (2007) use a classification with a cutoff of 4 million population for tier 1 cities (Ahmedabad, Bangalore, Chennai, Delhi, Hyderabad, Kolkata, Mumbai, and Pune); less than 4 million but up to and including 1 million for tier 2 cities (26 cities, such as Agra, Indore, Lucknow, Meerut, Nagpur, Patna, and Surat); less than 1 million but more than 500,000 for tier 3 cities (such as Amritsar, Faridabad, Goa, and Mangalore); and tier 4, or smaller cities.

to get "first-mover" advantages. The recession in 2008/09 temporarily reduced sales and forced some weaker chains out of business, but also dampened real estate prices and spurred some chains to increase the number of their outlets (AT Kearney 2009); however, sales data show that modern retail bounced back after the recession and resumed its growth path.

Moreover, the locational distribution of modern retail in Delhi is surprising (Minten et al. 2010, reporting results for the retail segment of the current value chain study). In other developing countries, modern retail outlets opened mainly in the richer neighborhoods during the early stage of modernization (Reardon et al. 2003). However, no significant relationship was apparent between the number of modern retail outlets and a measure of the value of nearby real estate in Delhi (Minten, Reardon, and Sutradhar 2010): None of the coefficients come out as significant in a tobit regression where the dependent variable is the number of modern retail outlets in the area (colony).[4] This appears to indicate that, in Delhi, modern retail stores had spread in this initial phase equally in rich and poor neighborhoods. The spread seems driven by four factors:

- First, both rich and poor residents lived in downtown Delhi, and modern retail had worked to penetrate the dense city with chains of small stores mixed with occasional larger ones.

- Second, in many richer residential areas, stringent laws regulated the operation of businesses, slowing the spread of modern retail to these areas.

- Third, modern retailers sold as cheaply as or more cheaply than traditional outlets (as shown in this chapter, and a common finding in developing countries, see Minten and Reardon 2008), and thus might already have sold to some poorer consumers.

- Fourth, given higher population densities and lower rental rates (a major operating cost in modern retail outlets in Delhi), and given that the modern retailers were already selling at relatively lower prices, modern retailing had profit incentives to focus not only on richer areas but to seek to capture economies of scale by expanding as much as possible.

4 The real estate value was estimated for the colony in which the chain outlet was located. The colony is the smallest urban geographical unit in India, a subdivision of a ward.

In Beijing, as noted in the background section (pp. 116–7), modern retailing expanded very rapidly during 2001–2009. Table 5.4 shows that sales of the leading 50 chains alone (of about 200 main chains) had risen from $13 billion in 2001 to $92 billion in 2009. Supermarkets in Beijing had spread rapidly—with 803 inventoried (by the PRC's China Chain Store and Franchise Association) inside the 5th ring road by 2009. Of the 60 retailers sampled for the study, most had started operating just 7 years earlier.

## Modern Retail Penetration of Urban Rice Markets

Modern retail had started to enter the rice markets in the cities, and was expanding its rice sales quickly. Modern retailing is likely to continue to gain market share (from traditional retailers) in rice during the next decade in the study economies and the region. Such a trend would follow a longer historical trend internationally wherein supermarkets dominated processed food markets well before they dominated fresh produce markets, as modern retailers can use economies of scale in procurement and marketing to reduce costs of staples to consumers, and can use economies of scope to differentiate quality and thus appeal to different segments of consumers.

In Delhi, even after just a few years of growth, modern retail had a 6.5% share of the rice market. Reardon and Minten (2011) argue that government food retail chains are a type of modern retail, as they are chain stores and a precursor to modern private retail in India (as in several other developing economies, including the PRC). Among the economies studied, only in India was the government maintaining retail chains selling rice as a subsidized public distribution service. The government retailers in Delhi had about twice the urban market share that modern retail had in rice (15% versus 6.5%). In India, the efficiency of the public distribution system of Fair Price Shops was being questioned. During the March 2009 survey for this study, fully two-thirds of the Fair Price Shops visited were not open during regular store hours, and those found open reported being open only half of the days of the preceding month, and half of the hours per day.

Table 5.5 shows supermarket sales of rice in Beijing in 2010. Compared with the findings for traditional rice retailers, the daily sales of an average Beijing leading chain (whether domestic or foreign) modern retail store were about 3.5 tons—about 10 times larger than a wet market rice shop. As there were about six rice stalls in a wet market, this means that one large supermarket or hypermarket sold as much rice as several wet markets.

**Table 5.5 Characteristics of Beijing Supermarket Chains that Sell Rice**

| Store Characteristic | Leading Chains | Local Chains | All |
|---|---|---|---|
| Years in operation | 8.1 | 8.6 | 8.4 |
| Distance to nearest wet market (km) | 1.28 | 1.31 | 1.30 |
| Rice sales per day (kg, Sep–Aug 2010) | 3,380 | 826 | 2,310 |

kg = kilogram, km = kilometer.

Data on the number of stores in Beijing from the PRC's China Chain Store and Franchise Association and from the current survey, along with consumption figures for rice, indicate that roughly 50% of the rice retailed in Beijing was sold through supermarkets. This was approximately the situation of Hong Kong, China in the early 1990s, about a decade after its supermarkets had started selling rice (Ho 2005)—so the paths appear similar. The rice sales share was still lower than the 78% of all processed food that supermarkets sold, as found in an extensive survey of consumers in major PRC cities in 2006 (Goldman and Vanhonacker 2006), but one can expect the supermarkets' penetration of rice markets to lag somewhat behind that of other processed food markets as consumers had traditionally purchased their rice from small rice shops. Ho (2005) tells a similar story of gradual habit change in the late 1970s and especially the 1980s and early 1990s in Hong Kong, China.

# Conduct of Rice Retail

## Procurement Methods of Traditional Rice Retailers

Table 5.6 shows procurement practices of traditional rice retailers. In all study cities, the traditional retailers sourced from the local wholesale market nearly exclusively, whether by going to the market themselves (as in Beijing and Dhaka, with very little use of traders) or from traders (as in Delhi).

**Table 5.6 Procurement by Traditional Rice Retailers: Source**

| Source | Dhaka, Bangladesh | Beijing, the PRC | Delhi, India |
|---|---|---|---|
| Wholesale market (%) | 100 | 99 | 5 |
| Traders operating between retailers and wholesalers or other retailers (%) | 0 | 1 | 95 |

PRC = People's Republic of China.

**Table 5.7 Procurement by Traditional Rice Retailers: Time and Transport**

| Time and Transport | Dhaka, Bangladesh | Beijing, the PRC | Delhi, India |
|---|---|---|---|
| Total time at place of purchase (minutes) | 62 | 165 | 62 |
| Transport (%) | | | |
| Motorized 3-wheeler | 6 | 0 | 56 |
| Bus | 0 | 1 | 0 |
| Car | 0 | 74 | 0 |
| Motorbike | 0 | 3 | 0 |
| Animal-drawn cart | 0 | 0 | 0 |
| Rickshaw or bicycle | 63 | 0 | 16 |
| Walk (with cart) | 31 | 0 | 28 |
| Other | 0 | 22 | 0 |
| Days between buying and selling | 1 | … | 7 |

… = no data available, PRC = People's Republic of China.

Table 5.7 shows the transport traditional retailers used and the time they spent at the wholesale market. The time was brief, but repeated each day in Dhaka and each week in Delhi: relatively short transaction cycles minimize working capital and waste. With transport time plus time at the market, an average retailer used about a day each week to buy inventory. The stages of transport evolution were striking across the cities. In Dhaka, very small-scale rice retailers bought their inventory in the most traditional way, using a bicycle or cart or by walking; in Delhi, they mainly used motorized three-wheeled bicycles; but in Beijing, most used a car. A decade or so previously, the Beijing situation was more similar to the Dhaka and Delhi cases, but it had changed quickly.

Table 5.8 shows whether retailers were in contact with wholesalers before the transaction, as a rough measure of potential price arbitrage and price discovery, and of the importance of cell phones. The first row shows that Beijing was the most advanced (along the commercial modernization continuum), Delhi second, and Dhaka third. As casual observation indicates that most retailers had a cell phone, the question that arises is: Why was the use of cell phones so low for arranging the price for rice? Reasons may include the following: As retailers bought frequently, negotiating price and delivery each time would be costly; rice prices varied little (compared with perishables) within a month or even over the year in the cities; retailers frequently went to the market, and they talked with each other and thus had a continuous sense of prices; and (as Table 5.9 shows), retailers often dealt with the same wholesaler over time.

**Table 5.8 Cellular Phone Use by Traditional Rice Retailers (%)**

| Cellular Phone Use | Bangladesh | PRC | India |
|---|---|---|---|
| Arranged by cell phone for price and quantity | 3 | 48 | 26 |
| If in contact, discussed prices? (yes) | 100 | 100 | 97 |
| If in contact, was this done by cell phone? (yes) | 100 | 100 | 100 |

PRC = People's Republic of China.

**Table 5.9 Frequency that Traditional Retailers Bought from a Seller and Reasons for the Choice (%)**

| Frequency and Reason | Beijing, the PRC | Delhi, India |
|---|---|---|
| Share of retailers who "always" or "regularly" bought from one seller | 74 | ... |
| Years selling to supplier: 2009 minus the year started buying from this seller | 4 | ... |
| Retailer's reason for buying from this seller: share citing this reason as "very important" | | |
| Always had large quantities | 51 | 55 |
| Offered better prices | 98 | 82 |
| Offered higher quality | 89 | 64 |
| Allowed retailer to buy on credit (pay supplier later) | 2 | 52 |
| Offered loans in case of need (marriage, sickness) | 8 | ... |
| Habit | 29 | ... |
| Organized transactions quickly and retailer lost little time | 9 | ... |
| Retailers who bought rice through auction in the last transaction | ... | 2 |

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

Table 5.9 shows retailers' reasons for choosing their rice supplier (in the last transaction they did before the interview). The decisions were based largely on market fundamentals. By far the main reasons were prices and quality, as well as, to a certain extent, volume available. Only in the Delhi case did value-chain finance figure (see the next subsection).

Table 5.10 shows retailers' assessments of quantity information that was available during the last time they bought rice from the wholesaler. Most of the retailers in Delhi and Dhaka reported getting enough information, but few in Beijing did. Only in Dhaka was the lot weighed in front of the retailers nearly all the time. The disparity between the data on weighing and the retailers' reporting on knowing the weights is explained by the fact that the rice was usually sold in sealed bags with standard weights. While key informants in Delhi and Dhaka said that wholesalers often tricked retailers with a "rounding off" tactic, the retailers did not believe the wholesalers do this. Only in Beijing did retailers report this tactic by wholesalers.

**Table 5.10 Traditional Rice Retailers' Information on Quantity of Rice (last transaction, % of retailers)**

| Information on Quantity | Dhaka, Bangladesh | Beijing, the PRC | Delhi, India |
|---|---|---|---|
| Reported sufficient quantity information before the transaction | 90 | 10 | 72 |
| Knew the exact weight of the lot | 98 | 74 | 72 |
| Lot weighed in front of them | 83 | 57 | 38 |
| Bought from seller using electronic/ mechanical scale | 100 | 60 | 38 |
| Seller used "rounding off" tactic to charge for higher amount than in the bag | 0 | 41 | 2 |

PRC = People's Republic of China.

**Table 5.11 Traditional Rice Retailers' Information on Quality of Rice (last transaction, % of retailers)**

| Quality Assessment | Dhaka, Bangladesh | Delhi, India |
|---|---|---|
| Reported sufficient quality information before the transaction | 80 | 76 |
| Checked quality | 95 | 71 |
| Checked part of the lot | 100 | 71 |
| Checked part of the lot, believed it represented the whole | 99 | 74 |

Table 5.11 shows that most retailers felt they had sufficient information on rice quality before the transaction. The data show that most of the time the retailers checked part of the lot, such as with a piercing instrument that withdraws some grains to inspect.

## Traditional Rice Retailers and Value-Chain Finance

Table 5.12 shows the extent to which traditional rice retailers engaged in value-chain finance. A widely held belief is that traditional retailers hold an advantage over modern retailers by providing consumer credit to the majority of their clients. This assumption is seldom tested empirically, and the present survey shows that it is simply wrong. The last two rows of the table show that the majority of the stores provided some credit, but only to a small share of their clients. Multiplying the share of retailers giving credit (row 1 of the table) by the share of their clients getting credit (not on the table) yields the bottom row of the table, which tells the key story: only 12%–13% of customers in Dhaka and Delhi, and only 17% in Beijing, received credit from

**Table 5.12 Traditional Rice Retailers' Credit with Suppliers and Customers (%)**

| Credit Flows | Dhaka, Bangladesh | Beijing, the PRC | Delhi, India |
|---|---|---|---|
| Suppliers paid by retailer with delay (on credit) | 85 | 28 | 49 |
| Retailers that paid suppliers late (on credit) | … | 14 | 50 |
| If credit was given, share of payment on credit | 39 | 56 | … |
| Share of retailers giving credit to consumers (for delayed payment) | 69 | 59 | 77 |
| Share of customers that bought rice on credit (paid later) | 12 | 17 | 13 |

… = no data available, PRC = People's Republic of China.

**Table 5.13 Traditional Rice Retailers' Home Delivery (%)**

| Home Delivery | Dhaka, Bangladesh | Beijing, the PRC | Delhi, India |
|---|---|---|---|
| Retailers that home-deliver | 8 | 92 | 40 |
| Consumers with home delivery from traditional rice retailers | … | 61 | 10 |

… = no data available, PRC = People's Republic of China.

rice shops, a simple average of 14% of all the consumers buying rice from the hundreds of retailers sampled. Key informants noted that some decades ago the small shops commonly provided credit, but the practice had become quite limited.

The top two rows show that many retailers received value-chain finance—de facto receiving credit from their suppliers by paying them with a delay. Retailers commonly got the bags of rice from the wholesaler, retailed them, and paid for them when they got a new lot from the wholesaler. This practice allows wholesalers to build long-term relationships with retailers.

Another traditional view that is at least partly undermined by the findings shown in Table 5.13 is that small shops typically deliver products to consumers' homes. But data from the South Asia sites indicate that only 8% of retailers home-delivered rice in Dhaka. In Delhi, only 10% of consumers had rice home-delivered by kirana stores (40% of which made deliveries, but only for 25% of their clients). By contrast, in Beijing, most rice shops home-delivered.

## Supermarkets' Procurement of Rice—the PRC Case

Given the degree that the supermarket chains had penetrated the urban rice market, the study undertook a unique supplementary survey of 10 chains operating in Beijing, comprising (1) Chinese chains, large and smaller

(Chaoshifa, Wumart, Lianhua, and Huapu); and (2) foreign chains, large and smaller (Carrefour [France], Walmart [United States], Tesco [United Kingdom], Lotus [Thailand], Lotte [Republic of Korea], and Ito-Yokado [Japan]). The procurement officers responsible for rice in each chain were interviewed in 2010. They were asked (1) whether the chain had a center in which rice was stored and distributed; (2) whether and to what extent, in 2006 and in 2010, the chain sourced rice from large mills, medium mills, wholesale markets in the production areas, Beijing-based wholesale markets, rice-specialized wholesale companies, farmers, and cooperatives; and (3) whether they procured from these suppliers under contracts or in spot relations. Several key points emerged.

First, in sharp contrast with small traditional retailers, the chains did not rely on the wholesale markets in production areas or in Beijing. The exception was one large foreign chain that combined sourcing half from large and medium mills in direct contract relations, and half from wholesale markets in production areas.

Second, 7 of the 10 chains (and, surprisingly, without distinction by size or whether domestic or foreign) sourced most of their rice from large and medium mills in a direct contract relation. On average, they sourced 24% from large mills in 2006, and 51% in 2010; and from medium-scale mills, 16% in 2006, and 23% in 2010.

Third, 8 of the 10 chains purchased from another major source—rice-specialized wholesale companies.[5] These are an example of the specialized dedicated wholesalers that have arisen in many developing countries to specialize in a product line, and dedicate themselves to servicing modern food industry clients (Reardon et al. 2003). In 2006, the eight chains sourced 60% of their rice from such companies; by 2010 this had actually fallen to 52% as direct relations with larger mills emerged. Again, as with the mills, the chains had a contract relation with wholesale companies. That is not surprising, given that chains need stable relations, long-term prices, and volume planning for basic staples.

Fourth, none of the chains sourced from cooperatives or individual farmers. This is because sourcing rice directly from the farmers involves coursing it through a mill and increased transaction costs.

In summary, the survey of supermarkets shows that they procured rice using two main strategies: (1) direct sourcing from large and medium mills under contract, and/or (2) sourcing from specialized dedicated rice wholesale companies that procured rice from the regions and met the chain's needs.

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5 The eight included some that did not source their rice directly from mills as well as many that did.

That the model's center of gravity was gradually shifting toward sourcing from large mills coincides with points made in Chapter 4 about the consolidation of the mill sector.

# Performance of Traditional Rice Retail

## Costs and Wastage of Traditional Rice Retailers

Table 5.14 shows operating costs that were "fixed" over the year (excluding amortization of capital) and variable costs for the last transaction. The total operating costs for the year varied across the zones in rough proportion to the turnover figures provided. The retailers' costs were strikingly lower than the costs of the midstream actors (mills and traders) noted in Chapter 4. This further illustrates the differences in scale across the value-chain segments, with mills handling large volumes of rice, traders generally handling medium-size volumes, and traditional retailers handling small volumes.

**Table 5.14 Costs of Traditional Rice Retailers**

| Cost Component | Dhaka, Bangladesh | Beijing, the PRC | Delhi, India |
|---|---|---|---|
| Operating costs per year ($) | 252 | 3,252 | 660 |
| Variable costs in last transactions (%) | | | |
| Labor costs to load | 18 | … | 17 |
| Transport costs from supplier to retailer | 41 | 14 | 46 |
| Personal transport from place of purchase to retailer | 12 | 28 | 14 |
| Fee at wholesaler in market or to broker that brought from source | 16 | 28 | 2 |
| Commission to wholesaler | 12 | 0 | 4 |
| Fee at retail place | 0 | 0 | 1 |
| Weighing fees | 0 | 0 | 3 |
| Transformation fees, bagging/packaging | 0 | 0 | 12 |
| Miscellaneous | 0 | 27 | 1 |
| Total variable costs | 100 | 100 | 100 |
| Variable cost ($/ton) | 7.2 | 39 | 52 |

… = no data available, PRC = People's Republic of China.

Moreover, the variable cost composition was roughly similar across the zones: the share of transport was 42% in Beijing, 60% in Delhi, and 53% in Dhaka. Casual labor costs in Dhaka and Delhi, and brokerage fees in Beijing, were other key elements. Market fees were minor in all three cases. Given that distances and transaction waiting times were roughly similar in all the cities, and traffic in all three was congested, it appears that the differences in cost were primarily due to the costs of transport. Transport costs (including fuel) were the most important in the midstream and downstream food value chains. Fuel costs directly link to the food security component and may be an important area for policy analysis in the future.

Finally, while high rates of wastage are generally assumed in the traditional supply chain, the survey data show quite limited wastage in rice retailing. Retailers in Delhi and Dhaka reported low to no waste over the short transaction cycle—they just repacked the sacks of rice bought from the market into small plastic bags, with little chance for exposure to the elements or pests. In Beijing, the retailers reported figures that imply wastage of only 0.5%.

## Rice Quality Differentiation and Dynamics among Traditional Retailers

Table 5.15 shows the composition and evolution of rice quality, packaging, and labeling in 1999 and 2009 for the South Asian sites and in 2004 and 2009 for the PRC. Several points stand out across zones and time.

First, in all zones, traditional rice retailers had increased the share of fine rice in their total sales, and differentiated the quality of their rice from the starting to ending year covered in the survey for each zone. Part of the increase of fine rice in Delhi was the shift toward the Indian equivalent of Southeast Asia's fragrant rice—basmati. In total rice turnover, basmati's share increased from 31% in 1999 to 43% in 2009, and the share of superfine rice rose from 5% to 9%. In Dhaka the shift occurred with a small displacement of coarse rice, and in Beijing and Delhi, with modest displacements of common rice. These shifts roughly mirror similar shifts in quality in the midstream and upstream. However, it is difficult to compare across zones and say that the share of fine rice was higher in India, as the classifications are local, somewhat subjective, and not strictly comparable.

Second, the shift from loose to packaged rice is an objective, observable fact, and it occurred mainly in the PRC—where it was happening quickly. In only 6 years, the share of rice sold loose, even by traditional retailers, dropped from 32% to only 24%, so that by 2009, 76% of the rice was sold packaged—that is even higher than what the supermarket chains reported. Moreover, all the packaged rice had the mill brand on the package.

**Table 5.15 Quality and Packaging in Traditional Rice Retail**
(% of type of rice in all rice sold)

| City; Type of Rice | Starting Year | Ending Year |
|---|---|---|
| **Dhaka, Bangladesh** | **1999** | **2009** |
| Coarse | 34 | 28 |
| Medium | 35 | 36 |
| Fine | 31 | 36 |
| Unpackaged | 93 | 91 |
| Packaged | 7 | 9 |
| Parboiled | 96 | 97 |
| Not parboiled | 4 | 3 |
| **Beijing, the PRC** | **2004** | **2009** |
| Regular, common | 62 | 57 |
| Regular, fine | 26 | 29 |
| Unpackaged | 32 | 24 |
| Packaged, with miller's name | 68 | 76 |
| Packaged, with retailer's name | 0 | 0 |
| **Delhi, India** | **1999** | **2009** |
| Common | 45 | 37 |
| Fine | 50 | 54 |
| Unpackaged | 99 | 98 |
| Packaged, no company name | 0.5 | 1 |
| Packaged, with company name | 0.5 | 1 |
| Raw | 69 | 70 |
| Parboiled | 31 | 30 |

PRC = People's Republic of China.

Thus, in sharp contrast to the traditional image of grain stores with open sacks of rice, little ability to trace the rice to millers, and little branding, the surprising point in the PRC data is that modern and traditional retailers in Beijing had shifted to selling rice that was packaged and branded with the mill logo.[6] While the survey results imply a deep shift in retail practice in the PRC, the change appears to be driven by a shift in the mill sector: it was the large and medium mills that had brands and logos, not the small village mills. The restructuring of the mill sector had as a counterpart the transformation of rice retail. With branding comes traceability (at least to the mill level), competition on the bases of quality and geographic origin, and bargaining power of mills whose brands gain wide consumer attraction. The change could be occurring first in the PRC because the restructuring of their mill sector had proceeded the furthest, as indicated in Chapter 4.

[6] But this was unique to the PRC data, as, apart from quality changes, South Asian traditional rice retailing had not changed much.

Third, the combinations of retailers' costs (and the supply chains leading to them), different quality compositions, and different demand profiles, led to different distributions of retail prices, with the PRC's greater than India's, which was greater than that of Bangladesh.

Figure 5.3 shows the cumulative density function for retail rice prices in each zone. Price levels and variation were lowest in the Dhaka case, and its price distribution was generally higher than those of Beijing and Delhi. In Dhaka, 88% of the rice prices fell below $650/ton. While low rice prices could also be found in Delhi, only 64% of the price observations were below $650/ton in the traditional markets. The cumulative density function curve in Delhi might thus indicate the wider variety of rice available in the market, presumably also reflecting the larger share of higher-income consumers willing to pay higher prices for rice. In Beijing, the lowest prices started at a higher level than in the two other cities, at about $550/ton, a level that was higher than three-quarters of the prices observed in Dhaka. As in Delhi, prices in Beijing varied significantly, reflecting the large variety of rice in the markets, which ranged from common, to fine, to sticky, and to fragrant rice.

**Figure 5.3 Cumulative Density Functions of the Price of Rice at Traditional Retailers**

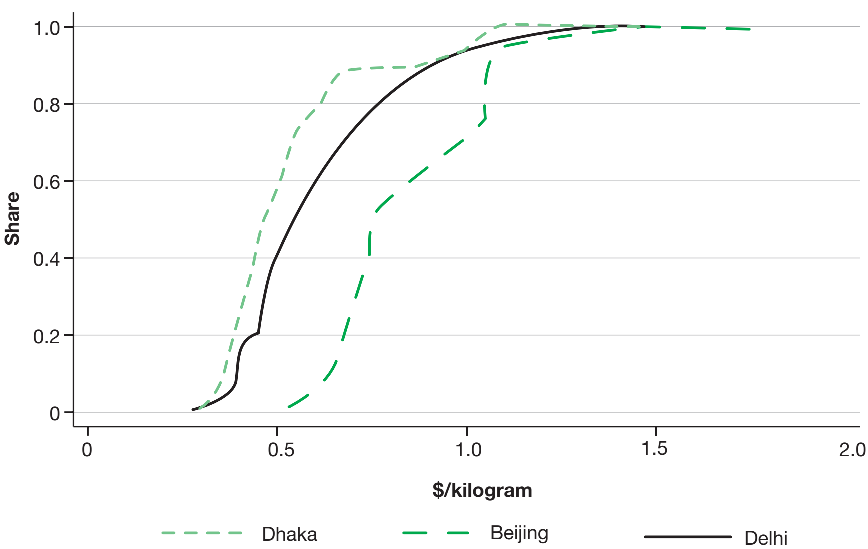

Table 5.16 shows margins differentiated by quality and season. Price and margin differentiation roughly followed quality differentiation.

For Dhaka, margins did not vary much seasonally. As prices for fine rice were significantly higher, relative margins were smaller than for common rice. The relative margin for fine rice was 6.9%, but for common rice it was 10.5%. This unexpected result may be due to fine rice being a substitute for medium rice, and thus the retailers could not permit themselves high margins on fine rice as it was not a segmented market where only the richer consumers buy fine rice.

**Table 5.16 Margins and Profits of Rice Retailers**

| City, Time | Sales Price – Purchase Price ($/ton) | | Sales Price/Purchase Price (%) | |
|---|---|---|---|---|
| | Common Rice | Fine Rice | Common Rice | Fine Rice |
| **Dhaka, Bangladesh** | | | | |
| Oct–Nov 2008 | 34.69 | 37.35 | 8.40 | 7.20 |
| Dec 2008–Jan 2009 | 29.35 | 29.35 | 7.70 | 6.20 |
| Feb–Mar 2009 | 29.35 | 29.35 | 8.60 | 6.60 |
| Apr–May 2009 | 30.68 | 28.02 | 12.50 | 6.60 |
| Jun–Jul 2009 | 28.02 | 29.35 | 12.00 | 7.70 |
| Aug–Sep 2009 | 28.02 | 28.02 | 12.00 | 7.10 |
| Oct–Nov 2009 | 29.35 | 29.35 | 12.10 | 6.80 |
| Average | 29.35 | 30.68 | 10.50 | 6.90 |
| **Beijing, the PRC** | | | | |
| Jun–Jul 2010 | 55.82 | 65.60 | 10.18 | 9.98 |
| Apr–May 2010 | 55.82 | 66.99 | 10.28 | 10.32 |
| Feb–Mar 2010 | 60.02 | 58.62 | 11.32 | 9.25 |
| Dec 2009–Jan 2010 | 58.62 | 68.39 | 11.32 | 11.14 |
| Nov 2009 | 55.83 | 62.81 | 10.96 | 10.32 |
| Oct 2009 | 61.41 | 54.43 | 12.43 | 9.37 |
| Aug–Sep 2009 | 54.43 | 51.64 | 10.95 | 8.94 |
| Average | 57.23 | 61.41 | 10.99 | 9.95 |
| **Delhi, India** | | | | |
| Jan–Feb 2009 | 34.27 | 54.43 | 12.30 | 13.20 |
| Mar–Apr 2009 | 32.26 | 54.43 | 11.30 | 12.90 |
| May–Jun 2009 | 32.26 | 50.40 | 10.80 | 11.40 |
| Jul–Aug 2009 | 34.27 | 50.40 | 11.20 | 11.20 |
| Sep–Oct 2009 | 34.27 | 48.38 | 10.80 | 10.40 |
| Nov–Dec 2009 | 34.27 | 50.40 | 10.40 | 10.50 |
| Jan–Feb 2010 | 34.27 | 54.43 | 10.00 | 11.20 |
| Average | 34.27 | 54.43 | 11.00 | 12.10 |

PRC = People's Republic of China.

In Beijing, price differentiation among qualities and types of rice was significant, with about the same rankings as in Dhaka. Interestingly, the margins for four types of rice (including sticky and fragrant rice) were around 10%. While this was somewhat lower than the margins wholesalers charged, the latter multiply those times far larger volumes. The margin of the Beijing rice retailer appeared quite modest (as in Bangladesh and India)—in line with what appeared to be a competitive market. Moreover, the interseasonal fluctuations among traditional retailers were even lower than among wholesalers—with the change between the lowest and highest price seasons only 11% for fine, 8% for common, 10% for sticky, and 7% for fragrant rice. Traditional retailers may have adjusted their margins to reduce even further the price fluctuations from wholesale, in order to keep their clientele.

For Delhi, although the sales price of common rice varied by 28% from peak to trough during the year, the absolute margin across months was very steady. The sales price of fine rice varied 17% from peak to trough, but the gross margin per ton fluctuated only between $55.56 and $60.00, about 8%. This suggests a relatively competitive pricing situation. Recall that Delhi wholesalers got $14.44 as a gross margin, so the retail margin was about 2.5 times higher for common and 5.0 times higher for fine rice. However, Delhi wholesalers traded about 15 tons a day—400 times more than a kirana store traded—and thus spread smaller margins over far more volume. Striking facts are (1) the difference in the average margin between common and fine rice, with fine rice being about $20/ton higher than common rice, which was the greatest difference among the three zones studied; and (2) the margin for common and fine rice in Delhi was the highest among the three zones, although it was not very significant.

## Rice Quality Differentiation by Modern Retailers in Beijing

Table 5.17 shows the shares of stores selling types of rice in Beijing. There was significant quality and price differentiation in modern retail, and substantial differences between the large or leading chains and the small local chains of supermarkets in both the quality profile and the price levels. The key points are as follows.

First, almost all stores (97% of both types of chain) sold loose (unpackaged) common rice. Half (50%) of modern stores sold some loose fine rice, but this was more prevalent among local rather than leading (large) chains. The same is seen in sticky rice: 83% of the chains sold loose sticky rice, but more of the local chains sold it loose. By contrast, about 42% of the stores sold loose fragrant rice, in leading and local chains alike.

**Table 5.17 Beijing Supermarket Chains' Rice Sales**
(inventory during the survey, September 2010)

| Rice Inventory | Leading Chains | Local Chains | All |
|---|---|---|---|
| **Loose rice sales** | | | |
| Stores selling at least some fine rice | | | |
| Loose (%) | 41 | 62 | 50 |
| Price ($/ton) | 886 | 984 | 941 |
| Japonica (%) | 100 | 100 | 100 |
| From the northeast (the survey region, %) | 100 | 100 | 100 |
| Stores selling at least some common rice | | | |
| Loose (%) | 97 | 96 | 97 |
| Price ($/ton) | 645 | 699 | 666 |
| Japonica (%) | 100 | 100 | 100 |
| From the northeast (%) | 94 | 100 | 96 |
| Stores selling at least some sticky rice loose (%) | 77 | 92 | 83 |
| Stores selling at least some fragrant rice loose (%) | 41 | 42 | 42 |
| **Packaged rice sales** | | | |
| Stores selling at least some fine rice | | | |
| Packaged (%) | 100 | 100 | 100 |
| Price ($/ton) | 1,639 | 2,241 | 1,897 |
| Japonica (%) | 100 | 100 | 100 |
| From the northeast (%) | 100 | 100 | 100 |
| Labeled with rice company name (%) | 100 | 100 | 100 |
| Stores selling at least some common rice | | | |
| Packaged (%) | 100 | 100 | 100 |
| Price ($/ton) | 967 | 974 | 970 |
| Japonica (%) | 100 | 100 | 100 |
| From the northeast (%) | 100 | 100 | 100 |
| Labeled with retailer company name (%) | 9 | 4 | 7 |
| Labeled with the mill brand/name (%) | 100 | 100 | 100 |
| Stores selling at least some sticky rice packaged (%) | 71 | 19 | 48 |
| Stores selling at least some fragrant rice packaged (%) | 100 | 100 | 100 |

The foregoing points about the prevalence of stores selling at least some common grade of rice loose give the impression at first glance that the selling of loose rice is commonplace, especially as PRC consumers were traditionally used to buying loose rice in rice shops. But, that supermarkets were offering loose rice is a surprise—and a strategic action. In a number of countries, supermarkets (in their early stages) focused on packaged rice, and thus presented an image of catering to the elite consumer. By selling at least some loose rice, the PRC supermarket chain was consciously (according to key informants) projecting the image of being like a wet market to some extent, and appealing to the broad mass of limited income consumers. At the same time, most of the chains were also offering an array of higher-quality rice, loose and packaged. In fact, the larger, leading chains (compared with local, smaller chains) actually sold a greater range of qualities and types of rice than other retailers, while also selling basic common loose rice. This dual strategy is what Levy et al. (2005) call the strategy of the "big middle" to capture the broadest spectrum of consumers possible. Gorton, Sauer, and Supatpongkul (2011) first linked Levy's idea with the strategy of Asian supermarket chains.

Second, quality differentiation among Beijing supermarkets was linked to geographic source differentiation. In the source and type of common and fine rice that Beijing supermarkets carried, a predominant amount was from the northeast (including Heilongjiang) and was japonica. But sticky rice from the northeast was available in only 48% of the stores, while sticky rice from other provinces (not in the south), such as Anhui, Hebei, and Hubei, was available in 59% of the stores selling it. For fragrant rice, 24% was from the northeast and 14% from the east, Jiangsu. Interestingly, no indica rice was picked up in the traditional retail survey, but a small amount of it was present in the supermarket and wholesale market surveys, as part of the diverse offering.

Third, in Beijing supermarkets, prices followed quality differentials, but did so differently between leading and local chains. Fine loose rice averaged CNY6.74/kg in the supermarkets, somewhat above the price in the traditional retail stalls; however, as in Delhi, the price of fine loose rice was higher in the local than in the leading chains. The price for common loose rice averaged CNY4.77/kg in supermarkets, closer to the traditional shop's price. Again, the local chains' price was significantly above the lead chains' price. The sticky loose rice was costly, at CNY11.00/kg, and the fragrant rice costlier yet, at CNY12.70/kg (with substantial price difference between the leading and local chains, being more expensive at the latter). The leading chains may have had lower prices because of more efficient procurement systems and bulk buying.

Fourth, in Beijing supermarkets, all the stores sold packaged rice, and had a greater diversity of qualities and types than did the traditional stores. All stores sold fine packaged rice. Fine packaged rice was costly in the supermarkets, at CNY13.6/kg, but the difference between the local (at CNY16.0/kg) and the leading chains (at CNY11.7/kg) was large. All this rice came from the northeast. Nearly all the stores sold "green food" (low pesticide) fine rice, and 55% of them (more among leading chains) sold organic fine rice. All fine rice was labeled with the mill company's brand. All the stores sold common packaged rice, again with the mill brand. The 2009 price was CNY6.95/kg, and was similar in leading and local chains. All was from the northeast. Interestingly, 7% was sold with the supermarket chain's private label (9% of leading chains and 4% of local chains did so; this excludes the mill brands). Only 2% of the stores sold packaged common rice without labels.

The stores sold quite a diversity of rice beyond the conventional common and fine types. Two-thirds of stores (67%) sold "green food" rice, with more of the local chain stores selling it than did the major chains. Only 3% of the stores sold organic common rice. Interestingly, while 48% of the stores sold packaged sticky rice, the share was far higher among leading chains, at 71% versus only 19% of local chain stores. Moreover, all of the stores sold fragrant rice, with all the stores selling fragrant rice from the south, all labeled with the rice company's name. And 87% sold "green food" fragrant rice (more among the lead chains). None sold it with a retailers' private label.

Finally, the supplementary survey of 10 supermarket chains provided corroborative evidence of the packaging of rice, and indicated that 59% of the rice the chains sold in 2006 was packaged; the share rose to 66% in 2010. Of that, 96% had been packed by the mill. Moreover, 93% of the packed rice was sold with the mill label on it; only 2% was sold with the chain's private label.

## Rice Quality in Traditional versus Modern South Asian Retailers

Table 5.18 compares the shares of rice types sold in traditional and modern retail outlets in Dhaka. As opposed to the "big middle" strategy that Beijing supermarkets followed, Dhaka supermarkets were in the earlier stage of focusing on the elite consumer market. Dhaka supermarkets sold no coarse rice: 2% of the rice offered was medium rice and 98% was considered fine rice. For traditional retailers, fine rice made up only 50% of all the rice they offered; 28% was coarse and 23% was medium rice. While almost 90% of the traditional rice retailers sold was parboiled, only 54% was parboiled in modern retail stores. Almost half of the rice in modern retail stores was sold packaged, but in traditional retailing only 8% of the rice was packaged.

In Delhi, supermarkets in their early stages also focused on the elite consumers. As reported in Minten, Reardon, and Sutradhar (2010), intraproduct diversity

**Table 5.18 Rice Quality in Traditional versus Modern Retailers in Bangladesh**
(% of rice type)

| Rice Quality and Preparation | Traditional Retail | Modern Retail |
|---|---|---|
| Coarse | 28 | 0 |
| Medium | 23 | 2 |
| Fine | 50 | 98 |
| Total | 100 | 100 |
| Parboiled | 89 | 54 |
| Bagged | 8 | 45 |

is much higher in modern retail than in traditional outlets. The number of rice varieties for sale in modern retailing averaged 9.15 versus only 4.12 in traditional retail outlets. Modern retailing focused almost exclusively (93% of rice products on offer) on the higher-quality basmati rice. In the traditional markets, basmati comprised less than 50% of the rice on offer; 19% was parmal rice (a long-grained rice, second in quality after basmati); and the remaining 33% was other rice. While 88% of the rice sold in modern retailing was branded, only 31% was branded in traditional outlets.

## Rice Price Comparisons between Traditional and Modern Retailers in South Asia

Table 5.19 compares rice prices between modern and traditional retailers in Dhaka. The upper part of the table compares them with a t-test; whether measured at the mean or median, the modern retail price was well above that of the traditional shop. The lower part of the table reports the intercept prices for modern versus traditional retailers from a hedonic price regression, hence this time controlling for the packaging and rice type, and again finds prices were much higher in modern retailing.

Table 5.20 and the subsequent tables focus on comparing traditional versus modern retail prices in Delhi, drawing on Minten, Reardon, and Sutradhar (2010). The table shows a simple pair-wise comparison using a t-test of rice prices in supermarkets compared with traditional retail (kirana shops). To improve comparability, branded and nonbranded rice are treated as separate products in the analysis below. Branded rice is found to have been less expensive in modern retail outlets than in traditional retailing, but unbranded loose rice was more expensive.

**Table 5.19 Rice Price Comparisons between Traditional and Modern Retail in Bangladesh**

| Average Price | Traditional Retail | Modern Retail |
|---|---|---|
| Mean ($/ton) | 480.27 | 733.75 |
| Median ($/ton) | 426.91 | 587 |
| | t-value | Pr (T>t) |
| T-test (modern-traditional) | 16.39 | 0 |
| | Coefficient | t-value |
| Hedonic pricing[a] (modern=1) | 2.76 | 7.95 |

[a] Controlling for packaging, variety, parboiled dummy, type of rice.

**Table 5.20 Rice Price Difference between Traditional and Modern Retailers in Delhi**

| Variable | Observations | Mean ($/ton) | Std. Error | Price Difference with Modern Retail | | | |
|---|---|---|---|---|---|---|---|
| | | | | Mean (Rs/kg) | Std. Error | t-Value | Pr (\|T\|>\|t\|) |
| **Unbranded rice** | | | | | | | |
| Modern retail | 59 | 707 | 1.85 | | | | |
| Traditional retail | 566 | 538 | 0.29 | -7.63 | 1.09 | -7.028 | 0.000 |
| **Branded rice** | | | | | | | |
| Modern retail | 489 | 1,438 | 1.18 | | | | |
| Traditional retail | 291 | 1,543 | 1.72 | 4.71 | 2.03 | 2.322 | 0.021 |

Pr = probability, Rs = Indian rupees, Std. = standard.

A large part of the difference in the pair-wise comparisons may be explained by other factors as well as the type of outlet. The following text reports on empirical analyses of the modern versus traditional price comparison, using a battery of controls related to the quality of the product and the location.

Table 5.21 reports hedonic price regressions for traditional versus modern retail in Delhi. The methodology regresses the retail price per kilogram on categorical variables for the type of retail outlet; the quality of the product (grain length, grain color, shape, degree of brokenness, and impurities due to rock particles and remaining bran or husk); the ward (the location, which controls for both location and time, as the survey was rolled out over a month in different wards); a wealth indicator of the colony to control for local potential demand factors; and a dummy for whether the rice was labeled with a brand.

The hedonic price regression shows that private-sector modern retail was cheaper than the traditional shops. The difference amounted to Rs5.81/kg (12%) for rice. Similar results were found for edible oil and wheat flour, two other main processed staples (Minten, Reardon, and Sutradhar 2010).

**Table 5.21 Hedonic Price Regression Results: Rice in Delhi**

| **Dependent Variable** (Rs/kg) | |
|---|---|
| Modern retail dummy | |
| Coefficient | -5.81 |
| t-value | -3.34 |
| Number of observations | 1,368 |
| $R^2$ | 0.56 |

kg = kilogram, Rs = Indian rupees.
Notes: Modern retailers versus kirana shops (small-scale retailers that sell numerous products)
F-test: Modern retail versus kirana shops, 11.15, probability > F = 0.00
* P in Rs/kg = f (retail outlets, quality/branded indicators, ward dummy, wealth colony dummy)
Only retail outlet coefficients are reported.
Kirana shop prices are the default. The colony is the smallest Indian urban geographical unit, a subdivision of a ward.

**Table 5.22 Propensity Score Matching: Results Comparing Prices at Traditional and Modern Retailers in Delhi**

| Sample | Treated (modern) | Controls (traditional) | Difference | Std. Error | t-Statistic |
|---|---|---|---|---|---|
| Unmatched | 61.28 | 39.69 | 21.59 | 1.55 | 13.89 |
| ATT | 61.28 | 69.12 | -7.84 | 2.40 | -3.27 |
| Number of observations | 532 | 813 | | | |

ATT = average treatment effect for the treated, Std. = standard.

Table 5.22 further explores the price differences using Propensity Score Matching probit regressions; these were run with dummy variables of rice sold in supermarkets coded as 1, and rice sold in traditional retail outlets coded as 0, as dependent variables. The controls include measures for quality, labeling, quantities sold, ward dummy variables, wealth dummy variables per colony, and an intercept. Using the results of these regressions to construct a propensity score, the table shows the Propensity Score Matching impact estimates on prices for rice comparing modern retail (treated) with traditional markets (control). The results are of the unmatched sample and the average treatment effect for the treated (ATT).

The finding is that rice was more expensive in modern retail in unmatched samples. However, modern retail was significantly less expensive for similar products, i.e., the matched samples, as shown by the large t-values for the average treatment effect for the modern retailers. For rice, the price differences of similar processed products in modern compared with traditional retail was 11% (shown in the table as the t-statistic with difference).

In summary, after controlling for confounding factors, rice was significantly cheaper in modern retail no matter which method is used.

## Comparison of Rice Prices between Traditional and Modern Retail in Beijing

Comparing prices in Beijing shows differences between the leading and local modern chains. Loose fine rice with a low share of broken grains was sold at CNY5.9/kg in the leading chain stores in November 2009, and CNY6.9/kg in the local chains. Loose common rice was CNY4.3/kg in both types of chains in November 2009, which is close to prices in traditional retail outlets at that time. In November 2009, packaged fine rice was CNY11.0/kg in the modern stores, and packaged common rice was CNY5.5. Hence, the packaged common rice price was close to the price in the traditional stores, while the fine rice price was somewhat higher, presumably in each case in view of the competitive situation per target consumer group.

## Profit Rates of Traditional Rice Retailers

Table 5.23 shows profit rates for traditional retailers. As in the calculations of profit in Chapter 4, these are gross of amortization, and so somewhat understate profit rates; however, that bias is smaller for the small retailers than for traders and mills with a much higher capital/labor ratio. The profit rate in Dhaka averaged 30%; this is somewhat lower than trader profit rates, and much lower than the rice retail profit rates calculated by Chowdhury (1992) from the International Food Policy Research Institute survey data in 1989/90. The rates for the PRC averaged about 20% (weighted by the importance of the rice types), and were the same in India.

**Table 5.23 Traditional Rice Retailers' Profit Rates**

| City<br>Rice Quality | Profit Margin<br>(%) |
|---|---|
| **Dhaka, Bangladesh** | |
| Coarse | 28 |
| Medium | 31 |
| Fine rice | 34 |
| **Beijing, the PRC** | |
| Common | 24 |
| Fine | 16 |
| Sticky | 7 |
| Fragrant | 2 |
| **Delhi, India** | |
| Common | 10 |
| Fine | 26 |

PRC = People's Republic of China.

# Conclusions

First, traditional rice retail, as revealed by the detailed survey, was significantly different from the images and assumptions normally associated with it. Traditional rice retail was evolving in ways that pointed toward greater quality differentiation, packaging, and brand development. In the PRC, this was proceeding fastest for packaging and branding, and traditional retailing was moving rapidly in quality differentiation in all three study zones. Over time, the branding and the resulting traceability will be important factors in the development of rice markets in urban Asia, and will probably also encourage continued consolidation in the mill and trader sector. Further, traditional retailers provided very little value-chain finance (by letting customers buy on credit), and they tended to do little home delivery (except in Beijing).

Second, modern retailing had already penetrated deeply into urban rice markets in Beijing, and was starting to penetrate them in South Asia. While supermarkets still charged more for rice in Dhaka, already in Delhi, controlling for the type of rice, supermarkets charged less than did traditional retailers, and prices were about the same in both types of retailing in Beijing. Moreover, supermarkets sold a greater variety of rice to appeal to quality differentiation needs and desires of consumers with increasing incomes, but also, especially in Beijing, the supermarkets sold cheap loose rice to target the broad group of limited-income consumers.

Third, the government had little direct role in rice retailing in the study zones, except in India, where it had about 15% of urban rice retail (about twice that of modern private retail). The government did not appear to have a comparative advantage in retailing rice. A large share of Indian public system shops was not open during store hours, corroborating the findings in the literature of inefficiency and low access by consumers to the subsidized retail.

However, the indirect role of government appears to have been appreciable in developing the retail sector. The authors especially saw this in the PRC, where liberalization of the retail sector had attracted substantial foreign and domestic investment that had brought "the supermarket revolution" to rice.

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# 6 Performance of the Rice Value Chain—Rewards, Costs, and Margins

This chapter presents findings concerning the distribution of costs, rewards, and overall margins across the value-chain segments, and the composition of value-chain costs in terms of functional categories (such as labor, transport, and wastage).

## Costs, Rewards, and Overall Margins in the Rice Value Chain

Tables 6.1–6.3, for Bangladesh, the People's Republic of China (PRC), and India, show the shares by segment in the rice value chain's total costs, rewards, and margins. The rewards are calculated as the difference between costs and revenues per unit sold. To convert prices per ton of paddy to the rice equivalents, the paddy costs, prices, and margin were divided by 0.65 (where 0.65 is assumed to be the paddy-to-rice conversion ratio). Total gross income per ton of the segment actor is calculated as the sum of rewards (profits) plus costs.

For farmers, the "total margin" (the gross income of the whole value chain) is the urban retail price, which in turn is the rice equivalent paddy price received per ton of paddy, and costs are the sum of the rice equivalent monetary costs of cultivating a ton of paddy and the rice equivalent marketing costs per ton of paddy. The farmers' share of total value added was higher than is typically assumed, partly because of disintermediation in the rice value chain, with (1) the role of village brokers decreasing and the farmers increasingly selling directly to mills (rather than through village traders), and (2) mills selling directly to city wholesale markets (rather than through rural wholesalers). However, the farmers' rewards were somewhat offset by the share taken by mills, village traders, rural wholesalers, urban wholesalers, and urban retailers. This change was occurring in the value chains' transformation from the most traditional local value chains (see Chapter 2), wherein farmers sold into local, rural consumer markets.

For millers and rural paddy wholesalers, margins and costs reported are the rice equivalent margins and costs for handling one ton of paddy. For wholesalers (rural and urban, paddy and rice) and retailers, margins are the difference between the sale price and the purchase price of rice and/or paddy.

**Bangladesh.** Rice farmers in Noagoan received $198/ton for common and $218/ton for fine rice, a small premium. However, midstream and downstream sellers received a substantial premium for fine rice. Thus, the farmers were not capturing the quality differential, as they had 79% of the urban retail price of common rice but only 52% of the urban retail price of fine rice (see Chapters 4 and 5, and Minten, Murshid, and Reardon 2012). The share of total margins (the urban retail price) of rural and urban wholesalers combined in the value chain jumped from 7% to 16% between the rice qualities. The gain for the miller was more modest, from 5% to 8%. The most spectacular gain was enjoyed by the urban traditional retailer, whose share in the total margins jumped from 8% to 24%. Given that the trend was toward higher quality rice, the postharvest segments' shares in the value chain are thus likely to rise over time.

**Table 6.1 Shares of Rewards, Costs, and Total Margins in the Rice Value Chain from Noagoan District to Dhaka**

| Item | Common Rice | | | Fine Rice | | |
|---|---|---|---|---|---|---|
| Average retail price of rice in Dhaka ($/ton) | 444.23 | | | 634.60 | | |
| **Share of rewards, costs, and total margins accruing to** (%) | **Rewards** | **Costs** | **Total Margins** | **Rewards** | **Costs** | **Total Margins** |
| Farmers (rice equivalent) | 69 | 87 | 79 | 38 | 86 | 52 |
| Rural paddy wholesalers (rice equivalent) | 4 | 1 | 2 | 17 | 1 | 12 |
| Millers | 8 | 3 | 5 | 10 | 3 | 8 |
| Urban rice wholesalers | 10 | 1 | 5 | 5 | 1 | 4 |
| Urban traditional retailers | 9 | 8 | 8 | 30 | 8 | 24 |
| Total rewards, costs, and total margins in the value chain (figures in parentheses show the share of the Dhaka retail price) | 100 (47) | 100 (53) | 100 (100) | 100 (70) | 100 (30) | 100 (100) |

Notes: Rewards are calculated as the difference between costs and margins:

1. For farmers, the total margin is the rice equivalent paddy price received per kilogram of paddy, while costs are the sum of the rice equivalent monetary costs of cultivating per kilogram of paddy and the rice equivalent marketing costs per kilogram of paddy.
2. For millers, wholesalers (rural and urban, paddy and rice), and retailers, margins are the difference between the sale price and the purchase price of rice/paddy.
3. For millers and rural paddy wholesalers, margins and costs reported are the rice equivalent margins and costs for handling per kilogram of paddy.
4. To convert prices per kilogram of paddy costs and margins to the rice equivalent prices costs and margins, the paddy costs, prices, and margin were divided by 0.65 (where 0.65 is assumed to be the paddy-to-rice conversion ratio).

**The PRC.** The Heilongjiang farmers' case was similar to that in Bogra, but less pronounced. The farmers' share in the urban retail price was lower for fine than for common rice, implying that the midstream and downstream segments captured (slightly) more the gains from quality differentiation.

The PRC millers' share of the value chain was larger than that of the South Asian millers, possibly because PRC millers tended to sell directly to large urban wholesale markets and buy directly from farmers.

**India.** Table 6.3 shows that the Shahjahanpur farmers' share of the total margins of the value chain averaged 65% across rice qualities. But in sharp contract to Bangladesh, the Indian farmers' share in the urban retail price did not differ between the rice qualities, and thus the farmers were capturing the quality differential in price. As in Bangladesh, the Indian miller's share was modest (averaging 9%) and rose slightly from common to fine rice. The share of the wholesalers was small—about 10% for common rice. The urban retailers, by contrast, commanded about 15% of the total margins, but their costs were

**Table 6.2 Shares of Rewards, Costs, and Total Margins in the Rice Value Chain from Heilongjiang to Beijing**

| Item | Common Rice | | | Fine Rice | | |
|---|---|---|---|---|---|---|
| Average retail price of loose rice in Beijing ($/ton) | 646 | | | 866 | | |
| **Share of rewards, costs, and total margins accruing to** (%) | **Rewards** | **Costs** | **Total Margins** | **Rewards** | **Costs** | **Total Margins** |
| Farmers | 60 | 44 | 54 | 41 | 44 | 42 |
| Millers | 33 | 36 | 35 | 25 | 36 | 29 |
| Urban rice wholesalers/ traders in Beijing | 6 | 11 | 8 | 22 | 11 | 19 |
| Traditional urban rice retailers in Beijing | 1 | 7 | 4 | 13 | 7 | 11 |
| Total rewards, costs, and margins in the value chain (parentheses show share of the Beijing retail price) | 100 (58) | 100 (42) | 100 (100) | 100 (69) | 100 (31) | 100 (100) |

Notes: Rewards are calculated as the difference between costs and margins:

1. For farmers, the total margin is the rice equivalent paddy price received per kilogram of paddy, while costs are the sum of the rice equivalent monetary costs of cultivating per kilogram of paddy and the rice equivalent marketing costs for per kilogram of paddy.
2. For millers, wholesalers (rural and urban, paddy and rice), and retailers, margins are the difference between the sale price and the purchase price of rice/paddy.
3. For millers and rural paddy wholesalers, margins and costs reported are the rice equivalent margins and costs for handling per kilogram of paddy.
4. To convert prices per kilogram of paddy costs and margins to the rice equivalent prices costs and margins, the paddy costs, prices, and margin were divided by 0.65 (where 0.65 is assumed to be the paddy-to-rice conversion ratio).

## Table 6.3 Shares of Rewards, Costs, and Total Margins in the Rice Value Chain from Shahjahanpur in Uttar Pradesh to Delhi

| | Common Rice | | | Fine Rice | | |
|---|---|---|---|---|---|---|
| Average retail price of rice in Delhi ($/ton) | 433.33 | | | 593.33 | | |
| **Share of rewards, costs, and total margins accruing to** (%) | **Rewards** | **Costs** | **Total Margins** | **Rewards** | **Costs** | **Total Margins** |
| Farmers (rice equivalent) | 69 | 63 | 66 | 65 | 61 | 64 |
| Rural paddy wholesalers (rice equivalent) | 6 | 2 | 4 | 6 | 4 | 5 |
| Millers | 6 | 7 | 7 | 13 | 9 | 11 |
| Rural rice wholesalers | 4 | 2 | 3 | 0 | 0 | 0 |
| Urban rice wholesalers | 3 | 3 | 3 | 7 | 5 | 6 |
| Urban traditional retailers | 13 | 22 | 18 | 9 | 22 | 15 |
| Total (figures in parentheses show the share of Delhi retail price) | 100 (46) | 100 (54) | 100 (100) | 100 (55) | 100 (45) | 100 (100) |

Notes: Rewards are calculated as the difference between costs and margins.

1. For farmers, the total margin is the rice equivalent paddy price received on selling per kilogram of paddy, while costs are the sum of the rice equivalent monetary costs of cultivating per kilogram of paddy and the rice equivalent marketing costs for per kilogram of paddy.
2. For millers, wholesalers (rural and urban, paddy and rice), and retailers, margins are the difference between the sale price and the purchase price of rice/paddy.
3. For millers and rural paddy wholesalers, margins and costs reported are the rice equivalent margins and costs for handling per kilogram of paddy.
4. To convert per kilogram of paddy prices, costs and margins to the rice equivalent prices costs and margins, the paddy costs, prices, and margin was divided by 0.65 (where 0.65 is assumed to be the paddy-to-rice conversion ratio).

especially high, as they had about a fifth of the costs of the whole value chain—the great majority of postharvest costs. This may imply an inefficient small shop sector in staples.

**The Three Zones.** In general, the South Asian farmers' share in the rice value chain was greater than conventional wisdom would have it; however, the share of off-farm segments of the value chain was still significant, at 35% on average. In the PRC, the postharvest segments' share of margins was 52%. Regarding farmers' shares of the price differential between common and fine rice, Bangladesh farmers captured the least share of that quality differential (and thus their share in the value chain for fine rice was much less than in the chain for common rice); the PRC farmers had only a modest share in the differential; and Indian farmers' share of the differential was the greatest.

The small Indian shops had an especially high share of costs, and the Bangladesh and PRC wholesalers had high shares of the margins. In the PRC, this apparently reflected the high costs of transport over a long distance (plus apparent market power—that is, the wholesalers' ability to influence the price of rice due to their control over its supply). The high share of costs borne by Bangladesh shops mainly reflected what appeared to be wholesalers' market power to capture margins of fine rice. The profit rates for wholesalers and retailers were not significantly correlated with their shares in total margins. Rice traders' profit rates were similar across zones studied, except for relatively high profits for rural rice wholesalers in Bangladesh (especially for fine rice) and urban rice traders in India.

## Cost Items in the Rice Value Chain

Tables 6.4–6.6 show cost items in the rice value chain in the three zones.

**Bangladesh.** As the share of costs in total margins averaged approximately 40% (as a simple average of the share of costs in the value chain for common rice, 53%, and for fine, 30%) in Bangladesh (Table 6.1), the share of a particular cost item in Table 6.4, multiplied by 40%, gives a rough idea of the impact that item had on the cost to the rice consumer. In the following discussion, an average of rice qualities is used unless a distinction is particularly merited.

Farmers' external inputs were the most important single cost item in Bangladesh—about 36% of value-chain costs (thus, with an impact factor of roughly 14% on the consumer price). Hired farm labor ranked second, at 33% of costs—an item that is likely to increase over time as nonfarm labor markets develop. If the wholesalers' and retailers' operational and transport costs and market fees are considered as one item, then they would rank third, and together they formed a scant 10% of total costs. The fourth-ranked item was the mill, at 4% of costs. Taken together, post farm-gate services of milling and trading formed 14% of rice value-chain costs, and thus only about 6% of the rice price.

**The PRC.** As the share of costs in total margins was 42% in the PRC for common rice (Table 6.2), the share of a particular cost item in Table 6.5, multiplied by 42%, can be used to approximate the impact that item had on the rice consumer.

**Table 6.4 Shares of Cost Items in the Rice Value Chain in Bangladesh**

| Item | Common Rice | Fine Rice |
|---|---|---|
| Total cost in the rice value chain ($/ton) | 200 | 190 |
| Share of items in the total cost of rice per ton (%) | | |
| Farmers | | |
| Rented-in land | 17 | 17 |
| Inputs (for all purchased inputs [other than land and labor], which include purchased seeds, fertilizers, crop chemicals, purchased irrigation, and purchased animal and machine traction) | 36 | 36 |
| Hired labor | 33 | 33 |
| Mills | | |
| Operating costs (electricity, diesel, water, telephone and fax use, rents for stalls and warehouse) | 1 | 1 |
| Transport (rents for trucks and costs for transport for transactions) | 2 | 2 |
| Wages (hired casual and permanent laborers) | 1 | 1 |
| Traders: wholesalers and retailers | | |
| Operating costs (for electricity, telephone and fax use, and rents for stalls and warehouses) | 3 | 3 |
| Wages (for casual and permanent laborers) | 2 | 2 |
| Fees (marketing and weighing fees for the entire value chain) | 1 | 1 |
| Transport (hired transport for transactions, rents of trucks, expenses for personal transport for transactions, wholesalers and retailers) | 3 | 3 |
| Other (bagging, stitching, grading, loading and unloading, payments at check points/road toll taxes incurred by trader during transactions) | 1 | 1 |
| Total | 100 | 100 |

Note: For farmers, all costs are calculated in "rice equivalent" terms. For this purpose, the cost per unit of paddy was divided by 0.65, where 0.65 is assumed to be the paddy-to-rice conversion ratio.

The largest category of costs in the PRC rice value chain was farmers' costs, at 44% of the total. Thus the impact on consumers was 42% times 44%, or 18%. Two-thirds of the farmers' costs (hence 29% of the costs in the system) were for farm inputs. Thus, farm inputs had a 12% impact on the price of rice to consumers.

The second largest cost was milling, at 36% of the overall costs of the rice value chain—nearly equal to overall farm costs and more than farm input costs. Rice milling costs translated into a 15% impact on rice prices—even higher than the impact of farm nonlabor input costs.

Third, total transport costs per ton were substantial, at 28% of the value chain costs in the PRC, for an impact of 12% on retail rice prices.

Fourth, energy costs in postharvest activities were a substantial cost in the chain. Energy costs (fuel and electricity in the mills and in transport to and

**Table 6.5 Shares of Cost Items in the Rice Value Chain in the People's Republic of China**

| Item | Common Unpackaged Rice |
|---|---|
| Total cost of rice per ton ($/ton) | 268 |
| Share of items in the total cost of rice per ton (%) | |
| Farmers | |
| Rented-in land | 8 |
| Inputs (for all purchased inputs [other than land and labor],which include purchased seeds, fertilizers, crop chemicals, and purchased irrigation) | 29 |
| Hired labor | 7 |
| Mills | |
| Operating costs (electricity, diesel, water, telephone and fax use, rents for stalls and warehouse) | 9 |
| Transport (rents, diesel, and insurance for trucks and diesel and insurance for own truck) | 18 |
| Wages (hired casual and permanent laborers) | 9 |
| Traders: wholesalers and retailers | |
| Operating costs (for electricity, telephone and fax use, and rents for stalls and warehouses) | 3 |
| Wages (for casual and permanent laborers) | 4 |
| Fees (marketing and weighing fees for the entire value chain) and insurance | 1 |
| Transport (costs of hired transport for transactions, rents of trucks, expenses for personal transport used for transactions) | 10 |
| Total | 100 |

Note: For farmers, all costs are calculated in "rice equivalent" terms. For this purpose, the cost per unit of paddy was divided by 0.65, where 0.65 is assumed to be the paddy-to-rice conversion ratio.

from the mills) comprised roughly 40% of milling costs, or 15% of the costs in the whole system. An additional 5% came from energy in the wholesale and retail segments (operational costs and transport). Thus, postharvest energy costs were a substantial 20% of all costs in the rice value chain, and had an 8% impact on consumer prices.

**India.** Table 6.3 shows that average costs in the Indian common rice value chain were roughly 54% of total margins, which can be thought of as the approximate impact of a cost item on consumer costs. The following discussion assumes an average across rice qualities unless a distinction is particularly needed.

The first ranked item in India was farmer's costs, at about 62% of costs in the value chain, for a 38% impact on consumers. Half of the farmers' costs were nonland, nonlabor external inputs, which thus were about 32% of total costs (Table 6.6). With a weighting of 54%, this means that external input costs had about a 17% impact on consumer rice costs.

**Table 6.6 Shares of Cost Items in the Rice Value Chain in India**

| Item | Common Rice | Fine Rice |
|---|---|---|
| Total cost in the rice value chain ($/ton) | 234 | 266 |
| Share of items in the total cost of rice per ton (%) | | |
| Farmers | | |
| Rented-in land | 4 | 4 |
| Inputs (for all purchased inputs [other than land and labor], which include purchased seeds, fertilizers, crop chemicals, and purchased irrigation) | 32 | 31 |
| Hired labor | 27 | 26 |
| Transport (for hired transport used in transaction) | 1 | 1 |
| Mills | | |
| Operating costs (for electricity, diesel, water, telephone and fax use, rents for stalls and warehouse) | 4 | 4 |
| Transport (rents on trucks and costs for transport for transactions) | 1 | 1 |
| Wages (hired casual and permanent laborers) | 2 | 2 |
| Traders: wholesalers and retailers | | |
| Operating costs (for electricity, telephone and fax use, and rents for stalls and warehouses) | 5 | 4 |
| Wages (for casual and permanent laborers | 6 | 5 |
| Fees (marketing and weighing fees for the entire value chain) | 2 | 1 |
| Transport (costs of hired transport for transactions, rents of trucks, expenses for personal transport used for transactions) | 12 | 11 |
| Other | 3 | 3 |
| Total | 100 | 100 |

Note: For farmers, to convert the per unit paddy costs to the rice equivalent costs, the per unit paddy cost was divided by 0.65, where 0.65 is assumed to be the paddy-to-rice conversion ratio.

Hired labor costs were another 42% of farm costs in India and 35% in the entire rice value chain. As noted in Chapter 3, own labor costs (valued at the imputed wage rate) were about the same as hired labor costs, so that the overall labor component in the farm sector was a major determinant of rice costs to consumers. Demand for nonfarm labor was pressuring farm wages to increase, which suggests that, over time, farms will become more mechanized, a trend the study observed in Indian paddy production.

Ranking third was the combined costs of the mill plus the trader (wholesale and retail), at about 30% of all costs. Transport costs were 13% of the value chains' costs—thus with an impact factor of about 7% on rice prices. The authors estimated that roughly 10% of the total costs in the value chain (from both transport and milling) were for energy (electricity and fuel-related) costs.

Although the public debate attached great importance to market fees in driving food price inflation, the data show that the impact of market fees was minimal, at 1.5% of the costs of the entire value chain and with less than a 1% impact on rice prices in Delhi.

**All Three Zones.** Comparing across the zones, several points stand out. Two items that "conventional wisdom" blames for high rice prices are market fees and transport costs. However, market fees were small and had an insignificant impact (less than 1%) on the retail price of rice.

Transport costs were significant, although their impact on retail rice prices was less than 4% in Bangladesh, less than 7% in India, and under 12% in the PRC. However, the Indian rice zone studied is 200 kilometers (km)–400 km from Delhi, about a quarter of the distance that the PRC rice zone is from Beijing. The cost in India was about \$34/ton, and that in the PRC was \$77/ton. Thus, the Indian costs were about twice the PRC costs measured per ton per kilometer.

Farm inputs had a large impact on the price of rice to the consumer—17% in Delhi, 14% in Dhaka, and 12% in Beijing. Therefore, efficient input supply chains to farmers and correct use of inputs are important to reduce value chain costs. Reducing farm input and machine costs would have a significant effect on rice prices.

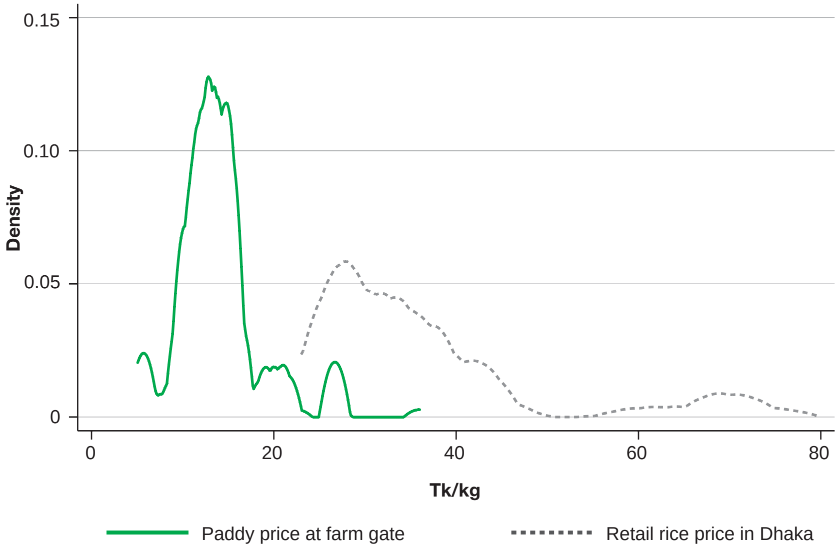
Energy costs also had a significant effect on the rice price via the costs of the postharvest segments (in addition to the direct and indirect effects they have on the farm segment's costs).

## Rice Markets

While the markets appeared to be changing, transforming, and restructuring, they did not seem to be well integrated yet, with arbitrage complete. Prices varied substantially even at a single point in time in a given segment of the rice value chain, and over seasons. The variations were generally greater in midstream and downstream segments than in the farm segment (Figures 6.1–6.3).

Figure 6.1 shows the density function of the variation of prices at the beginning and end stages of the Bangladesh value chain—rice farmers in Noagoan and rice retailers in Dhaka. Retail prices showed a much larger variation than was seen at the farmer level, even though farm prices were collected for the year and retail prices were only those asked for on the day of the survey. The differences between the two price distributions reflected the costs and benefits of delivering different types of services.

**Figure 6.1 Producer and Retail Price Variation of Rice in Bangladesh**

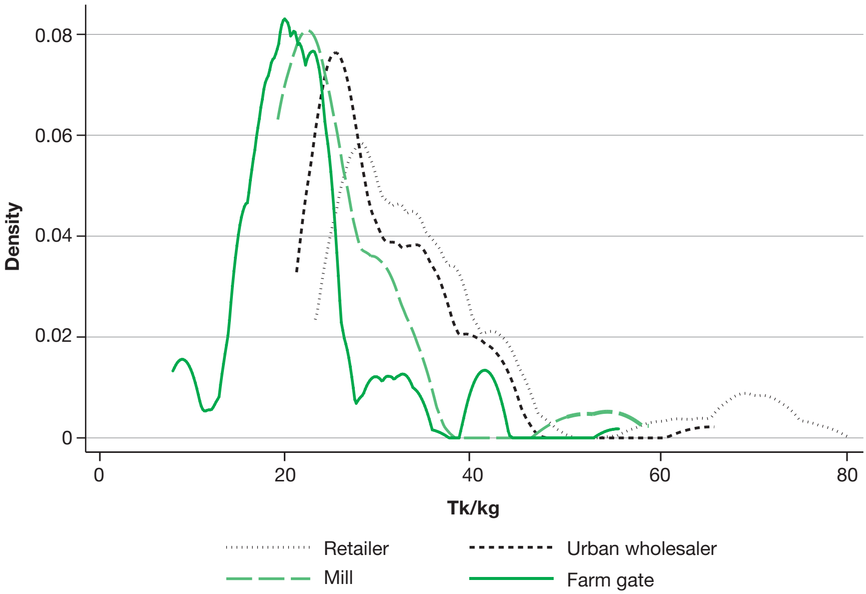



kg = kilogram, Tk = taka.

Figure 6.2 shows the density function of sales price variation by segment for rice prices in Bangladesh. While prices were asked at the time of the survey for all segments, the price at the farm level reflects the variation during the last marketing period, because farmers had few transactions during the year. The figure shows an expected right shift for each segment, reflecting the marketing between the segments. However, the figure also illustrates the large variation within each segment, often reflecting differences in quality and location.

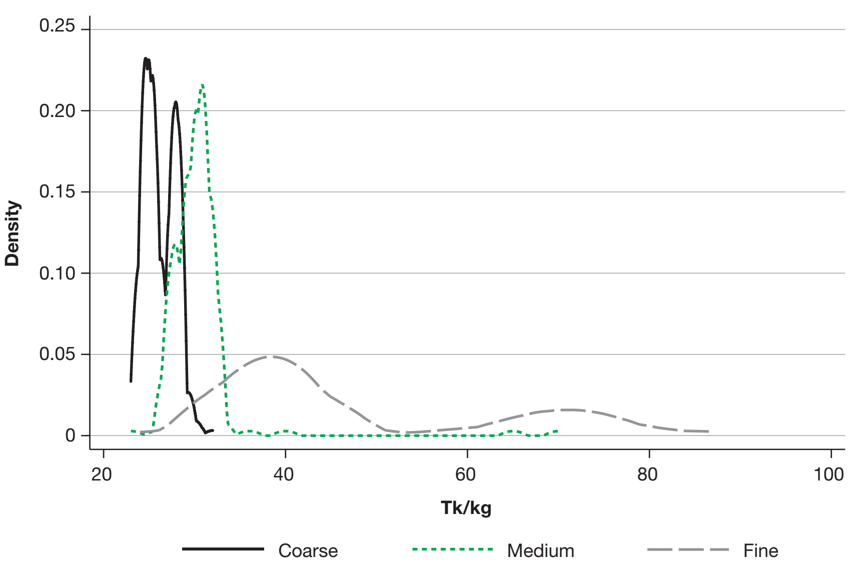
Furthermore, there was significant price variation at any point in time, especially at the retail level (Figure 6.3). Retail prices varied widely, primarily depending on quality. While the average prices of coarse and medium rice were \$0.38 per kilogram (kg) and \$0.44/kg, respectively, the average price for fine rice was as high as \$0.69/kg and the median was \$0.60/kg. However, the variation for fine rice was significantly higher than that for the other types of rice—from \$0.35/kg to more than \$1.17/kg. This larger variability is shown in Figure 6.3, where the peaks of the density distribution for coarse and medium rice are much more tightly centered than those for fine rice.

**Figure 6.2 Price Variation by Segment during the Survey in Bangladesh**




kg = kilogram, Tk = taka.

**Figure 6.3 Retail Prices of Rice during the Survey in Bangladesh**




kg = kilogram, Tk = taka.

**Table 6.7 Prices Received by Players in the Value Chain in India during September–February**

| Item | Sep–Oct 2009 | Nov–Dec 2009 | Jan–Feb 2010 | Average |
|---|---|---|---|---|
| **Common rice** | | | | |
| **Average sales price received** ($/ton) | | | | |
| Farmers | 180.00 | 184.44 | 186.67 | 184.44 |
| Shahjahanpur paddy wholesalers | 188.89 | 188.89 | 188.89 | 188.89 |
| Millers | 346.67 | 357.78 | 337.78 | 346.67 |
| Shahjahanpur rice wholesalers | 333.33 | 342.22 | 344.44 | 340.00 |
| Delhi rice wholesalers | 346.67 | 362.22 | 364.44 | 357.78 |
| Delhi retailers (traditional) | 388.89 | 402.22 | 431.11 | 406.67 |
| **Share in final retail price of** (%) | | | | |
| Farmers' sale price | 46 | 46 | 43 | 45 |
| Shahjahanpur paddy wholesalers' sale price | 49 | 47 | 44 | 46 |
| Millers' sale price | 89 | 89 | 78 | 85 |
| Shahjahanpur rice wholesalers' sale price | 86 | 85 | 80 | 84 |
| Delhi wholesalers' sale price | 89 | 90 | 84 | 88 |
| **Fine rice** | | | | |
| **Average sales price received** ($/ton) | | | | |
| Farmers | 204.44 | 204.44 | 244.44 | 208.89 |
| Shahjahanpur paddy wholesalers | 291.11 | 291.11 | 288.89 | 291.11 |
| Millers | 382.22 | 384.44 | 386.67 | 384.44 |
| Shahjahanpur rice wholesalers | | | | |
| Delhi rice wholesalers | 513.33 | 531.11 | 533.33 | 526.67 |
| Delhi retailers (traditional) | 564.44 | 584.44 | 593.33 | 580.00 |
| **Share in final retail price of** (%) | | | | |
| Farmers' sale price | 40 | 38 | 46 | 40 |
| Shahjahanpur paddy wholesalers' sale price | 52 | 50 | 49 | 50 |
| Millers' sale price | 68 | 66 | 65 | 66 |
| Delhi wholesalers' sale price | 91 | 91 | 90 | 91 |

Moreover, as shown in Table 6.7 there was some, but not much, variation across seasons in the farmer's share in the value chain. This point is illustrated by the survey evidence from India.

In India, for common rice, the farmers' share in the final traditional retail price declined only slightly from harvest to mid off-season, from 46% to 43%. The millers' share went from 43% to 35% of the retail price, and the Delhi wholesalers' share went from nearly none to 6%. The retailers' share went from 11% to 16% between those two periods. The two main price capturers in the common rice chain were thus the farmers and millers.

For fine rice, the Indian farmers' share of the final retail price rose somewhat from harvest to mid off-season, from 40% to 46%. In the same period, the millers' share went from 28% to 19% of the retail price; the Delhi wholesalers' share, from 23% to 25%; and the retailers' share, from 9% to 10%. The two main sets of price capturers in the fine rice chain were thus the farmers and, with smaller shares, the millers and Delhi wholesalers. This result was somewhat attenuated when using the rice-equivalent price for the farmers, and the mills' margin was reduced. However, common paddy and rice prices varied little over the seasons.

During recent years in India there has been an important debate on food price inflation. Therefore, the study looked at the extent that price inflation was linked to agents' increasing margins in the value chain. The analysis centered on the time series of price data only at the wholesale and retail levels in Delhi, taken from government sources (the survey for the study did not collect price series over the decade). Thus, the discussion on rice price inflation will be limited to the relative impact of retail margins and wholesale prices.

Figure 6.4 plots the monthly nominal wholesale and retail prices for 2000–2010.[1] The figure highlights how the nominal prices of both indicators had "blipped up" since 2008, thus indicating nominal inflation in rice prices at both levels. To ascertain to what extent middlemen between wholesale and retail were benefiting from or causing this upward trend, the ratio and the difference between the two series are examined. Figure 6.5 plots the share of the wholesale price in the retail price during 2000–2010, showing significant variability in this ratio over time but no clear upward or downward trend. Figure 6.6 plots nominal and real rice retail margins.[2] While the nominal price rose over time, and with significant variability, there seems to be no evidence of increasing real retail margins over time.

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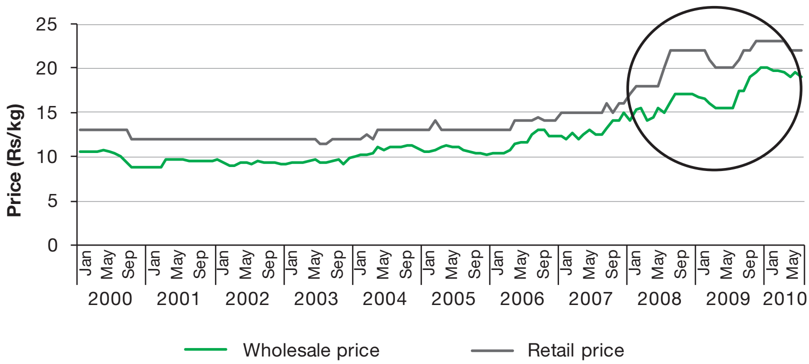
1 From the Price Monitoring Cell, Ministry of Consumer Affairs and Public Distribution, Government of India's Fcaininfoweb website.

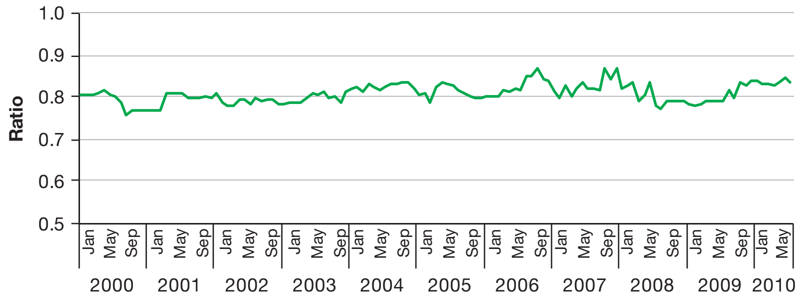
2 The margins were obtained by dividing the prices with the consumer price index for industrial workers, where the index in 2009 is equated to retail margins, defined as the absolute difference between wholesale and retail prices, over time.

## Figure 6.4 Wholesale and Retail Rice Prices in Delhi

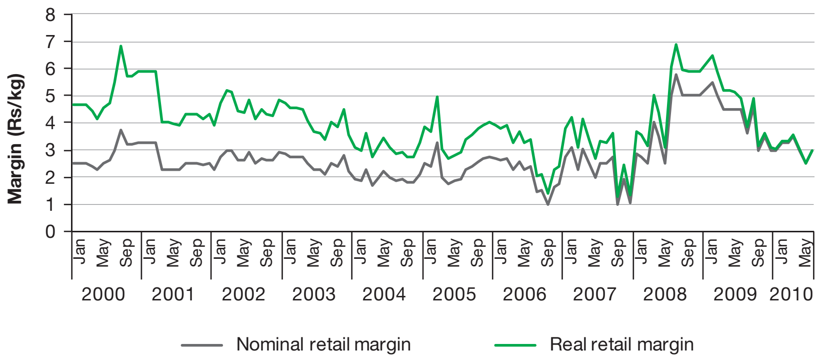



kg = kilogram, Rs = Indian rupees.

## Figure 6.5 Ratio of Wholesale to Final Rice Retail Price in Delhi




## Figure 6.6 Nominal and Real Rice Retail Margins in Delhi




kg = kilogram, Rs = Indian rupees.

To statistically test how nominal rice prices had changed over time and what the contributing factors had been to that inflation, the authors ran several regressions of the form where the price of rice (expressed in Rs/kg) is linked with quarterly dummies, to capture the seasonal variation in prices, and yearly dummies, to capture nominal inflation in prices (Table 6.8). Several important insights emerge:

(1) There were seasonal movements in the prices and margins, and both were significantly higher during the 4 months prior to the harvest period.

(2) The coefficients of the yearly dummies indicate how prices had changed over time, on average. Rice retail prices were estimated to be Rs7/kg in 2008 and Rs8.6/kg in 2009 higher than in 2000. About 17%–18% of that increase was explained by higher nominal retail

**Table 6.8 Rice Regressions: Nominal Wholesale and Retail Prices, and Nominal and Real Retail Margins**

| Explanatory Variables | Dependent Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Nominal Wholesale Price (Rs/kg) | | Nominal Retail Price (Rs/kg) | | Nominal Retail Margin (Rs/kg) | | Real Retail Margin (Rs/kg) | |
| | Coefficient | t | Coefficient | t | Coefficient | t | Coefficient | t |
| Intercept | 9.55 | 35.94 | 12.49 | 47.04 | 2.94 | 14.30 | 5.44 | 19.64 |
| Mar–Apr | 0.002 | -0.01 | -0.02 | -0.10 | -0.02 | -0.11 | -0.07 | -0.30 |
| May–Jun | 0.30 | 1.32 | -0.45 | -0.20 | -0.35 | -1.96 | -0.59 | -2.47 |
| Jul–Aug | 0.38 | 1.64 | 0.26 | 1.14 | -0.12 | -0.65 | -0.37 | -1.54 |
| Sep–Oct | 0.80 | 3.39 | 0.63 | 2.66 | -0.17 | -0.94 | -0.44 | -1.80 |
| Nov–Dec | 0.91 | 3.83 | 0.71 | 2.98 | -0.20 | -1.10 | -0.49 | -2.00 |
| 2001 | -0.54 | -1.75 | -0.75 | -2.41 | -0.205 | -0.85 | -0.53 | -1.64 |
| 2002 | -0.64 | -2.08 | -0.75 | -2.41 | -0.104 | -0.43 | -0.54 | -1.67 |
| 2003 | -0.53 | -1.73 | -0.83 | -2.68 | -0.29 | -1.23 | -1.04 | -3.21 |
| 2004 | 0.81 | 2.61 | -0.42 | -0.13 | -0.85 | -3.55 | -2.05 | -6.32 |
| 2005 | 0.77 | 2.49 | 0.33 | 1.07 | -0.44 | -1.82 | -1.57 | -4.83 |
| 2006 | 1.69 | 5.46 | 0.96 | 3.08 | -0.74 | -3.06 | -2.16 | -6.65 |
| 2007 | 3.02 | 9.73 | 2.50 | 8.04 | -0.52 | -2.18 | -2.06 | -6.34 |
| 2008 | 5.73 | 18.44 | 7.00 | 22.52 | 1.27 | 5.26 | -0.15 | -0.46 |
| 2009 | 7.10 | 22.84 | 8.58 | 27.62 | 1.48 | 6.16 | -0.31 | -0.95 |
| 2010 (till July) | 9.81 | 26.81 | 10.06 | 27.49 | 0.24 | 0.39 | -2.10 | -5.50 |

margins and 82%–83% by higher wholesale prices. As the coefficients on the yearly dummies in the retail margin regression were always smaller than in the wholesale price regression, increases in retail margins always contributed less to retail price inflation than wholesale price inflation.

(3) The last two columns of Table 6.8 present the results of a regression of the real retail margin on time dummies. Compared with the year 2000, the time dummies are insignificant or significantly negative, suggesting that margins in the food retail sector had not increased in real terms during this period. Thus, the study found that rice price inflation was not being driven by traditional retail margins, but rather mainly by changes in wholesale prices.

## Conclusions

This overview of the distribution of costs and rewards in the rice value chains in Bangladesh, the PRC, and India, and the composition of the costs, gave rise to several salient points.

First, rice farmers in Bangladesh and India captured roughly two-thirds of the final price, and in the PRC, half of the final price, in the rice value chain. That share varied by quality of rice. Farmers in Bangladesh captured least the differential between fine and common rice (and had a higher share in the value chain for common rice than for fine rice), and the PRC farmers captured a moderate share. By contrast in India, the share of the quality premium captured by farmers was similar to that of the other segments, and thus the gains from quality differentiation were shared fairly equally across the value-chain segments.

Second, the largest single component of rice value-chain costs was farm-level external inputs (other than labor), at roughly a third in all three zones. Therefore, improving the efficiency with which inputs are delivered and used could have a significant effect on the rice value chain.

Hired labor was about a third of value-chain costs in Bangladesh and India. Developments in the nonfarm labor market could put upward pressure on rice prices over time unless both countries continue to mechanize their farms. Mechanization has already advanced well in PRC rice farms, which used little hired labor.

Third, the share of the off-farm components in total margins of the value chain was greatest in the PRC (at half of the costs of the food system), followed by an average of 35% in India and Bangladesh. The PRC's higher share was partly because of the long distance between the farms and retailers, and thus higher transport costs. In addition, the mills were capturing a larger share of the value chain because of branding and disintermediation.

While market fees have figured mightily in food security debates, in particular in India, their impact in the rice value chains was slight.

Fourth, energy costs were important in the rice value chain, at the farm level in mechanization, and intensively so in the mill and trading segments of the three zones. Thus, energy shocks can translate into higher rice prices.

Finally, transport costs as a share of rice prices were modest in Bangladesh and India, mainly because the chains were relatively short, but were significant in the PRC because of the long distance traveled. However, transport costs per ton per kilometer in India were twice as high as in the PRC.

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# PART C
# POTATO VALUE CHAIN

# 7 | Upstream—Potato Farm Transformation

Chapters 7–10 focus on the potato value chains in Bangladesh, the People's Republic of China (PRC), and India. The structure, conduct, and performance of each value chain segment are traced, from farm to cold storage to wholesale to retail. As in the rice market, the conventional wisdom is that, apart from a few dynamic pockets of rapid technology change and larger farms as in the Indian Punjab, the potato economy is essentially "traditional" and is transforming only gradually.

This chapter looks at the farm segment of the potato value chain. It starts with the conventional views regarding the characteristics of the staples farm segment of value chains: (1) that the staples farmers are barely engaged in factor markets, use few inputs, sell a small portion of output, and subsist on the rest, making few capital investments; and (2) that when the farmers turn to the market, they are facing at the farm gate a rapacious and exploitative village trader, a "tied" output–credit market where the trader holds the farmers in thrall by providing credit at the start of the season and requiring them to sell to the trader at disadvantageous terms, and where the farmers sell their entire harvest without storing or "playing the market," leaving the harvest and its gains to the trader.

The chapter marshals the evidence from the farm household surveys on potato in the three study zones—Bogra in Bangladesh, Gansu in the PRC, and Agra in India—to assess the extent to which the "traditional" staples farm segment persists, to what extent the segment has transformed, and what are the key characteristics of that transformation.

## Structure of the Potato Farm Segment

### Potato Farmland Distribution and Land Rental

Table 7.1 shows land operated, including potato and other land, that was rented or owned. The Bangladesh and PRC potato areas come closest to the "traditional image" of Asian rural areas as having a rather flat distribution of farm sizes, averaging small to quite small. The average of total operated land in the study zones was 1.26 hectares (ha) in Bogra, Bangladesh and 1.19 ha in Gansu, the PRC. This is smaller than the rice farms in the Heilongjiang study area, where farms were larger than the average rice farms in the PRC; the Gansu potato farms were closer to the national average. The Bogra potato farms were semispecialized in potato (70% of their farm areas were under potato); the Gansu sample farms were even less specialized (with only 30% of their area used for potato as the main cash crop).[1]

## Table 7.1 Potato Farmland Distribution and Rental

| Zone and Land Type | **Farm Size Strata** (measured in all operational land, owned plus rented-in minus rented-out, under any crop) | | | |
|---|---|---|---|---|
| **Bangladesh** | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **Total** |
| Potato land | 0.53 | 1.39 | | 0.90 |
| Potato land (share of all land) | 61% | 50% | | 70% |
| Land rented-out | 0.08 | 0.46 | | 0.24 |
| Land rented-in | 0.18 | 0.26 | | 0.21 |
| Share of land rented-in (of all operational land) | 25% | 13% | | 17% |
| All operational land | 0.70 | 2.00 | | 1.26 |
| **China, People's Rep. of** | | | | |
| Potato land | 0.26 | 0.44 | | 0.36 |
| Potato land (share of all land) | 36% | 29% | | 30% |
| Land rented-out | 0.0067 | 0.0046 | | 0.0054 |
| Land rented-in | 0.026 | 0.047 | | 0.038 |
| Share of land rented-in (in all operational land) | 4% | 3% | | 3% |
| All operational land | 0.73 | 1.51 | | 1.19 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **Total** |
| Potato land | 1.1 | 2.5 | 8.3 | 4.3 |
| Potato land (share of all land) | 92% | 93% | 82% | 91% |
| Land rented-out | 0 | 0.2 | 0.01 | 0.05 |
| Land rented-in in all operational land | 0.1 | 0.2 | 1.4 | 0.6 |
| Share of land rented-in in all operational land | 8% | 7% | 15% | 13% |
| All operational land | 1.2 | 2.7 | 9.1 | 4.7 |

ha = hectare.

1 The Gansu farmers produced other vegetables, grains, fruit, and pulses, with several as cash crops in addition to potato, chiefly maize and ginger.

However, the small average size masks heterogeneity in the farm population in the Bangladesh and PRC study zones: there was an important jump in average size between the marginal and small potato farm strata. This heterogeneity is underappreciated in the policy debate, where it seems that the perception is of a homogeneously small farm population. Moreover marginal farmers are, in asset terms (and as shown later, also in behavioral terms), disadvantaged compared with even small-scale farmers.

Moreover, concentration was modest but present even in areas of small farms, such as the Bangladesh potato study zone. In Bogra, half of the potato land was cultivated on farms smaller than 0.6 ha. The biggest potato farm in the 10 villages that were part of the study's census was 3.8 ha. But even the low average farm size in the Bangladesh sample masks variation in farm size. Based on the data gathered in the sample villages and from farmers interviewed in the survey, 20% of the potato area in these villages was cultivated by 50% of the potato farmers, and 32% of the potato area was cultivated by the top 10% of the potato farmers. The distribution of the sample closely followed the distribution of the census.

By contrast, the farms in Agra were somewhat larger, with an average operational land size for potato farms of 4.7 ha—somewhat smaller than the 5.4 ha average of the rice farms in the Indian rice study area, the nearby district of Shahjahanpur in Uttar Pradesh. The average area in Agra was several times larger than the average potato farm in the state.[2] The ratio of the size of land dedicated to potato in the largest farm stratum compared with the smallest was 7.5:1, close to the ratio of average operated land, because 91% of the Agra potato farm areas were used for potato.

Again the average masks substantial heterogeneity: the total operational land area of the medium–large potato farm stratum in Agra has an average 7.6 times that of the marginal–small stratum.

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2 It is commonly held that western and central-western Uttar Pradesh have larger farms because Punjabi Sikh farmers had migrated into the area. However, in the study's potato farm sample, only 8% of farmers were from that origin (none in the marginal–small category, and 10%–13% of the semi-medium and medium–large categories); the Punjabi Sikh farmers' land was on average larger than the others. The farms in the sampled area may have been larger for the following reasons: (1) there was a more active rental market in the area (although renting accounted for only 13% of the operational farm size); (2) the former landlord (*zamindar*) system may have had secondary effects in land concentration; and (3) the proximity of Delhi and the intensity of rural nonfarm employment, as well as the introduction and commercialization of potato in the 1990s and 2000s, may have driven land acquisition over time, leading to higher concentration.

Moreover, in the India potato study zone, the degree of concentration was much greater than in the Bangladesh and PRC study zones. The shares of the strata in all 1,251 potato farmers in all the villages surveyed were as follows: 39% marginal–small (less than 2 ha), 33% semi-medium (2 to less than 4 ha), and 28% medium–large (a category combining medium farms of 4 to less than 10 ha and large farms of 10 ha and over. Therefore, this commercialized potato district was more concentrated (had larger farm sizes) than the rest of the state, which predominantly has small grain farms. Government data on the 23 million farms in Uttar Pradesh show that 92% of the farms were marginal–small, 6% semi-medium, and 2% medium–large (Government of India 2010). The Agra zone's farmers were larger: the average farm size owned in the census of all potato growers in the study villages was 3.3 ha—compared with 0.8 ha in the state for all farms. Key informants explained that the Agra area had larger farm sizes because of land consolidation during the 1990s–2000s, when horticultural farmers bought grain land while the grain farmers moved into the periurban and urban economies nearby.

Importantly, while the marginal–small stratum in the Agra census had 39% of the farms, it only had 7% of the farmland. Medium–large farms, with a mere 28% of farms in Agra, occupied 65% of the land. The average farm size in the study area and the shares of the farm strata were similar to those in Punjab's potato area (Jalandhar), as noted by Singh (2008a). In contrast, for Uttar Pradesh as a whole, marginal–small farmers had 92% of farms versus 63% of farmland. This dichotomy is more striking among the marginal farms (less than 1 ha)—at the state level, where the census indicated that they had 78% of the holdings but only 39% of the land.

Thus, in Uttar Pradesh, the smallest farmers were overwhelmingly the most numerous and comprised the largest share of the population. But, in the study area and statewide, they had only a minor share of the land and thus of the market and the volumes marketed in value chains. This general phenomenon was accentuated in important commercial potato areas such as Agra (which supplied the bulk of potatoes to Delhi), where the medium–large farms were a minority, with a quarter of the farms, but produced two-thirds of the potato. Thus, the medium–large farms quantitatively dominated output, the market, and the potato value chain to Delhi. This runs counter to the saying heard in India that "only small farms feed the great cities."

Table 7.1 shows a substantial land rental market. The average share of rented-in land (in total operated land) was 17% in the Bangladesh potato study area (versus only 12% in the rice study area), only 3% in the Gansu area (compared with 37% in the Heilongjiang rice area), and 13% in India (compared with 27% in the nearby rice area).

The rice areas, rather than the horticultural crop potato areas, had taken the lead in land rental market development. This could be due to economies of scale in rice and the quest for mechanization, a hypothesis that merits further exploration. The differences between rice and potato areas in land rental markets were modest in Bangladesh and India but striking in the PRC. But the PRC comparison is between a dynamic eastern rice area and a hinterland western mountainous potato area. Moreover, while rice farmers in Heilongjiang invested their nonfarm incomes in land rental and machines, Gansu potato farmers were also investing in equipment, but much more in livestock (rather than renting land from each other).

In Bangladesh, the marginal stratum's share of rented-in land in total land was twice that of the small stratum, while in India, the opposite held, with the larger farmers renting a much higher share of land per farm. The lower rental share by the smaller Indian farms could be due, as key informants suggested, to the larger farmers renting land from poorer households that work off-farm in this zone, which is periurban and a few hours from Delhi. These findings about interstrata rental mean that the land rental market was highly concentrated in the medium–large farms in India, exacerbating inequality in land ownership, while in Bangladesh it smoothed inequality in land access by compensating for inequality in land ownership.

## Potato Farmers' Nonland Assets

Table 7.2 shows a lot of heterogeneity in nonland assets such as education, livestock, and farm equipment across farmers in each study zone. The findings again belied the common belief that small-scale farmers have similar nonland assets. Several points stand out.

First, demographics and human capital differed across the study zones:

- India's farm households, when compared with those in Bangladesh and the PRC, even in Agra, a commercialized zone near Delhi, had on average larger families and were headed by older males who were less educated on average than in the study zones in Bangladesh and the PRC.

## Table 7.2 Potato Farmers and Nonland Assets

| Asset | Marginal (<1 ha) | Small (≥1 ha) | Total |
|---|---|---|---|
| **Bangladesh** | | | |
| Age of household head (years) | 47 | 47 | 47 |
| Gender of household head (share male) | 99% | 100% | 99% |
| Household size | 4.6 | 4.9 | 4.7 |
| Share of household heads who never went to school | 19% | 13% | 16% |
| Value of livestock assets in 2009 ($) | 618 | 941 | 765 |
| Value of farm assets in 2009 ($) | 147 | 441 | 279 |
| Mean value of tractors owned in 2009 ($; parentheses show the share of tractors in total value farm assets) | 0 (0%) | 70 (16%) | 35 (12%) |
| Mean value of power tillers owned in 2009 ($; parentheses show the share of power tillers in total value of farm assets) | 34 (23%) | 155 (35%) | 95 (34%) |
| Share of households owning tractors in 2009 | 0% | 4% | 2% |
| Share of households owning power tillers in 2009 | 6% | 12% | 9% |
| Share of households using machine traction (tractors/power tillers) in 2009 | 82% | 96% | 89% |
| **China, People's Rep. of** | | | |
| Age of household head (years) | 34 | 37 | 36 |
| Gender of household head (share male) | 64% | 74% | 71% |
| Household size | 5 | 5 | 5 |
| Share of household heads with high school education | 38% | 37% | 37% |
| Livestock in 2009 ($) | 578 | 884 | 760 |
| Livestock in 2005 ($) | 434 | 688 | 585 |
| Nonland nonlivestock farm assets 2009 ($) | 978 | 1,770 | 1,448 |
| Nonland nonlivestock farm assets in 2005 ($) | 436 | 1,028 | 788 |
| Mean value of tractors owned in 2009 ($; parentheses show the share of tractors in total value farm assets) | 145 (15%) | 145 (8%) | 145 (10%) |
| Mean value of power tillers owned in 2009 ($; parentheses show the share of power tillers in total value of farm assets) | 27 (3%) | 53 (3%) | 43 (3%) |
| Share of households owning tractors in 2009 | 15% | 15% | 15% |
| Share of households owning power tillers in 2009 | 5% | 11% | 8% |

*continued on next page*

Table 7.2 *continued*

| **Asset** | **Marginal** (<1 ha) | **Small** (≥1 ha)) | | **Total** |
|---|---|---|---|---|
| Share of households owning tractors in 2005 | 11% | 9% | | 10% |
| Share of households owning power tillers in 2005 | 1% | 3% | | 2% |
| Share of households using machine traction (tractors/power tillers) in 2009 | 29% | 27% | | 28% |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **Total** |
| Age of household head | 57 | 54 | 55 | 55 |
| Gender of household head (share male) | 100% | 100% | 100% | 100% |
| Household size | 8 | 8 | 9 | 8 |
| Share of household heads who were literate | 63% | 75% | 78% | 72% |
| Livestock in 2009 ($) | 2,000 | 2,000 | 2,667 | 2,444 |
| Nonlivestock, nonland farm asset in 2009 ($) | 889 | 1,333 | 8,222 | 3,481 |
| Mean value of tractors owned in 2009 ($; parentheses show the share of tractors in total value of non-livestock, nonland farm assets) | 124 (14%) | 558 (42%) | 2,851 (35%) | 1,178 (34%) |
| Share of households owning tractors in 2009 | 5% | 22% | 67% | 41% |
| Share of households using machine traction (tractors) in 2009 | 23% | 59% | 87% | 63% |

ha = hectare.

- In Bangladesh, household heads of commercial potato area farms were somewhat more educated than their Indian counterparts, somewhat younger, but still all male. The Bangladesh households had 40% fewer members than the Indian households, and their farmlands were roughly 25% of the Indian farm sizes, thus having roughly half the land per person compared with the Indian potato farm.

- Heads of potato farm households in the PRC study zone had more education than the South Asian counterparts, and fewer were male (70%, because of migration). Farms were the same size as those in Bangladesh, and the land/person ratio was the same.

Second, the farm capital/land, labor/land, and labor/capital ratios differed sharply across study zones; hence, so did the technologies used for potato production. Abstracting from differences in prices for like equipment, the rough ratios tell an important story:

- The ratio of farm capital[3] (in dollars) to land was 221:1 in Bangladesh; 1,216:1 in the PRC; and 1,134:1 in India.

- The ratio of traction machinery (tractors and power tillers) in dollars of machinery to land was 103:1 in Bangladesh, 157:1 in the PRC, and 250:1 in India. The Agra potato area had larger landholdings than the other two study zones, and the medium–large farm stratum in Agra had particularly high tractor ownership.

- In all the study zones, the share of farms using traction machines was higher than the share of farms owning these machines. The difference between the share of farmers using and owning machines (few owning and many using) was especially large in Bangladesh. The difference is explained by the active market for renting machines plus labor services, which appears most developed in Bangladesh, where the gap between use and ownership was highest, and least developed in Gansu Province, with the Agra situation in the middle.

- The ratio of labor holdings (proxied by family size) to land was 3.7/ha in Bangladesh, 4.2/ha in the PRC, and only 1.7/ha in India.

- The farm traction-machine capital to labor holdings ratio in the study zones was $147/ha in India, $38/ha in the PRC, and only $26/ha in Bangladesh. The traction-machine ratio is used because of the labor intensity of land preparation. By this measure, the Indian operation in Agra was much more capital intensive than that in the PRC, where the study zone was a relatively poor, small-farm, hinterland area, and than in Bangladesh, where farms were highly labor intensive and poorly endowed in farm capital.

The ratio of machine-traction owned capital to land differed across the farm size strata, and that difference varied across the zones. That ratio for the highest compared with the lowest farm size stratum was 2.3 for Bangladesh, 0.5 for the PRC, and 1.2 for India. Compared with the small farms, the

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[3] Farm capital includes a range of assets from farm traction machinery to other farm machinery and vehicles.

larger ones were nearly twice as capital intensive in Bangladesh, marginally more so in India, but actually less capital intensive in the PRC. That is, large farms used twice as much machine traction per land area as small farms in Bangladesh, marginally more in India, and the situation was the opposite in the PRC, where large-scale farmers used less machine traction than small-scale ones. This suggests that, compared with larger farmers, the opportunity cost of labor was much lower among the marginal farmers in Bangladesh and somewhat lower among marginal/small farmers in India, implying that the small-scale farmers faced greater constraints to getting off-farm jobs than did the larger-scale farmers. These results correlate closely with the survey findings regarding the participation rates in the off-farm employment market, which were the highest in the PRC study zone, medium in India, and lowest in Bangladesh.

Third, there was not a sharp difference in the livestock/land ratio across the three zones: it was 607:1 for Bangladesh, 638:1 for the PRC, and 520:1 for India. Ownership of dairy animals was particularly important for the Bangladesh and India farmers.

Fourth, the data for the PRC indicate a stunning boom in farm capital and livestock investment in only 5 years: livestock holdings leapt by 30% and farm capital by 80%. The rice farm chapter (Chapter 3) showed a near doubling of farm capital in 5 years in the northeast PRC. The combination of nonfarm income and equipment subsidies was spurring heavy farm investments in the PRC.

## Potato Farmers and Labor Markets

Table 7.3 shows off-farm employment (in manufactures and services, wage or self-employment, and locally or in migration) and migration remittances.

Most of the PRC's potato farm households engaged in some off-farm employment, much of it locally, in the villages and towns of Gansu Province. Off-farm employment was more common among Gansu households than among those in the Bangladesh and India samples. Only 13% of the Gansu households received remittances from migration, contrary to the popular conception that rural PRC households working off their farms are mainly migrants. Moreover, the share of families doing off-farm work leapt from 55% to 76% in the 5-year recall period. This increase in turn links with the farm capital and livestock holdings investment noted above.

Table 7.3 Potato Farmers and Nonfarm Labor (%)

| Zone and Assets | Farm Size | | | |
| --- | --- | --- | --- | --- |
| | Marginal (<1 ha) | Small (≥1 ha) | | Total |
| **Bangladesh** | | | | |
| With off-farm jobs in 2009 | 15 | 25 | | 20 |
| Received remittances in 2009 | 3 | 7 | | 5 |
| **China, People's Rep. of** | | | | |
| With off-farm jobs in 2009 | 79 | 74 | | 76 |
| Received remittances in 2009 | 16 | 12 | | 13 |
| With off-farm jobs in 2005 | 57 | 53 | | 55 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **Total** |
| With off-farm jobs in 2009 | 46 | 38 | 35 | 40 |
| Received remittances in 2009 | 7 | 5 | 1 | 4 |

ha = hectare.

By contrast, the South Asian potato farmers were less engaged in off-farm employment (40% of the farm households in India and 20% in Bangladesh), and were far less engaged in migration. Yet the combination of cash cropping, government subsidies for equipment, and substantial off-farm employment had been able to fuel a major investment in farm capital. This had allowed India's commercial potato area to increase the capital intensity of its production. Government subsidies for farm mechanization were a factor in the commercialization of India's potato farms.

# Conduct of the Potato Farm Segment

## Potato Farm Technology

Table 7.4 shows potato production technologies measured as the flow of expenditures in kind and in cash on farm inputs. Several key findings emerge. First, potato farmers' costs in the Bangladesh zone were 50% higher than the costs of their counterparts in the PRC and India. That difference can be accounted for by three factors: (1) the costs were net of amortization of capital—because the PRC and India potato farms had a higher capital/land ratio than the Bangladesh farms, the amortization costs could be substantial; (2) fertilizer was highly subsidized in India; and (3) Bangladesh farms used

**Table 7.4 Composition of Potato Farmers' Production Costs**

| Input | Bangladesh | | China, People's Rep. of | | India | |
|---|---|---|---|---|---|---|
| | $/ha | % of Total Costs | $/ha | % of Total Costs | $/ha | % of Total Costs |
| Seed | | | | | | |
| Own | 398 | 19 | 196 | 13 | 48 | 4 |
| Purchased | 47 | 2 | 78 | 5 | 152 | 12 |
| Chemical fertilizer | 573 | 27 | 268 | 17 | 38 | 3 |
| kg/ha | 1,119 | | 1,206 | | 238 | |
| $/kg | 0.50 | | 0.22 | | 0.16 | |
| Crop chemicals | 176 | 8 | 7 | 1 | 170 | 13 |
| Irrigation costs | 43 | 2 | 0 | 0 | 41 | 3 |
| Manure | 67 | 3 | 134 | 9 | 35 | 3 |
| Labor, total | 623 | 30 | 764 | 50 | 403 | 31 |
| Own labor imputed at the wage labor rate | 256 | 12 | … | | 274 | 21 |
| Hired labor | 368 | 18 | … | | 129 | 10 |
| Animal traction | 0 | 0 | 14 | 1 | 0 | 0 |
| Machine traction | 52 | 3 | 79 | 5 | 85 | 7 |
| Hired tractor | 49 | 2 | 13 | 1 | 32 | 2 |
| Own tractor | 3 | 1 | 66 | 4 | 53 | 4 |
| Land rental | 122 | 6 | 0 | 0 | 320 | 25 |
| Total cost (cash outlays + imputed in-kind costs) | 2,101 | 100 | 1,540 | 100 | 1,292 | 100 |
| Total monetary cost | 1,447 | 69 | … | | 917 | 71 |
| Total imputed in-kind costs | 653 | 31 | … | | 375 | 29 |

… = no data available, ha = hectare, kg = kilogram.

more farm labor, possibly because of inadequate off-farm employment opportunities, than did the PRC and India farms.

Second, the largest single item in all three budgets was the outlay on labor, controlling for the fact that the budgets did not show capital amortization costs. Labor cost in Bangladesh and the PRC was about 50% greater than in India, which accords with the finding that potato producers in Agra used more capital (and thus less labor) than the producers in Bogra and Gansu. Moreover, the hired labor component of the Bangladesh labor outlay was three times that in India. (There was little hired labor in the PRC study area.) Farm labor markets were thus far more important in the potato areas of Bangladesh. Farm labor markets are typically the refuge of the poorest people, who have little access to nonagricultural labor markets and own farming opportunities (Haggblade, Hazell, and Reardon 2007). The relative dearth of capital, lower use of herbicides, less nonfarm employment, and very small farm size explain why the farm wage labor market was far more important in the Bogra than in the Agra potato zone.

Third, fertilizer was a very large expenditure in Bangladesh compared with India and, to a lesser extent, the PRC, for two reasons—price and quantity. The price per kilogram of fertilizer in Bangladesh was \$0.50, versus only \$0.16 in the highly subsidized Indian setting and \$0.22 in the subsidized PRC setting. The Indian farmer had to spend very little indeed on fertilizer. Also, the Bangladesh and PRC farmers were using 1,100–1,200 kilograms (kg)/ha of fertilizer, compared with the Agra use rate of 238 kg/ha, which was still high by all-India standards but close to the recommended fertilizer use rate of approximately 250–300 kg/ha on Bangladesh and Indian potato plots. This nearly fivefold difference is at first puzzling; however, the Indian households had 1.7 times more members but 4 times more land than the Bangladesh households, so the population pressure on the land in the Bangladesh study zone was well above that in the Indian study zone; thus, the Bangladesh farmers used more fertilizer to intensify their production in response to population pressure on the land.

Fourth, interestingly, farms in both South Asian countries averaged the same outlay on farm chemicals other than fertilizer, but they spent much more than the farmers in the PRC study zone. These outlays were not directly subsidized in any of the zones. The outlay may correspond to the similarity of climate and pests in the South Asian production zones, which are fairly close geographically.

Finally, the share of the farm budget for machine use measured as outlay on equipment use (own and hired) was highest in India, followed by the PRC and Bangladesh. This conforms to the above results concerning machine ownership and the presence of active machine rental markets. Effective outlays on equipment were undercounted in India because amortization was not costed.

In summary, the technology and cost picture that emerges is roughly consonant with the differences in factor endowments among the study areas. Bangladesh and PRC (Gansu) farmers conducted more labor- and fertilizer-intensive farming on very small farms, while Agra farmers used labor-saving, capital-intensive farming. Both South Asian sites used substantial farm chemicals in a setting where intensive farming and warm wet conditions are conducive to pest attacks. The Indian system delivered a hectare of potato production at substantially less private cost and substantially more social cost (through fertilizer subsidies) than the system in Bangladesh.

## Potato Farmers' Accessing Water

Table 7.5 shows potato farmers' ownership of irrigation pumps, and purchases and sales of water. There was great variation across sites in the development of water markets, but in some zones the market was substantially well developed.

**Table 7.5 Potato Farmers' Access to Irrigation Water** (% of farmers)

| Water Source | Farm Size | | | |
|---|---|---|---|---|
| | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **All** |
| **Bangladesh** | | | | |
| Own irrigation pump | 14 | 23 | | 18 |
| Bought water from other farmers | 89 | 86 | | 88 |
| Sold water to other farmers | 7 | 13 | | 10 |
| **China, People's Rep. of** | | | | |
| Own pump irrigation | 39 | 36 | | 37 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Own pump irrigation | 8 | 31 | 80 | 50 |
| Bought water from other farmers | 91 | 71 | 46 | 64 |
| Sold water to other farmers | 8 | 29 | 61 | 40 |

ha = hectare.

In India, potato farmers engaged in a very active private irrigation water market, as in the rice zone. Half of the farmers owned the main irrigation mechanism—tube well pump irrigation—but the distribution of the pumps was extremely skewed, as only 8% of small–marginal farmers owned them compared with 31% of semi-medium and 80% of medium–large farmers. In addition, 40% of potato farmers sold water. Nearly all the farmers who owned irrigation pumps sold water to other farmers. Nearly two-thirds of farmers bought water from others. This was skewed in the opposite direction to ownership of pumps and sales of water. The smaller farmers had a much greater probability of buying water from the larger farmers; 91% of marginal–small and 71% of semi-medium farmers bought water from other farmers, versus 46% of the medium–large. In short, large potato farmers accessed the government-subsidized water pumps, and sold water to the small farmers who did not own pumps.

The Bangladesh water market was similar in function to the Indian one: 88% of farmers reported buying irrigation water from other farmers, 10% reported selling it, and 18% owned irrigation pumps. However, in the Bangladesh case, as land ownership in the potato zone was not so concentrated, ownership of irrigation pumps and selling of water were less correlated with farm size than in India.

By contrast, the private water market was not developed in the Gansu case. Only 33% of farms had a water well in 2009 and none had water towers; only 18% had a water pump in 2009, up from 11% in 2005; the incidence was slightly higher for the medium farmers (from 12% in 2005 to 21% in 2009). But only 1% of the farmers bought irrigation water; 37% of the farmers reported using some irrigation, nearly all from on-farm sources.

## Potato Farmers' Accessing Seeds

Table 7.6 shows how farmers acquired seed potato. Overall, potato farmers relied less on seed markets than did rice farmers. In Bangladesh, 89% of potato farmers used their own stored seed potato, and in the PRC, 72% of farmers did so; however, in Agra, only 24% of farmers used their own. The India case appears to be linked to the rise of cold storage facilities (CSFs), which also provided access to seed potato.

In Bangladesh, 18% of the seed bought was acquired at the CSFs, versus 64% in Agra. Moreover, in India, the share of farmers reporting CSFs as their main potato seed supplier had been rising greatly—from 22% in 1999 to 64% in 2009. The jump was fastest and the current reliance on CSFs for seed highest among medium–large farmers. Only in Bangladesh did the wholesale market play a potato seed supply role, at 64% of seed purchases by the sample farmers.

The more traditional source of seeds—buying from other farmers—was minor in both South Asian study zones, at about 20% of seed bought. However, in the South Asian cases there was a strong negative correlation with farm size in buying seed from other farmers. In the PRC, farmers bought very little from other farmers, and they noted in the survey that they felt this was a poor quality source.

**Table 7.6 Seed Potato Acquisition: Shares of Households Declaring their Main Sources (%)**

| Seed Source | Farm Size | | | |
|---|---|---|---|---|
| | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **All** |
| **Bangladesh** | | | | |
| Average share of own seed in total seed use | 82 | 96 | | 89 |
| Other seed source | | | | |
| Wholesale market trader | 65 | 64 | | 64 |
| Cold storage | 15 | 27 | | 18 |
| Other farm | 21 | 9 | | 18 |
| Total (with rounding error) | 100 | 100 | | 100 |
| **China, People's Rep. of** | | | | |
| Average share of own seed in total seed use | 71 | 72 | | 72 |
| Share of purchased seed on any potato plots | 39 | 41 | | 40 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Average share of own seed in total seed use | 23 | 21 | 26 | 24 |
| Cold storage facilities as main seed supplier | 49 | 73 | 69 | 64 |
| Other farms as main seed supplier | 37 | 20 | 15 | 22 |

ha = hectare.

The governments had only a small or no role in the sale of seed potato. Of the little seed that was purchased in Gansu, some came from the state-owned seed stores and some from the Gansu Potato Research Institute, but most was bought from private retailers. None of the Bangladesh farmers reported buying seed from the Bangladesh Agricultural Development Corporation in 2009. This seems in strong contrast with the reported situation in the 1990s (Ilangantileke et al. 2000). In India, the state did not sell potato seed in the study zone.

## Potato Farmers' Accessing Fertilizer and Crop Chemicals

Table 7.7 shows widespread and substantial development of the fertilizer and pesticide markets; even very small-scale farmers participated in them very actively. All three zones presented a picture of intensive use of fertilizers and crop chemicals (pesticides, herbicides, and fungicides).

In Bangladesh in 2009, 98% of the potato farmers bought chemical fertilizer and 99% bought crop chemicals. They obtained most of their inputs from wholesale market traders, specific dealers, or private shops. Farmers very seldom bought inputs on credit from suppliers.

**Table 7.7 Shares of Potato Farmers Buying Chemical Fertilizers and Crop Chemicals** (insecticides, fungicides, and herbicides; % of farmers)

| Chemical Type | Farm Size | | | |
|---|---|---|---|---|
| | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **All** |
| **Bangladesh** | | | | |
| Chemical fertilizer | 98 | 97 | | 98 |
| Crop chemicals | 99 | 98 | | 99 |
| **China, People's Rep. of** | | | | |
| Chemical fertilizer | 99 | 98 | | 99 |
| Crop chemicals | 100 | 100 | | 100 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Chemical fertilizer | 100 | 98 | 100 | 100 |
| Crop chemicals | 99 | 94 | 99 | 98 |

ha = hectare.

In the PRC study zone, fully 99% of the farmers bought chemical fertilizers. Of the fertilizer purchases, 81% were from private shops; the balance was bought from marketing cooperatives, wholesale markets, state-owned seed stores, and other farmers. Only 5% of the transactions were on credit. Nearly all the potato farmers bought crop chemicals. Their foremost source was the private retailers; a distant second was the supply and marketing cooperatives; and only a small amount was from the state-owned seed stores, the wholesale markets, and the Gansu Potato Research Institute. Fully 99% of the purchases were made without credit from suppliers.

In the India study zone, nearly all of the potato farmers used both chemical fertilizers and crop chemicals. By far the main source was small private shops, from which 59% of the farmers bought their fertilizer and 90% bought their farm chemicals.

In Agra, only 37% of the farmers bought subsidized fertilizers from the primary agricultural cooperative societies (PACS, state-sponsored cooperatives). Interestingly, there was a strong correlation between farm size and buying fertilizer from the PACS: The great bulk of the PACS' sales were in fact to the medium–large farmers; thus the subsidies were regressively distributed.

About 12% of the farmers bought chemicals from the modern input retailers (the rural business hubs that had emerged in the last decade). Their customers were mainly the semi-medium and medium–large farmers.

Of particular note regarding farm chemicals is the strikingly high rate of herbicide use among potato farmers: 65% of the farmers used herbicides, with a steep bias toward medium–larger farmers, as only 40% of the marginal–small farmers used herbicides but 81% of the medium–large farmers used them. Herbicides are substitutes for mechanical and hand weeding. Herbicide use tends to increase with the opportunity cost of time, which is influenced by the growth of the off-farm labor market. Herbicide use was also spurred by being widely available in the study areas through distribution campaigns and networks by multinational and domestic companies.

## Potato Farmers' Marketing

Table 7.8 shows that the small potato farms studied were small businesses—small commercial farms that were highly engaged in food markets, supplying vast cities. Potato is farmed as a cash crop: the marketed surplus rates (sales divided by output) were 79% for the Bangladesh study zone and 89% for the India study zone. The rest was used for seed and home consumption. Even in the more hinterland Gansu, almost 70% of the crop was sold. Moreover, in both the PRC and India, the marketed surplus rates were similar across farm size strata; only in Bangladesh did marginal farms sell a bit less of their output than did small farms. In short, as farmers in the study zones adopted and planted potatoes in the study zones during the last 2 decades, displacing grains, they oriented their production overwhelmingly to the market, and mainly to supply the great cities.

In terms of output across zones and strata, the average Indian (Agra) farm grew about 10 times more potatoes than the farms in the other zones. Output was heterogeneous across farms: a large farm in Agra produced 5 times more potatoes than a small Agra farm, and a small Bangladesh (Bogra) farm grew 3 times more than a marginal farm.

Table 7.9 shows farmers' use of cold storage. Potato production is a seasonal activity, with only one crop per year in all three study zones. To spread out sales and to store seed potatoes, CSFs had arisen. The alternative storage is on the farm in cellars. Major differences in farmers' use of cold storage were apparent between the zones, with Agra having the most advanced diffusion of CSFs, Bogra being intermediate, and Gansu being the least developed.

Nearly all the Indian farmers stored potatoes; this is useful, given that potatoes are produced in one season a year.[4] There had been rapid and widespread

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[4] Potatoes are *rabi* crops, which are sown in winter and harvested in summer.

**Table 7.8 Potato Farmers' Marketed Surplus Rates, 2009**

| Potato Production and Use | Farm Size | | | |
|---|---|---|---|---|
| | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **All** |
| **Bangladesh** | | | | |
| Production (tons/farm) | 7 | 23 | | 14 |
| Marketed surplus rate (sales/output) | 71% | 83% | | 79% |
| Retention from output of seed | 8% | 8% | | 8% |
| **China, People's Rep. of** | | | | |
| Total (in tons) of potato per farm | 5 | 7 | | 6 |
| Market surplus rate | 69% | 70% | | 69% |
| Home consumption rate | 15% | 15% | | 15% |
| Retention from output of seed | 8% | 11% | | 10% |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Production (tons/farm) | 31.3 | 67.8 | 167.8 | 109.5 |
| Marketed surplus rate | 89% | 85% | 89% | 89% |
| Retention from output of seed | 13% | 13% | 16% | 14% |

ha = hectare.

change in the technology of storage in Agra, and traditional methods of on- farm storage had mostly been abandoned, from being nearly ubiquitous in the late 1980s and early 1990s (Fuglie et al. 1997). The share of farmers using traditional storage for at least part of their potato storage had dropped from 23% in 1999 to 18% in 2009, and the drop had been most rapid among larger farmers. In 2009, only 1% of farmers stored potato in the traditional way.

Modernization of potato storage had gone far in the India study zone. This trend arose from the massive investment in CSFs in the 1990s and 2000s (see Chapter 8). By 2009, the survey shows that two-thirds to three-quarters of potatoes were cold stored in Agra, and 78% of the Agra farmers used only CSFs—surprisingly, with little difference across farm size strata. Most farmers (62%) had used CSFs for some part of the last 10 years; only 38%had used them for longer than 10 years, and that tended to be correlated with current farm size. Most farmers used just one CSF, generally starting to store their potatoes in March (right after harvest) and taking them out in October, compared with traditional storage methods, which kept potatoes for only 2–3 months. Most farmers reported using CSFs for a combination of potatoes for seed, sale, and home consumption.

**Table 7.9 Potato Farmers and Cold Storage (%)**

| Potato Storage and Sales | Farm Size | | | |
|---|---|---|---|---|
| | Marginal (<1 ha) | Small (≥1 ha) | | All |
| **Bangladesh** | | | | |
| Share of production stored | 36 | 42 | | 41 |
| Sales composition share | | | | |
| Fresh | 52 | 58 | | 55 |
| Without cold storage, after drying | 21 | 21 | | 21 |
| After traditional storage | 2 | 2 | | 2 |
| In or after cold storage | 25 | 19 | | 22 |
| Total | 100 | 100 | | 100 |
| **China, People's Rep. of** | | | | |
| Sales composition share | | | | |
| Without storage | 95 | 95 | | 95 |
| After traditional storage at home | 5 | 5 | | 5 |
| In or after storage in cellar (cold store) | 0 | 0 | | 0 |
| Total | 100 | 100 | | 100 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Share of production cold stored | 67 | 76 | 64 | 65 |
| Sales composition share | | | | |
| Fresh from field without drying | 16 | 13 | 17 | 15 |
| Without storage but after drying for couple of weeks | 8 | 6 | 8 | 8 |
| After traditional storage | 7 | 6 | 0.25 | 4 |
| In or after cold storage | 70 | 75 | 75 | 73 |
| Total | 100 | 100 | 100 | 100 |

ha = hectare.

All respondents felt that cold storage was highly accessible in Agra, implying that barriers to adoption were low. Much of the adoption was in the 1990s. By 2009, 98% of farmers used CSFs for some portion of their crop, up from an already high 95% 10 years earlier. Even though most farmers used some cold storage, the share of potatoes they put in CSFs had risen quickly in the 5 years before the survey. Confirming the importance of cold storage, 65% of potatoes were put into CSFs in 2009, compared with a finding of 40% in western Uttar Pradesh in 2004 (Singh 2008b) and 1996 (Fuglie et al. 1997). In Agra, for marginal–small farms, the share was 67%, similar to the 64% for medium–large farms. The finding runs counter to the conventional image that small farmers stick to traditional on-farm storage and eschew modern cold storage.

The potato survey data showed that larger farmers typically sold quite late, when prices were best, in the quarters starting in July and October; smaller farmers sold a third of their potatoes at harvest when the prices were lowest, and the rest throughout the year. The data for the whole sample show that only 20% of Agra's marketed potato harvest was sold in the first 2 quarters (the harvest is in the first quarter), and 80% was marketed in the second 2 quarters.

By using cold storage and selling later, Agra farmers received higher prices, avoiding the big rush of potatoes coming in from Punjab early in the year. A positive externality is that this helps to smooth across seasons the availability of potatoes to consumers in Delhi. The many Agra farmers who used CSFs cited as their main reason that they expected prices to rise later in the year, and their secondary reason (mainly cited by the small-scale farmers) was for storing seed potatoes. The few farmers who did not store reported their main reason as needing money urgently after harvest (also mainly cited by the smaller farmers).

Farmers in Agra reported that they used a particular CSF for a range of reasons. All cited quality of storage. Interestingly, 80% (rising slightly with farm size) used a CSF that had contacts with "buyers who offer good prices." The third-ranked reason (cited by nearly 50% of respondents) was access to advances/credit—contrary to expectations, the share of respondents citing credit as the motivation rose with farm size. The fourth-ranked (by nearly 40%) reason cited was low cost and proximity. Farmers noted unanimously that if the potatoes were damaged during storage, they alone would bear the cost; but that did not dissuade them from using the storage.

By constrast, the CSF use rate was somewhat lower in the Bangladesh study zone: 41% of potato output was stored (with marginal farms storing 36% of the crop and small farms storing 42%). Of the 84% of Bogra farmers who stored some potatoes in 2009 (79% of marginal farmers and 91% of small farmers), 95% used CSFs. It is surprising that small farmers used CSFs so much, and were willing to forego cash at harvest. Part of the reason was that small farmers relied more on the cold storage for seed than did the large farmers, who used the storage more for output market sales. That explains why marginal farmers stored 36% of their potatoes but sold only 19% after cold storage; the other 17% was stored for seed. For small farms, of the 42% of their potatoes that were stored: 21% was for seed and 21% for sale.

The above is corroborated with Bogra farmers' declarations of their reasons for storage. Only 16% of the Bangladesh farmers did not store potatoes, and 80% of them said the reason was that they needed cash right after harvest. Of the farmers who stored potatoes, 50% reported they did so mainly for seed potatoes. Significantly more marginal farmers (64%) than small farmers (33%) stored potatoes for seed purposes. The two other reasons given for storage—expectation of a rise in prices and a need for money later in the year—were both mentioned to the same extent.

Most of the Bogra farmers had used CSFs for more than a decade. Their major reasons for choosing a particular CSF were related to quality of the storage (60% of the answers) and the distance to it (33% of the answers). Unlike in Agra, few Bogra farmers mentioned access to input advances/credit from CSFs as a reason to store there. The storage period was also somewhat shorter than in the Agra case: in Bogra, farmers cold-stored potatoes for about 4 months, from March to July.

In Gansu, very little of the potato crop was stored: 85% of the harvest was sold during September–November—at harvest. Only about 3% was sold in the following quarter, 1.6% in the next, and 0.5% in the last quarter before the following harvest. Hence, Gansu farmers did not store and then "play the market" later. The 15% not sold at harvest was stored and sold or home-consumed gradually over the seasons. However, 95% of the farms stored some potatoes after the harvest, for one or more reasons: 80% said they did so for their own consumption, 59% for seed potato, only 6% to sell later when prices were higher, and just 2% to supply cash later in the year.

Almost all of the Gansu farms (97%) had some potato storage facility, averaging 1.7 storages per farm. The storage on average held 8.6 tons, and was thus a relatively small on-farm storage. Of the farm storage facilities, 80% were cellars without air circulation, the most traditional type in the hillside or ground; 17% were cellars with air circulation; a small group—2.5% overall (3% of medium farms and 1.5% of small farms) had above-ground storage; and only 2% had refrigeration-controlled (constant temperature) storage facilities.

While the PRC government had a program to finance and encourage building of storage, the program had very little impact, given that most of the farmers who built storage did so without subsidy. The mainly on-farm or near-farm Gansu storages were built in the early 1990s. Only 5% of the farmers reported getting subsidies to build storage facilities (at a potential subsidy rate of 20%). Only 2.8% of the farmers got a loan and extension advice on storage from the government to build their storage unit. One may well ask why the Gansu farmers did not build many modern storage facilities, given the government subsidy and the sharp seasonality of their production. Hypotheses include that (1) because few farmers reported getting the subsidies, this may indicate limited implementation of the program and farmer access to it; (2) Beijing potato traders sourced from a number of provinces and thereby reduced the seasonality of their supplies, thus reducing price seasonality and the potential gain from storage; and (3) whereas the Bangladesh and Indian potato production zones specialized mainly in potato, potatoes were only one of several cash crops for the Gansu area farmers, and this may reduce the incentive to store. Finally, the current study did not ascertain if there was substantial cold storage of potatoes in other provinces, so the Gansu cold storage findings cannot be extrapolated to all of the PRC.

Tables 7.10 and 7.11 show to whom and where farmers sold potatoes in 2009 in shares of farmers and of sales. Several points stand out.

First, there was a stark contrast in the importance of the rural wholesale market for farmers' sales of potatoes between Bangladesh and the PRC on the one hand and India on the other. In Bangladesh and the PRC, wholesalers accounted for 85% of sales volume. By contrast, in Agra, the wholesale market had only 7% of potato farm sales.

Second, the inverse was seen for sales to traders at the CSFs (as the intermediation venue). Sales to traders at the CSFs were 8% of sales in Bangladesh, none in the PRC, and a stunning 80% in India. The India totals varied from 64% for marginal–small farmers to 93% for semi-medium farmers to 83% for medium–large farmers. Thus, the marginal–small farmers were somewhat less apt to sell at the CSFs, but not by much. The sales volumes were larger at the CSFs than at the rural wholesale market. This important result indicates that farmers had sidestepped the rural wholesale market to sell directly to traders at the place chosen by the farmers and traders. Thus, although the Agricultural Produce Marketing Committee Act (known as the APMC Act) mandated that farmers must sell at the wholesale market in Agra, farmers and traders had chosen to ignore the APMC Act, because it was, as farmers and traders explained to the authors in supplementary interviews, more convenient in terms of transaction costs and intermediation information services for farmers to sell at the CSFs. The cold storage was displacing the wholesale market. CSFs in Agra had taken on a major role of facilitating trade, and thus they brought rural traders, Agra-based wholesalers, Delhi wholesalers, and traders from other states to compete at the CSFs as the venue for most trade.

**Table 7.10 Composition of Potato Farmers' Clients**
(% of farmers selling to buyer types: totals do not have to equal 100%)

| Buyer | Farm Size | | | |
|---|---|---|---|---|
| | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **All** |
| **Bangladesh** | | | | |
| Village trader | 4 | 8 | | 6 |
| Wholesaler in wholesale market | 79 | 83 | | 81 |
| Trader at cold storage | 17 | 9 | | 13 |
| Total | 100 | 100 | | 100 |
| **China, People's Rep. of** | | | | |
| Did not sell | 8 | 9 | | 8 |
| Broker | 2 | 2 | | 2 |
| Wholesaler | 62 | 64 | | 63 |
| Collection center belonging to company | 0.77 | 0.53 | | 0.63 |
| Processing company | 7 | 6 | | 6 |
| Government | 0.77 | 0 | | 0.31 |
| Wholesaler of potato association | 11 | 16 | | 14 |
| Farmer cooperative | 8 | 2 | | 4 |
| Consumer | 0.77 | 0.53 | | 0.63 |
| Total | 100 | 100 | | 100 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Village trader | 23 | 25 | 25 | 23 |
| Wholesaler on wholesale market | 2 | 3 | 3 | 3 |
| Cold storage owner | 6 | 5 | 6 | 6 |
| Trader at cold store | 59 | 72 | 63 | 64 |
| Supermarket | 0 | 0 | 0.3 | 0.1 |
| Others | 8 | 4 | 4 | 5 |
| Total | 97 | 109 | 101 | 101 |

ha = hectare.

Third, by contrast, the share of the village trader intermediating at the farm or in the village was minor everywhere. The village traders had been cut out of intermediation at the farms and in the villages to a great extent in Bangladesh (where they had only 7% of farmers' sales), the PRC (2%), and India (10%, although this involved 23% of the Indian farmers, showing that small volumes per farm were still sold to the local traders).

The results show that intermediationally shorter value chains were emerging and CSFs were proliferating in rural areas, providing a convenient local venue

**Table 7.11 Composition of Potato Farmers' Sales to their Clients**
(% of farmers' total sales by type of buyer)

| Buyer | Farm Size | | | |
|---|---|---|---|---|
| | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **All** |
| **Bangladesh** | | | | |
| Village trader | 4 | 11 | | 7 |
| Wholesaler in wholesale market | 87 | 82 | | 85 |
| Trader at cold storage | 9 | 7 | | 8 |
| Total | 100 | 100 | | 100 |
| **China, People's Rep. of** | | | | |
| Share of farmers not selling | 8 | 11 | | 10 |
| Broker (for commission) | 2 | 1 | | 2 |
| Wholesaler | 61 | 68 | | 65 |
| Company collection center | 0 | 0.52 | | 0.31 |
| Processing company | 2 | 3 | | 3 |
| Government sector | 0.12 | 0 | | 0.05 |
| Wholesale arm of potato association | 19 | 20 | | 20 |
| Farmer cooperative | 16 | 6 | | 10 |
| Consumer | 0.12 | 0.23 | | 0.18 |
| Total (with rounding error) | 100 | 100 | | 100 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **All** |
| Village trader | 19 | 3 | 6 | 10 |
| Wholesaler on wholesale market | 11 | 1 | 8 | 7 |
| Cold storage owner | 1.0 | 0 | 0.2 | 0.4 |
| Trader at cold storage | 64 | 93 | 83 | 80 |
| Supermarket | 0 | 0 | 0.3 | 0.2 |
| Other | 5 | 3 | 3 | 3 |
| Total (with rounding error) | 100 | 100 | 100 | 100 |

ha = hectare.

where farmers could find a plethora of traders and could take their potatoes directly from cold storage to traders' or transporters' trucks. In Bangladesh, the cold storage had not yet taken on this role, but the wholesale market traders had sidelined the traditional village traders by directly purchasing from farmers.

Fourth, only in the PRC did potato cooperatives have a role, especially for the smaller farmers, who sold 16% of their volumes to cooperatives. The cooperatives' market share was 10% overall.

Fifth, in Gansu, despite the relatively high share of processing potato varieties in total production, farmers sold very little directly to processors: only 2.6%. However, wholesalers who bought from the farmers then sold part to processors (see Chapter 8).

Sixth, conforming to a general finding of the whole study, few contracts were part of the potato value chains: Only 2.5% of Gansu potato farmers said they had contracts with a buyer, and the contracts were with processing or seed companies. None of the Indian or Bangladesh sample farmers had a contract with a buyer.

Finally, but not shown in the table, the use of mobile phones was an important part of farmers' marketing behavior. Mobiles were widely available in the study's rural areas. A large share (73%–97%) of the potato farmers in the supply areas owned mobile phones at the time of the survey. Except in Gansu, the farmers used the mobile phones extensively to set up deals with traders or receive information from CSFs (especially in India, where most of the trade took place "off-market"). This was a recent phenomenon, as a majority of the farmers had acquired their phones in the 4 years prior to the survey; less than a quarter of the farmers had a mobile phone before 2004.

## Potato Farmers' Accessing or Providing Value-Chain Finance

Table 7.12 shows transactions involving credit in terms of shares of potato farmers getting advances from buyers or credit from CSFs, or de facto giving credit to buyers (by the buyers' paying with a delay after receiving the potatoes). Three conclusions emerge from the data.

First, the traditional image is of farmers having relationships with traders wherein their receiving advances from the traders is "tied" to their committing to sell their harvests to those traders; this constitutes interlinkages between output and credit markets. During preparation for the survey, key informants said that they believed that these relationships were nearly universal, and represented an exploitation of the potato farmer by the trader; the extant literature gave the same information. In sharp contrast, the survey data showed that traders provided very little credit to potato farmers—the share of potato farmers getting advances was 1% in Bangladesh, 3% in the PRC, and 11% in India.

Second, by contrast, potato farmers de facto provided credit to traders, as farmers were in many cases paid by the traders only after a delay; this was the case for 24% of potato farmers in the Bangladesh study zone (with a

**Table 7.12 Potato Farmers and Credit** (% of farms)

| Credit | Farm Size | | | |
|---|---|---|---|---|
| | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **Total** |
| **Bangladesh** | | | | |
| Farmers getting advance | 1 | 0 | | 1 |
| Farmers paid with delay | 34 | 17 | | 24 |
| **China, People's Rep. of** | | | | |
| Farmers getting advance | 4 | 2 | | 3 |
| Farmers paid with delay | 14 | 11 | | 12 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **Total** |
| Farmers receiving advances from buyer | 12 | 8 | 13 | 11 |
| Farmers paid with delay | 45 | 46 | 47 | 46 |
| Farmers using cold storage because it gives credit (against stored potatoes) | 38 | 42 | 53 | 47 |
| Share of farmers receiving (non-down-payment) loans from cold storages | 4 | 3 | 2 | 3 |

ha = hectare.

higher share among the smallest farms, at 34%); 12% in the PRC; and fully 46% in India. These delays were much more common than in the case of rice, where nearly all the farmers were paid on the spot. The delay was usually a week to a few weeks while the trader sold the crop and then was able to pay the farmer.

Third, in India, 47% of the farmers received advances (which thus constitute value-chain finance) from the CSFs; this was biased toward the larger farmers, as only 38% of the smallest stratum versus 53% of the largest stratum got credit. By contrast, in Bangladesh, few farmers reported receiving credit from CSFs, or extension advice, potato seeds, or bags.

The share of Agra farmers getting credit from the CSFs rose by 50% during the decade. The farmers and the CSF respondents noted that this practice had spread as CSFs competed for farmers and traders as clients, and to induce farmers to forego immediate cash from selling at harvest and instead to store their crop and await higher prices. This is the first time the credit-providing role of CSFs has been brought out in the potato supply chain literature in general, or in the agricultural economics literature in India.

# Performance of the Potato Farm Segment

## Farm Yields

Table 7.13 shows yields of the main potato types in the study zones. The Agra zone had by far the highest yields of white potato of all the study zones—averaging 25 tons/hectare (t/ha); this was 56% above the 16 t/ha yield in the study zones in Bangladesh and the PRC. Agra's yields were also above the all-India average of 18 t/ha in 2004/05 (CPRI online n.d.), which would be expected, given that Agra is a commercialized and technologically intensive zone. Agra's 25 t/ha yield is similar to that in other Indian commercial potato zones, such as Gujarat and Punjab.

Interestingly, in Agra, the medium–small farmers' yields were a third higher than those of the larger farmers. This is a common finding in the international literature, as the small-scale farmers apply labor more intensively, and all the farmers in the zone intensively used external inputs such as fertilizers and chemicals. Smaller farmers also had higher yields in Gansu. By contrast, in Bangladesh, small farms' yields were 20% higher on average than marginal farms' yields. This could be because the two farm strata were close in size but the small-scale farmers used more inputs than did the marginal farmers.

**Table 7.13 Potato Farm Yields** (tons/hectare)

| Type of Potato, Year | Farm Size | | | |
|---|---|---|---|---|
| | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **Total** |
| **Bangladesh** | | | | |
| White potato, 2009 | 15 | 18 | | 16 |
| White potato, 1999 | 14 | 13 | | 14 |
| Red potato, 2009 | 13 | 13 | | 13 |
| Red potato, 1999 | 12 | 13 | | 12 |
| **China, People's Rep. of** | | | | |
| White potato, 2009 | 17 | 15 | | 16 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **Total** |
| White potato, 2009 | 29 | 27 | 20 | 25 |

ha = hectare, t = ton.

## Quality and Varietal Differentiation and Evolution among Potato Farmers

Table 7.14 shows the evolution of varietal change in the study zones. The most striking changes occurred in Bangladesh and the PRC. Much less change occurred in India, mainly because, as key informants noted, most of the big shift in varieties had occurred in the 1990s when the Indian government's potato research system introduced new varieties at the same time as potato production spread across Agra's farms.

The table shows a rapid shift from red to white potatoes in the 2000s in the Bangladesh study zone. Beginning in the 1970s, several high-yielding varieties had been introduced in Bangladesh by the national agricultural research system (NARS) (CIP 2009). Most of them were white varieties, while traditional varieties were mostly red. Thus, the new white varieties appear to have been heavily adopted in the district studied in the last decade. A major advantage of the new white potato is its much higher yield: farmers reported the average yield of white potato was nearly 40% higher than that of the red potato (Table 7.13). Ilangantileke et al. (2000) reported that the lower yields of the traditional, mostly red, varieties were primarily due to degeneration of the seed stock and suboptimal production practices.

Moreover, Bogra potato farm yields were increasing over the years. Key informants noted that the white potato stored better than traditional varieties, better varieties of white potatoes were available, and the seed stock of the traditional red potatoes had degenerated.

In Gansu, during the 5 years before the survey, production of processing varieties of potato dropped slightly (measured as share of farms or of output), with a marked shift especially by the smaller farmers from processing to table potato varieties (explained mainly by the latter commanding a better price).

Table 7.14 shows that, within the table and processing potato categories, there was a major "churning" of variety change, with experimentation by the farmers, extension agents, and the NARSs.

**Table 7.14 Potato Farmers and Varietal Change (%)**

| Variety | Farm Size Strata, Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Smaller | | Middle | | Upper | | Total | |
| **Bangladesh** | **1999** | **2009** | **1999** | **2009** | | | **1999** | **2009** |
| Share of white potato in output | 33 | 84 | 23 | 86 | | | 29 | 85 |
| **China, People's Rep. of** | **2004** | **2009** | **2004** | **2009** | **2004** | **2009** | **2004** | **2009** |
| Share of farms growing processing variety | 46 | 37 | 0 | 0 | 41 | 44 | 43 | 41 |
| Share of potato production in processing variety | 18 | 13 | 0 | 0 | 15 | 16 | 16 | 15 |
| Share of farms growing table varieties | 62 | 78 | … | … | 66 | 73 | 64 | 75 |
| Share of potato production in table variety | 89 | 85 | … | … | 88 | 81 | 89 | 83 |
| **India** (average shares of farms' potato land) | **1999** | **2009** | **1999** | **2009** | **1999** | **2009** | **1999** | **2009** |
| Share of seed potato | … | 6 | … | 13 | … | 18 | … | 12 |
| Share of nonseed potato | … | 94 | … | 87 | … | 82 | … | 88 |
| White 3797 (kufri bahar) variety | 89 | 82 | 96 | 96 | 94 | 89 | 93 | 88 |
| White hybrids (satlej and pukhraj ) | 12 | 18 | 4 | 4 | 6 | 11 | 7 | 12 |

… = no data available.

In India, of the nearly 100 tons of potato the average farmer in the study zone sold, about 13% was seed potato, and the rest was table potato. No processing potatoes were sold. The varietal change story in the last decade in Agra was not dramatic; the share of the variety 3797 (kufri bahar) dropped slightly, from 93% to 88%, in favor of its rivals, 5857 (kufri satlej) and C-166 (kufri pukhraj). While larger farms relied a little more on 3797, the difference was not striking—again contradicting expected large differences in behavior between small and large farmers. Key informants noted that the main varietal change had already occurred in the 1990s, when there was a big shift toward 3797, which had been developed by the NARS (the government's Central Potato Research Institute). Characteristics informants attributed to the new white varieties include white flesh, good taste, strong skin (for long distance transport), and good yields (see also Pal, Singh, and Mathur 2006). The increased use of 3797 coincided with west Uttar Pradesh rising to become a main potato area in India (in 2009, it supplied 25% of India's potatoes), and thus characteristics such as resilience to storage and shipping became important.

## Potato Farmers' Wastage in Transactions

Table 7.15 shows farmers' reports of physical wastage from harvest to sale of the potato, and during storage, based on data on the last transaction (from sale at harvest or from storage). The concept of wastage as used here is from the perspective of the value-chain actors who, because they aim to maximize returns, will minimize wastage as much as possible.

The survey data show that wastage rates in potato farm production, handling, and storage are much lower than conventionally asserted: only 0.13%–0.51% in Agra and Bogra and 2.23% in Gansu.

However, value-chain analysis also discusses (1) wastage as the difference between optimal and actual performance, e.g., optimal versus actual yields achieved; and (2) wastage due to spoilage because of lack of CSFs, proper warehousing, and roads and trucking. To fully assess changes in wastage over time because of investments in the value chain such as the advent of cold storage and improved roads would require time series data that this study does not have. However, given the widespread adoption of cold storage in South Asia and investment in improved storage in the PRC, as well as major improvements in roads during the decade in all study zones, technological and infrastructural change are likely to have reduced the wastage over time.

**Table 7.15 Potato Farmers and Wastage** (potatoes discarded, %)

| Wastage | Farm Size | | | |
|---|---|---|---|---|
| | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **Total** |
| **Bangladesh** | | | | |
| Percent wasted | 0.62 | 0.47 | | 0.51 |
| **China, People's Rep. of** | | | | |
| Percent wasted, of which: | 2.20 | 2.25 | | 2.23 |
| Harvesting to storage/market | 0.16 | 0.21 | | 0.19 |
| In storage | 2.00 | 2.00 | | 2.00 |
| After storage | 0.04 | 0.04 | | 0.04 |
| **India** | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | **Total** |
| Percent wasted | 0.00 | 0.15 | 0.19 | 0.13 |

ha = hectare.

**Table 7.16 Potato Price at the Farm Gate** ($ per ton)

| Study Zone | Farm Size | | | |
|---|---|---|---|---|
| | **Marginal** (<1 ha) | **Small** (≥1 ha) | | **Total** |
| **Bangladesh** | 179 | 214 | | 202 |
| **China, People's Rep. of** | 125 | 123 | | 124 |
| | **Marginal–Small** (<2 ha) | **Semi-Medium** (≥2 ha <4) | **Medium–Large** (≥4 ha) | |
| **India** | 143 | 167 | 165 | 159 |

ha = hectare.

## Prices Received by Potato Farmers

Table 7.16 shows that producer prices tended to diverge markedly between smaller and larger farmers in Bangladesh and India. But if sales timing (whether at harvest or from cold storage) is controlled for, the interstrata differences become insignificant. Prices were similar between the PRC and India, but Bangladesh's farm price was much higher than the others. This difference roughly tracks the different costs of production.

# Conclusions

Most of the chapter's key messages punch significant holes in the general views of Asia's potato farmers as traditional, and of input and output markets as underdeveloped and static, and instead paint a picture of a ferment of change and development in this segment and the input and output markets that serve it.

Two messages about farm assets are as follows:

- Contrary to the "default" image of Asian farmers as operating millions of tiny farms, there was substantial heterogeneity in farm sizes, and some evidence of land concentration at least in the India study zone. The upshot of this is what the authors call in India the "30/70 rule"—that 30% of the farms, especially the medium farms, occupied 70% of the area under potatoes, and thus in a sense dominated 70% of the food supply chains to the major cities—even though the small and marginal farms predominated numerically. Moreover, land rental markets were developing rapidly, especially in the India study zone and to a certain extent in Bangladesh.

- There was substantial heterogeneity among potato farmers within and across zones in nonland assets—livestock, farm equipment, and irrigation. This variation often tracked, rather than compensated for, farm size variation. Thus, the capital/land ratio was similar across farm strata, implying that labor scarcity may be increasing even for smaller farms.

There were vibrant land, labor, capital, and inputs markets. Four messages about the rapid development of input markets serving farmers are as follows:

- In Bangladesh and India, tube well owners (larger potato farmers) were selling a lot of water to smaller farms bereft of tube wells. Moreover, private water markets in Bangladesh and India were a major development, spurred by the fact that larger farmers captured the great majority of the subsidies for tube wells for irrigation in India and then sold water to the small farmers without wells.

- Farmers were substantially engaged in rural nonfarm employment, especially in the PRC and India. This was by far dominated by local—not migratory—employment in the South Asian study zones. Local nonfarm employment was a major source of cash, which may help to explain why credit and output markets were no longer "tied" in these areas.

- Farmers in all the study zones participated extremely broadly in seed, fertilizer, pesticide, and herbicide markets; and in nearly all cases the smallest farmers were as fully engaged as, sometimes more than, the larger farmers. The state played a minor role in these markets in terms of direct sale of inputs.

- While the foregoing input market stories point to substantial "capital-led intensification" (in the words of Lele and Stone [1989]), the study found evidence of modest yield growth, especially from variety change.

Finally, a set of messages, some surprising, about the rapidly transforming output market, follow.

- Small- and medium-scale potato farms were commercial businesses, selling to those who offered the best price, focused on supplying the cities, and responsive to technology and the market.

- In most of the study zones, potato value chains were apparently shifting from traditional to an intermediate stage of transformation. The traditional rural middleman or village trader role was in decline, and farmers were increasingly selling directly to wholesale markets, with CSFs as new intermediation venues.

- The rapid rise of modern CSFs, particularly in the South Asia sites, is an extremely important phenomenon. Storage resulted in higher prices for farmers, lower wastage in the system, new venues of facilitated intermediation as an option to the old wholesale market system, and access to new sources of extension and seed. The rise of cold storage technology had changed the market behavior of key actors in the chain—all of whom were responding to increasing incomes while providing stable prices for potatoes, year-round supply of the highly seasonal crop, and change in the type of potatoes (abetted by the NARS introducing new varieties). Farmers' access to CSFs had few barriers, so their use was very widespread.

- The specter of massive wastage in food supply chains in Asia is often evoked but seldom empirically tested with detailed data from sample surveys. This study found the wastage to be very modest. Investments in CSFs and roads appear to have helped keep the wastage low in the system.

- Whereas the traditional literature on food markets in Asia emphasizes (rightly, in the historical context) the linkage between credit and output markets—where traders "tie" output transactions to credit for the coming harvest—the study found this now to be rare in potato production. Nonfarm income, mobile phones, multiple trading sites, better roads, and other forms of credit seem to have undermined the old tie over time. However, CSFs (especially in India) had become major purveyors of value-chain finance to farmers.

- While the authors expected small-scale farmers to receive lower prices than medium and larger farmers, this was rarely the case. The hypothesized bargaining and social capital power of medium and larger farmers was not observed via differential prices.

- Mobile phones were important in facilitating change in the farmers' interface with the potato market. Mobile phones are cheap and versatile, assisting farmers to overcome asymmetries of market information, and ensuring connectivity.

- Technological change in the form of new seed varieties was an important driver of farm-level transformation. Regardless of farm size, the adoption of new varieties was rapid. This showed the strategic role of the NARS in disseminating new varieties and the farmers' rapid response to and uptake of the new varieties when spurred on by output market incentives.

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# 8 Midstream—Transformation of the Potato Cold Storage and Trading Segments

Much of the policy discussion concerning food security in Asia assumes that the value chains of basic produce staples such as potatoes are still essentially dominated by "traditional" players and structures. That view appears to carry with it the following assumptions about the midstream segment of potato value chains, as expressed by many key informants and in policy discussions. First, potato cold storage is very underdeveloped. Second, the potato wholesale system remains as it was decades ago: a long chain wherein urban wholesalers buy from traders who bring the product from rural wholesale markets. Third, the wholesale markets in turn depend on a web of rural brokers or village traders who are the main interface between the farmer and the market, an interface characterized by exploitative "tied output–credit markets."

Where the midstream segments of the potato value chain do enter the policy debate, they tend to evoke fears of speculation, as recently occurred in the Indian onion crisis. Yet few hard data are used in the debate.

To assess the extent to which "traditional" potato midstream segments (wholesale, storage, and processing) persist or have transformed, and the key characteristics of any transformation, this chapter marshals evidence from the midstream surveys of potato cold storage and traders in Bangladesh, the People's Republic of China (PRC), and India, The new findings presented show that the structure of the midstream segments of the potato value chains has transformed markedly in the areas under study; the findings indicate that the current value chaims no longer conform to the traditional image of the chain presented above.

## Structure of the Cold Storage Segment

Because potato farming in the study zones takes place primarily in one season, storage is needed. Three storage methods were used in the study zones.

The first was traditional or "rustic" storage on farm. In India, this involved storing potatoes in a field in a shaded spot; in a storehouse at ambient temperature, covered with straw or stalks; or in a farmhouse, in a bag or earthen pot. The storage typically entailed a few kilograms to a few tons. These methods are good for 2–3 months, after which heat, humidity, and heavy rains create problems (Fuglie et al. 1997, Khatana et al. 1997). The second method was an improved version of the first, using, for example, reinforced tunnels on or near the farm, as in Gansu.

The third method was the modern refrigerated warehouse, or cold storage facility (CSF). Lowering the temperature during storage allows potatoes to be stored for longer periods than with the first two methods, and to be marketed later in the year when no production is possible. Table and seed potatoes are usually cold stored at 2–4°C. Most of the CSFs in the South Asian region are used for potatoes.

During the 1980s and 1990s, potato storage in South Asia was shifting from traditional to modern storage. Heavy investment in storage continued into the 2000s as potato production soared. For example, by the mid-1990s, India had about 7 million tons of cold storage capacity. The great majority of this was in the private sector, which had expanded both because of the rapid growth in potato production and because of government subsidies for private investments and government investments in the local electricity grid (Fuglie et al. 1997). The potato sector in both Bangladesh and India then grew faster than the population, an expansion made possible because the availability of improved storage allowed for increased consumption of potatoes year-round.

In Gansu in the PRC, the traditional in-field storage methods had been displaced by improved on-farm and near-farm storage by farmers, and by traders' cold storage cellars. Of the traders' storage facilities, only 30% were the traditional variety (caves dug into the mountain)—68% were large tunnels with air circulation, and 1.4% were refrigerated modern cold storage facilities such as in the India and Bangladesh study zones. Key informants in Gansu noted that refrigeration was not needed due to the cold climate. However, the authors noted that as spring starts, about 5 months before the coming harvest, the weather warms and cellars are less effective than refrigerated cold storage. Most (81%) of the traders' cellars and tunnels were built during 2005–2010; only 11% had been constructed during 2000–2004, 7% in the 1990s, and 1% in the 1980s. Traders' use of cellars was partly subsidized indirectly by the government: 25% of the cellars were on land the government provided to traders. Among traders with cellars, the average cellar capacity had increased from 180 tons in 2000 to 3,000 tons (large cellars) by 2009. The average capacity of the cellars was 991 tons (about 15 times smaller than those in the Bangladesh and India study zones). As the median in Gansu was only 120 tons, the great majority of traders owned small storage facilities and only a few owned large ones.

Several factors may explain why modern potato cold storage was less developed among farmers and traders in the PRC study zone than in the study zones in India and Bangladesh. All three sites had conditions in the cold or cooler period when storage in cellars or caves constituted "improved" storage and thus was a partial substitute for modern cold storage. But improved storage may have been cheaper in Gansu than in the warmer study zones in South Asia. Moreover, Beijing potato wholesalers procured from a variety of zones and so had a less sharply seasonal supply of fresh potatoes than was observed in Bangladesh and India. This may account for the observed low rate of storage in Gansu, regardless of storage method. Finally, the Indian state governments (e.g., in the commercial potato zones of Gujarat, Punjab, and Uttar Pradesh) had subsidized the construction of CSFs, unlike in Gansu, and had invested heavily in power grids. For these reasons, the following discussion focuses on the cold storage segment in the South Asian sites.

Table 8.1 shows the development and capacities of cold storage in the Bangladesh and India rural study areas. Several points are salient.

First, in both areas, the average start-up was in the mid-1990s. In India, 74% of the CSFs started operating in the 1990s, and most of the rest in the 2000s. In both countries, the (currently) smaller CSFs were started in the 1980s or 1990s, and the larger ones in the 2000s.

Key informants noted several reasons for the rapid spread of the CSFs. (1) There was rapid growth in demand for potatoes in the off-season near the production areas in Dhaka and Delhi as those cities grew and incomes rose. (2) Potato production in the study zones grew rapidly in the 1990s and 2000s. (3) CSF establishment was encouraged and enabled by an increase in the availability of electricity as the government made major investments in the electricity grid in

**Table 8.1 Cold Storage Capacity and Diffusion: Bangladesh and India**

| | Storage Capacity | | | |
|---|---|---|---|---|
| | | | | **All** |
| **Bangladesh** | | | | |
| Year of start-up | | | | 1996 |
| Storage capacity at start-up, if started before 2000 (tons) | | | | 5,825 |
| Storage capacity at start-up, if started after 2000 (tons) | | | | 7,668 |
| Storage capacity, 2001 (tons) | | | | 9,240 |
| Storage capacity at start-up (tons) | | | | 6,468 |
| Capacity increase (2009/start-up) | | | | 43% |
| Current value of cold storage (self-reported, $ million) | | | | 2.9 |
| Capacity utilization in 2009 (average) | | | | 84% |
| CSFs operating at 100% capacity (share) | | | | 70% |
| CSFs operating at 65%–99% capacity (share) | | | | 15% |
| CSFs operating at less than 65% capacity (share) | | | | 15% |
| Potato type in total potato storage | | | | |
| Seed potato (share in 2009) | | | | 37% |
| Seed potato (share in 1999) | | | | 61% |
| Table varieties, for sale (share in 2009) | | | | 43% |
| Table varieties, for sale (share in 1999) | | | | 22% |
| Processing varieties (share in 2009) | | | | 20% |
| Processing varieties (share in 1999) | | | | 17% |
| **India** | **Small** (<7,000 tons) | **Medium** (7,000–10,000 tons) | **Large** (>10,000 tons) | **All** |
| Share of CSFs starting before 1990s | 18% | 0 | 0 | 6% |
| Share of CSFs starting in 1990s | 64% | 82% | 78% | 74% |
| Share of CSFs starting in 2000 and after | 18% | 18% | 22% | 19% |
| Total | 100% | 100% | 100% | 100% |
| Average start-up year | 1989 | 1998 | 1997 | 1994 |
| Average storage capacity at start-up (1,000 tons) | 4.4 | 7.8 | 12.8 | 8.1 |
| Average storage capacity, 2009 (1,000 tons) | 7.7 | 12.7 | 23.9 | 14.2 |
| Growth in capacity (2009/start-up) | | | | 75% |
| Current value of CSF (self-reported, $ million) | 0.6 | 0.9 | 1.3 | 0.9 |
| CSF capacity utilization (share of capacity in tons) | | | | |
| October–December | 5% | 3% | 2% | 3% |
| January–March (harvest) | 73% | 58% | 26% | 45% |
| April–June | 100% | 95% | 46% | 76% |
| July–September | 42% | 39% | 19% | 33% |
| Average capacity utilization over the year | 73% | 65% | 31% | 51% |
| CSFs storing (share, multiple answers possible) | | | | |
| Table potato | 100% | 100% | 100% | 100% |
| Seed potato | 64% | 64% | 78% | 68% |
| Processing variety | 9% | 9% | 0 | 7% |

CSF = cold storage facility.

the zones. (4) Government provided subsidies to establish and expand CSFs in the 1990s and the 2000s. (5) In the Agra case, regulations regarding pollution near the Taj Mahal limited industrial investment and served to funnel business investment toward CSFs in the 2000s.

Second, the capacity of the average CSF in both zones was large (in comparison with the PRC study zone). In 2009 in Bangladesh, the CSFs averaged 9,240 tons, and in India, 14,200 tons. However, the utilization rate was higher in Bangladesh, so that the average utilized capacity was about 7,000 tons in each country.

Yet the India data show substantial differentiation of capacities among CSFs. An inventory of CSFs obtained from the government in Agra shows that in 2009, the study zone had 182 registered CSFs—25% in the large category, 34% medium, and 41% small. Thus, there was only modest concentration: the large and medium categories had 59% of the units, but 75% of the total volume stored (about 1.5 million tons). The sample for the current study's survey had only slightly higher representation of large and medium CSFs (29% and 35%, respectively), so the figures presented here are essentially representative of the zone.

The large cold storage stratum averaged three times the capacity of the small stratum. The capacity utilization rate fell as the size increased. Multiplying the capacity utilization rates times the capacities of the strata gives the utilized capacity, which differed by a factor of 1.25 between the small and large Indian CSFs.

Third, CSFs entail major investments (compared with farm-level investments in irrigation or vehicles, or with rural traders' investments in small warehouses or trucks). The CSFs reported that their worth in 2009 was about $3 million in Bangladesh and nearly $1 million in India. In India, the investment cost per ton of potato sold was $64 ($890,000/14,000 tons)—somewhat below the $100/ton reported in the authors' recent study in Bihar (Minten et al. 2010). Moreover, the investment included both establishment and expansion of the CSFs. In Bangladesh, the average capacity was increased by 43% (during the roughly 12 years since start-up), and in India, by 75%. The increase entailed adding capacity to existing CSFs (such as additional buildings), and a shift toward starting up larger CSFs over the years.

Clearly, such large investments in CSFs were not feasible for small and medium farmers; key informants said that the large and medium CSFs were typically set up by industrialists or larger farmers in the area. But not all the Indian cold storage owners were from the nonfarm business sector. Interestingly, about a quarter of cold storage owners (with a similar share across cold storage size strata) were also potato farmers, but none were wholesalers (unlike in the PRC study sample, where the wholesalers owned the off-farm tunnel storages) or processors (possibly because the share of potatoes going to processing was small).

Fourth, the combination of factors driving the rapid expansion of cold storage also led to overexpansion. The capacity utilization rates averaged only 51% in Agra—the rates were as low as 31% for the large CSFs and a healthy 73% for the smaller ones. In Bangladesh, the rates averaged 70% (at full capacity), although 15% of the CSFs were operating at below 65% capacity. This indicates that some attrition and consolidation may occur in the segment in both study areas, and further investment is likely in areas such as Bihar and eastern Uttar Pradesh that are currently underserved by cold storage but where potato production is expanding rapidly.

Fifth, all the CSFs dealt in table potatoes. Most also dealt in seed potatoes, although farmers' storage of their own seed potatoes was declining, as farmers relied increasingly on the seed market. In Bangladesh, for example, seed potatoes comprised 61% of all potatoes stored in 1999; by 2009 that share was 37%. In India, only 9% of the potatoes farmers put in cold storage were for their own use as seed (see Chapter 7). Few CSFs dealt in the varieties of potato used for processing; as noted in Chapter 2, processing was a very minor use of potatoes in Bangladesh and India.

## Conduct of the Potato Cold Storage Segment

### Seasonality of Supply from Cold Storage to Cities

Figure 8.1 shows the total supply from the Bangladesh potato study area to Dhaka, and uses the cold store data to estimate the share of cold stored potatoes in the total supply. During the harvest period, when potato volumes traded are high, almost all potatoes in the market were fresh potatoes. Hence, in January–March the share of stored potatoes in the total supply was about 15%; by April–June, the share was 57%. During July–November, essentially the entire potato supply in Dhaka had been stored. Overall, an estimated 65% of potatoes consumed in Dhaka had been in cold storage (projecting from the supply from the study zone, which is a major supplier).

**Figure 8.1 Share of Potatoes from Cold Storage Facilities in Dhaka's Potato Supply**

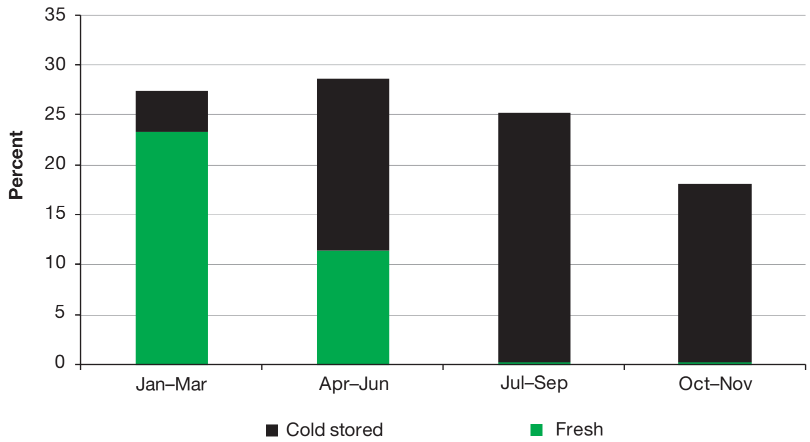
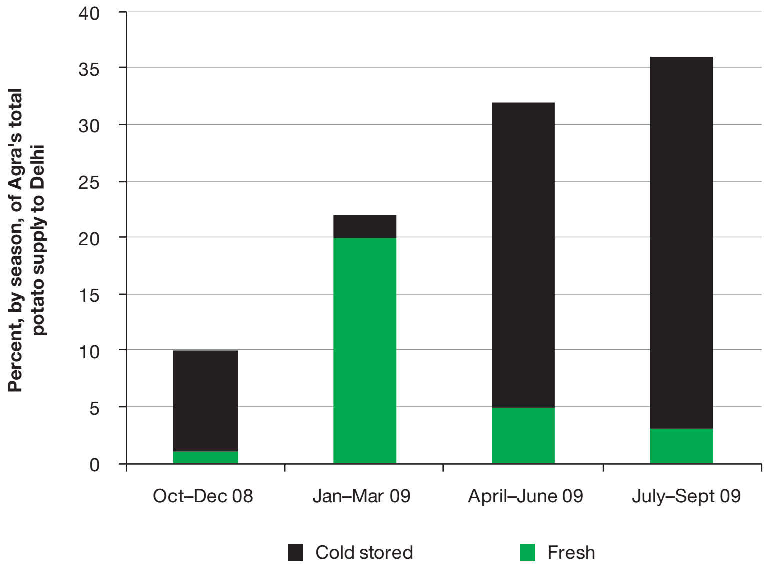



Figure 8.2 is the counterpart for Delhi of Figure 8.1 for Dhaka. The importance of cold-storage in the supply of potato to Delhi is estimated by examining the share of cold stored potatoes in the Agra supply of potatoes to Delhi by season and overall. Agra and the rest of western Uttar Pradesh supplied 66% of the potatoes to Delhi, so the approximation may be close. In January–March (the Agra harvest season), only 10% of the potato supply to Delhi was from cold storage; by April–June this rose to 83%. In July–September, the share was 93%, and it then declined to 86% in October–December as the early harvest came in.

Thus, 68% of all potatoes sent from Agra to Delhi had been cold stored, which may approximate the share in Delhi's total consumption.

In summary, CSFs are important for urban food security by extending the seasons during which potatoes are available. At the same time, the growing demand for potatoes from Delhi was a key driver of the rise of the cold storage segment, the development of which is a virtuous cycle for food security.

**Figure 8.2 Share of Cold-Stored Potatoes in Delhi's Total**




## Seasonality of Storage Activity

Figures 8.3 and 8.4 show the seasonality of cold storage in the Bangladesh and India study zones. The similarity of the patterns is striking. The CSFs in both zones shut down around November–January for cleaning and maintenance. The potato harvest starts arriving in January–February, and the stored bags have all been added by the end of March. From April to November–December, stocks are released fairly smoothly onto the market (by the owners of the stocks, mainly farmers and traders). Waiting longer gets a better price, but selling earlier generates needed cash income.

**Figure 8.3 Monthly Potato Storage per Cold Storage Facility: Bangladesh**
(October 2008–October 2009)

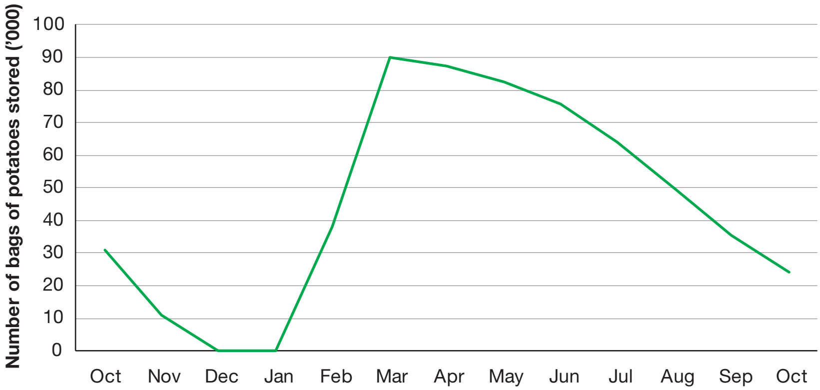
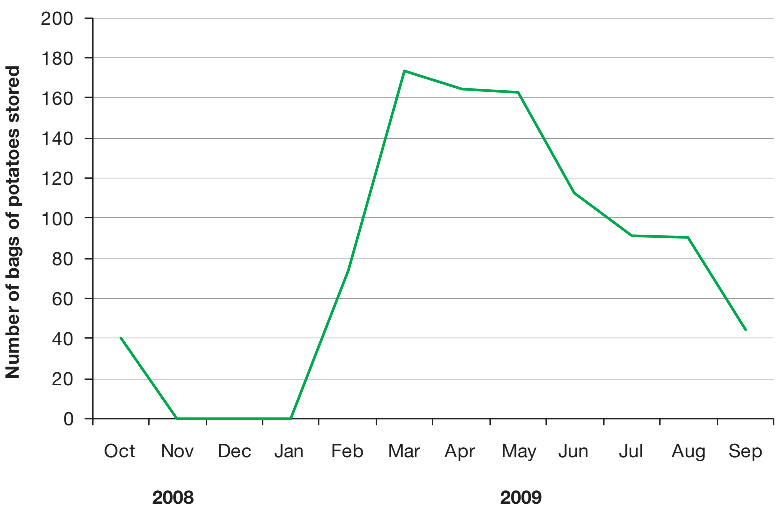



**Figure 8.4 Monthly Potato Storage per Cold Storage Facility: Agra**
(80-kg bags, October 2008–September 2009)




kg = kilogram.

## Cold Storage Clients: Composition, Procurement, and Sales

Tables 8.2 and 8.3 show the composition of cold storage clients—the sources of the potatoes stored. The total number of clients in Bangladesh was 554, versus 315 in India. However, the average Bangladesh CSF stored 9,000 tons,

at an average of 16 tons per client (although each trader client owned 8 times as many bags as each farmer client). In India, the CSFs averaged 14,000 tons, at 44 tons per client. This reflects the differences in farm size and trader scale between the two study zones.

Moreover, in both countries, farmers formed the great majority of the CSFs' clienteles—81% in Bangladesh and 91% in India. Yet in Bangladesh, farmers had a mere 40% of the stored volume and traders, each of which had a larger volume of stored potatoes than the average farmer, took 56% of the stored volume. The traders' share of the stored volume had grown steadily in

### Table 8.2 Bangladesh: Cold Storage Clients

| Client | Number or Share |
|---|---|
| Farmers who used cold storage | 451 |
| Traders who used cold storage | 103 |
| Share of stored volume owned by farmers, 2009 | 40% |
| Share of stored volume owned by farmers, 1999 | 60% |
| Share of stored volume owned by traders, 2009 | 56% |
| Share of stored volume owned by traders, 1999 | 35% |
| Share of stored volume owned by cold storage owners, 2009 | 4% |
| Share of stored volume owned by cold storage owners, 1999 | 5% |

### Table 8.3 India: Cold Storage Clients and Procurement Sources

| Item | Storage Size | | | |
|---|---|---|---|---|
| | **Small** (<7,000 tons) | **Medium** (7,000–10,000 tons) | **Large** (>10,000 tons) | **All** |
| Number of farmers storing potatoes per CSF | 178 | 301 | 399 | 286 |
| Number of traders storing potatoes per CSF | 17 | 40 | 31 | 29 |
| Procurement sources (shares of volume) | | | | |
| Brought directly by farmers for storage | 74% | 70% | 75% | 73% |
| Brought by rural brokers to store for themselves | 17% | 18% | 15% | 16% |
| Brought by traders from wholesale markets to store for themselves | 0 | 1% | 3% | 1% |
| Brought by the CSF itself | 9% | 11% | 7% | 10% |
| Total | 100% | 100% | 100% | 100% |

CSF = cold storage facility.

Bangladesh, from only 35% in 1999. Cold storage owners owned only 4% of the volume. Farmers and traders had been attracted to cold storage as a way of extending their sales seasons and thus raising the average price they secured, but Bangladesh potato traders had captured an increasing share of the "pie" of storage gains.

The situation was different in India. Farmers owned 73% of the stocks (similarly across CSF strata), nearly twice the share as in Bangladesh, and traders controlled only 17% (this was mainly the village traders, with only 1% from rural wholesale market traders). The lower share of traders in India could result from the average farm being larger in the potato zone in western Uttar Pradesh than in the Bangladesh study zone, or from the declining role of village traders over time. The declining role is partly due to the rising importance of the CSF as a point of intermediation (discussed further below).

The India finding that farmers were an important share of the CSF clients is significant from the perspective of the debate on CSF development in the 1990s and early 2000s. As recently as the mid-1990s, conventional wisdom was that larger farmers would use modern CSFs while the small-scale farmers would not be able to afford them (Fuglie et al. 1997). The authors think that this assumption induced the International Potato Center and others, even in the India study area, to emphasize improving on-farm traditional storage (which had nearly disappeared from use in the study zone a decade later). Indeed, the study found that all farm strata were generally using cold storage by the end of the 2000s.

Table 8.4 reports the responses of Agra cold storage managers to the question of where they sold the potatoes that they purchased. Their potato purchases comprised only a small share (10%) of all the potatoes they stored, as the great majority of their storage was a service for a fee. But it is interesting to examine what they did with the potatoes purchased, as in future they may increase their potato purchase to take over trading per se, just as they captured from the wholesale markets the provision of an exchange venue. Most (64%) of the CSFs' own (purchased) stock was sold other than to Uttar Pradesh or Delhi, and mainly to the south Indian states. This makes sense, as traders from the south directly sourced from the main northern production zone (Agra and other western Uttar Pradesh areas) rather than from Delhi, where they would have had to incur further intermediation costs. The finding was corroborated by the traders and cold storage key informants, who noted that interregional trade had increased in the last decade, with increasing amounts of their potatoes heading to the south in the off-season. This underscores what appears to be the emergence of a national potato market. Equally surprising is the composition of buyers of potatoes stored by the CSFs for their own sales. The stored potatoes were not mainly going first to the local

**Table 8.4 India: Cold Storage Facilities' Sales from Own** (purchased) **Stocks: Destinations** (%)

| Item | Capacity Storage | | | |
|---|---|---|---|---|
| | **Small** (<7,000 tons) | **Medium** (7,000–10,000 tons) | **Large** (>10,000 tons) | **All** |
| **Where sold** (shares of sales from own stocks) | | | | |
| Agra (same district) | 14 | 13 | 16 | 15 |
| Uttar Pradesh outside Agra | 15 | 14 | 18 | 16 |
| Delhi | 8 | 3 | 6 | 5 |
| North and West Indian states | 9 | 8 | 3 | 7 |
| South Indian states | 53 | 52 | 52 | 53 |
| Eastern Indian states | 2 | 10 | 5 | 4 |
| Total | 100 | 100 | 100 | 100 |
| **To whom sold** (shares of sales from own stocks) | | | | |
| At wholesale market in Agra (own district) | 8 | 8 | 10 | 9 |
| Delhi-based trader | 6 | 3 | 1 | 3 |
| Local rural broker | 0 | 0 | 2 | 1 |
| Brokers/wholesalers from outside Agra and Delhi | 86 | 88 | 85 | 86 |
| Traditional retailers in Agra directly | 1 | 1 | 2 | 1 |
| Total | 100 | 100 | 100 | 100 |

rural wholesale market, to be channeled on to other markets; rather, there was a disintermediation, with about 86% of the potatoes bought directly from the CSFs by brokers and wholesalers from other districts and states. Only 9% went. Only 9% went to the rural wholesale market in Agra. Traders at the CSFs noted that the rise of cold storage had meant side-stepping the local wholesale market. This is made even more interesting, given that the Agricultural Produce Marketing Committee Act (known as the APMC Act) required trade to go via the wholesale market—clearly the forces of the market were shaping the realities. Also, only 1% of the stored potatoes went to local retail—another indication that this was a commercial farming area with all of India as its main market.

## Cold Storage Facilities' Provision of Value-Chain Finance

Table 8.5 shows that CSFs were substantially engaged in providing value-chain finance to their clients. Surprisingly high shares of CSFs—large and small alike—provided advances to their clientele in both Bangladesh and India. In India, 84% of the CSFs provided credit to farmers before they stored potatoes, and 97% did so after they stored; in Bangladesh, the shares were 15% and 55%, respectively. The impact on farmers' credit access was broad: in India, 57% of potato farmers (large and small) using CSFs took credit (in the form of advance payments using the stored or to-be-stored potato as collateral) from the CSFs. In Bangladesh, 30% of the CSF users got such credit and 39% of the bags in storage were used as collateral to guarantee the loans to the farmers. Typical advances were as high as $7.20 on a bag valued at $23.70 when sold off-season. This seems better than using land as collateral, as required by some other credit mechanisms. In Bangladesh, the interest rates the CSFs charged were low, averaging 8% for the duration of storage (averaging roughly 6 months), and in line with or even lower than formal sector interest rates. The Indian CSFs charged 12% interest (also for the duration of storage) on the advances. For another study the authors have done in western Uttar Pradesh, farmers reported 9% yearly interest on bank credit via Kisaan Credit Cards. As the cold storage advance was for half a year, the credit was fairly costly; however, only a third of farmers were getting credit of any kind, and the 12% rate was probably below the village moneylender's rate (see Reardon et al. 2011 for a farm survey on rural business hubs catchment areas in Uttar Pradesh).

**Table 8.5 Cold Storage Facilities' Provision of Value-Chain Finance**

| Item | Cold Storage Size | | | |
|---|---|---|---|---|
| | **Small** (<7,000 tons) | **Medium** (7,000–10,000 tons) | **Large** (>10,000 tons) | **All** |
| **Bangladesh** | | | | |
| Share of CSFs that provided advance payments before storage | | | | 15% |
| Share of CSFs that provided advance payments after storage | | | | 55% |
| If yes, share of users that cold storages gave advances to | | | | 30% |
| If yes, advance given per bag ($/kg) | | | | 0.08 |
| Share of bags that credit was given for (% using bags as collateral) | | | | 39% |
| **India** | | | | |
| Share of CSFs that provided advance payments to farmers before storage | 73% | 91% | 89% | 84% |
| Share of farmers per CSF, who got advance from CSF before storage | 22% | 29% | 31% | 27% |
| Share of CSFs that provided advance payments after start of storage | 91% | 100% | 100% | 97% |
| Share of users per CSF who got advances from CSF after start of storage | 35% | 26% | 31% | 30% |
| Rs/kg as advance given per CSF | 0.9 | 1.0 | 0.9 | 0.9 |
| Share of tons stored per CSF, on which the CSF provided advances (using bags as collateral) | 4% | 4% | 4% | 4% |

CSF = cold storage facility, kg = kilogram, Rs = Indian rupees.

While formal channels in Bangladesh and India had made significant efforts to launch warehouse receipt systems, action by CSFs seems to have outpaced these efforts at least in the study area. CSFs were active in credit markets, and they increasingly competed among each other to attract customers based on the advances given (as indicated by storage owners during interviews). The farmer surveys (reported in Chapter 7) also confirmed CSFs as important providers of credit. This is interesting, especially from the perspective of the recent debate. In the 1990s, the debate concerned farmers not wanting to use cold storage because they would forego the cash at harvest. Clearly, the CSFs anticipated this problem, and addressed it in the 2000s by releasing cash as credit during the cropping season.

## Other Services of Cold Storage Facilities

Table 8.6 shows services other than storage and finance that CSFs provided to clients. The most important finding is that CSFs had started to engage in facilitating or intermediating transactions. In Bangladesh, 55% of the CSFs reported putting clients in contact with potential buyers, and the CSFs that did this, did so for fully 62% of their users—thus, roughly a third of all their clients received this intermediation service. India's CSFs lagged somewhat behind those of Bangladesh in this practice, as only a third of them provided such intermediation and they did it only for a small share (5%) of their clients. For the South Asian sites, this appeared to be a part of the general shift of the locus of potato trade to the CSFs (as noted in Chapter 7). As the data show and local key informants in the wholesale markets noted, the CSF had largely displaced the wholesale market as the venue for potato exchanges.

Moreover, in Bangladesh, all the CSFs reported that they arranged farmers' access to seed, if needed. In India, 61% of the CSFs (especially the larger ones) arranged access to seed. However, few farmers actually accessed seed via the CSFs—as proved both by the CSFs' reports and the data in Chapter 7. The CSFs provided little by way of chemicals and extension. In Bangladesh, 80% of the CSFs provided grading and sorting services, but in India, only 10% of them (and mainly the large ones) provided these services.

Finally, the CSFs in Bangladesh were not much involved in transport: 5% of them provided transport from farm to cold storage and none provided transport to the buyer.

In summary, the CSFs had branched out from providing storage and finance to intermediating (facilitating transactions by informing clients about potential buyers for their potatoes); facilitating the transactions taking place at their site; and providing inputs and services (seed; information; grading and sorting; and, in India, transport). This made CSFs both competitive and complementary with the trader community they served, as well as a major alternative for credit and for an exchange venue. Consequently, farmers and traders were attracted to the CSFs.

**Table 8.6 Other Services of Cold Storage Facilities (%)**

| Service | Share Provided by Cold Storage | | | |
|---|---|---|---|---|
| | **Small** (<7,000 tons) | **Medium** (7,000–10,000 tons) | **Large** (>10,000 tons) | **All** |
| **Bangladesh** | | | | |
| Arranged farmers' access to seed potato | | | | 100 |
| If yes, share of farmers that got access through CSFs | | | | 52 |
| Arranged farmers' access to chemicals/ pesticides | | | | 0 |
| Provided agricultural extension services to farmers | | | | 10 |
| Contacted buyers and arranged transactions for storers | | | | 55 |
| If yes, share of users put in contact with buyers | | | | 62 |
| Provided grading and sorting services | | | | 80 |
| Provided transport from farm to CSF | | | | 5 |
| Provided transport from CSF to buyer | | | | 0 |
| **India** | | | | |
| Arranged farmers' access to seed potato | 55 | 55 | 78 | 61 |
| Farmers per CSF, who accessed seed potato through the CSF | 11 | 9 | 13 | 11 |
| Contacted farmers on request of traders and arranged transactions | 46 | 22 | 44 | 36 |
| Contacted traders on request of farmers and arranged transactions | 18 | 18 | 22 | 19 |
| Users per CSF put in contact with buyers by the CSF | 6 | 5 | 5 | 5 |
| Provided grading and sorting services | 9 | 0 | 22 | 10 |
| Provided transport from farm to CSF | 100 | 100 | 100 | 100 |
| Provided transport from CSF to buyer | 100 | 100 | 100 | 100 |

CSF = cold storage facility.

# Performance of the Cold Storage Segment

## Evolution of the Variety of Potatoes Stored

Table 8.7 focuses on Bangladesh, where there was a large shift in the last decade from red to white potato varieties, and out of the granola variety, partly into white diamond, in the storage patterns of the cold storages. (There was no significant shift in potato variety or in the composition of cold-stored potatoes during the same decade in India.) This reflected the same shift in production in the study zone—farmers shifted to white potato because of yield advantages, and to white diamond because of disease problems with granola.

**Table 8.7 Type of Potato Stored in Bangladesh, 1999 and 2009** (%)

| Type of Potato | 1999 | 2009 |
|---|---|---|
| White versus red potato | | |
| White | 31 | 72 |
| Red | 69 | 28 |
| Total | 100 | 100 |
| Type of white potato | | |
| Diamond | 17 | 48 |
| Granola | 68 | 1 |
| Other | 15 | 51 |
| Total | 100 | 100 |

## Cold Storage Costs

Table 8.8 shows the CSFs' yearly operating costs. Several interesting points emerge from the table and other findings in the survey.

First, although (in terms of utilized capacity, not capacity per se) the Bangladesh and India CSFs were about the same scale, the total operating cost of $340,000 per year for the Bangladesh CSFs was far above the $262,000 in India. Most of the difference was due to higher costs for energy used by CSFs in Bangladesh. Energy costs formed fully 63% of total CSFs' costs in Bangladesh and 71% of costs in India. About 80% of the energy cost was for electricity. This shows the important link between energy costs and food security, and is a concern given the increasing costs of energy and the implications for carbon emissions. Moreover, while the utilized capacity averages were the same in both countries, the yearly energy outlay in India

**Table 8.8 Average Annual Operating Costs per Cold Storage**
(in $'000; figures in parentheses are in % of cost)

| Item | Storage Capacity | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Small** (<7,000 tons) | | **Medium** (7,000–10,000 tons) | | **Large** (>10,000 tons) | | **All** | |
| **Bangladesh** | | | | | | | | |
| Yearly costs of permanent employees | | | | | | | 12 | (3.5) |
| Yearly costs of temporary employees | | | | | | | 34 | (10) |
| Electricity | | | | | | | 177 | (52) |
| Diesel | | | | | | | 38 | (11) |
| Other | | | | | | | 79 | (23) |
| Total | | | | | | | 340 | (100) |
| **India** | | | | | | | | |
| Permanent employees | 10 | (6) | 16 | (7) | 34 | (8) | 19 | (7) |
| Temporary employees | 1.8 | (1) | 1.1 | (0.4) | 0.2 | | 1.1 | (0.4) |
| Electricity | 100 | (60) | 149 | (64) | 198 | (49) | 149 | (57) |
| Diesel | 16 | (10) | 29 | (12) | 67 | (17) | 36 | (14) |
| Ammonia gas | 4 | (3) | 4 | (2) | 16 | (4) | 9 | (3) |
| Compression oil | 7 | (4) | 9 | (4) | 13 | (3) | 9 | (3) |
| Telephone/mobile bills | 0.9 | (1) | 1.3 | (0.6) | 1.8 | (0.4) | 1.3 | (1) |
| Fees and taxes | 1 | (0.5) | 1 | (0.3) | 22 | (5) | 1 | (0.4) |
| Other | 27 | (16) | 22 | (9) | 51 | (13) | 36 | (14) |
| Total operating costs (summing to 100% with rounding error) | 168 | (100) | 233 | (100) | 403 | (100) | 262 | (100) |

was $185,000 but in Bangladesh it was about 16% higher, at $215,000. This could be from higher unit costs of energy, use of more energy to achieve the same degree of cooling, or both. Interestingly, there was a twofold difference in energy expenditures between large and small CSFs in India, although there was only a 1.25-fold difference in utilized capacity. Thus, the large CSFs were especially energy-intensive (and perhaps energy inefficient), given that all the CSFs faced about the same energy prices in the same area of India.

Second, after energy, labor was the next highest single cost, although it formed only 13.5% of total costs in Bangladesh and 7.4% in India. This cost share is very small relative to that in farming. Cold storage is capital-intensive, rather than labor-intensive. However, the CSFs' labor outlay in Bangladesh was more than twice that in India, despite similar utilized capacities, roughly similar mechanical technologies, and similar labor wages (at least for day labor) in the two countries. Thus, it appears that the Bangladesh CSFs overspent on labor. While this may have spurred rural employment, it may also have entailed a cost to consumers.

Third, in India, as just noted, the large cold storage stratum had a utilized capacity of 7,400 tons, which was 1.25 times that of the small one, at 5,900 tons. But the cost ratio was 2.5. Thus, rather than having economies of scale, the large strata in India had twice the cost per ton stored of the small cold storages. By contrast, the ratio of utilized capacity and the ratio of costs between the medium and small strata were 1.4:1 each. Hence, inefficiencies are apparent in the large CSFs. This may be linked to the substantial electricity costs for cooling large storage areas.

## Cold Storage Facilities' Profit Rates and Internal Rates of Return

Table 8.9 shows profit rates and internal rates of return of CSFs. The rates are gross of amortization, and thus overstate profit. Even so, they are quite modest relative to profit rates that the study found for the trader and retail segments. The Indian profit rates are somewhat above the Bangladesh rate.

Given the relatively large fixed costs for this type of operation, the internal rates of return are quite sensitive to the capacity of the CSF that is used in the calculation. Using simplified assumptions for costs and benefits (uniform prices charged at the median; no costs imposed for services delivered in input, output, and financial markets), the internal rate of return at the average capacity in 2009 was evaluated at 7.4% for Bangladesh and 5.0% for large and 2.0% for small CSFs in India. For Bangladesh, financial internal rates of

**Table 8.9 Profit Rates and Internal Rates of Return for Cold Storage Facilities** (%)

| Rate | Cold Storage Size | | | |
|---|---|---|---|---|
| | **Small** (<7,000 tons) | **Medium** (7,000–10,000 tons) | **Large** (>10,000 tons) | **All** |
| **Bangladesh** | | | | |
| Profit rate | | | | 9 |
| Internal rate of return at | | | | |
| Current capacity (81%) | | | | 7 |
| Full capacity (100%) | | | | 42 |
| 90% of capacity | | | | 23 |
| 78% of capacity | | | | 2 |
| **India** | | | | |
| Profit rate | 3 | 17 | 28 | 16 |
| Internal rate of return at | | | | |
| Current capacity (51%) | 2 | 4 | 5 | 4 |
| 100% of capacity | 6 | 10 | 12 | 9 |
| 80% of capacity | 5 | 6 | 8 | 6 |

return decline quickly from a high 42.0% at full capacity to 23.0% at 90% use of capacity, to 1.8% at 78% use of capacity. Below this capacity, CSFs would not be able to repay investments. Using the distribution of used capacity, this finding implies that 25% of the CSFs were running losses in Bangladesh (as their capacity was significantly below 78%), while the others showed healthy profits. Thus, over time, there may be a trend of consolidation and exit of the least efficient firms, likely in both Bangladesh and India. If this transpires, over time the average efficiency of CSFs will rise. All else being equal, such a rise could reduce consumer prices of potatoes.

## Structure of the Potato Trader Segment

### Characteristics of Potato Traders

Tables 8.10–8.13 show characteristics of potato traders in the three zones. As with rice, the types of traders included village traders, traders on the rural wholesale market, and urban wholesale market traders. While there was substantial diversity across subsegments and zones, several similarities emerge.

**Table 8.10 Characteristics of Potato Traders in Bangladesh**

| Characteristic | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village | Rural Wholesale Market | Urban Wholesale Market | All |
| **Overall background** | | | | |
| Age (years) | 40 | 45 | 43 | 43 |
| Gender (male) | 100% | 100% | 100% | 100% |
| Education (share) | | | | |
| None | 23% | 37% | 20% | 27% |
| Primary (year 5) or less | 20% | 13% | 50% | 37% |
| Primary but not more than year 9 | 30% | 23% | 13% | 22% |
| Beyond year 9 | 27% | 27% | 17% | 14% |
| Wholesalers who also sold other products | 100% | 100% | 100% | 100% |
| Share of potato in total sales | 68% | 45% | 74% | 62% |
| **Working capital and business assets** | | | | |
| Current working capital ($) | 4,147 | 16,147 | 12,588 | 10,956 |
| Share from own funds | 79% | 91% | 93% | 88% |
| Fixed monthly operating costs ($, excluding labor and stall rental) | 463 | 451 | 201 | 372 |
| Value of food trade business assets owned ($) | 5,044 | 35,705 | 8,382 | 24,647 |

## Table 8.11 Characteristics of Potato Traders and Wholesalers in Delhi and Agra (October 2009)

| Characteristic | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Agra | | Delhi Wholesale Market Traders | All |
| | Off-Market (village traders) | Rural Wholesale Market Traders | | |
| Average age of trader (years, simple average) | 33 | 39 | 30 | 35 |
| Share of wholesalers that are male | 100% | 100% | 100% | 100% |
| Education (share) | | | | |
| No schooling | 0 | 0 | 10 | 3.3% |
| Primary (year 5) or less | 0 | 0 | 10 | 3.3% |
| Primary but not more than year 9 | 16.3% | 15.8% | 6.7% | 12.9% |
| Beyond year 9 | 83.7% | 84.2% | 73.3% | 80.5% |
| Year started potato trading (average) | 1991 | 1979 | 1979 | 1981 |
| Year started potato wholesaling (average) | 1997 | 1980 | 1980 | 1983 |
| Share of traders who also sold other products | 6.9% | 36.8% | 10.0% | 22.9% |
| Share of potato in total sales per trader | 97.3% | 88.4% | 95.8% | 92.4% |
| Share of traders trading in (multiple answers possible) | | | | |
| Table varieties | 100% | 100% | 100% | 100% |
| Processing varieties | 2.3% | 10.5% | 50 | 22.3% |
| Seed potato | 39.5% | 5.3% | 0 | 9.2% |
| Working capital ($'000, 2009) | 10 | 11 | 19 | 15 |
| Share of working capital from own funds | 50% | 63% | 95% | 76% |

## Table 8.12 Characteristics of Potato Traders in the PRC

| Characteristic | Value |
|---|---|
| Years as potato trader (2010 minus year started) | 10 |
| Initial funding (at start of business) | $7,453 |
| Share of initial funding from household/family | 41% |
| Share of traders in the Potato Marketing Association | 93% |
| Shares of traders in the following categories (can be multiple roles) | |
| Broker charging commission | 33% |
| Wholesaler (took possession) from farmer to local wholesale market | 67% |
| Wholesale from farmer to wholesalers from elsewhere (not local wholesale market) | 63% |
| Wholesaler or broker selling/bringing potato to potato processing plants | 56% |
| Share of potatoes in trader's total sales | 82% |
| Shares of traders that (can be multiple per trader) | |
| Market in local wholesale market | 78% |
| Transport to nonlocal wholesale market | 59% |
| Market in stall in nonlocal wholesale market | 15% |
| Share of traders with storage cellar in 2009 | 78% |
| Share of traders with storage cellar in 2005 | 48% |
| Storage capacity in 2009 of traders who have cellar (average tons) | 3,061 |
| Storage capacity in 2005 of traders who have cellar (average tons) | 458 |

PRC = People's Republic of China.

**Table 8.13 Characteristics of Potato Wholesalers in Beijing**

| Characteristic | Value |
|---|---|
| Share of wholesalers by role (%) | |
| Fixed wholesaler at wholesale market (buys, also trades for a fee) | 60 |
| Broker fixed/based in Beijing, selling on commission | 0 |
| "Semi-wholesaler" buying from other wholesalers in Beijing | 20 |
| Wholesaler based in production area bringing potato to Beijing | 80 |
| Agent/representative for supermarket chain buying from other wholesalers | 0 |
| Years in business | |
| Trading potato | 6.13 |
| In wholesale market | 5.73 |
| Base before being wholesaler (%) | |
| Beijing | 16 |
| Gansu | 0 |
| Other province | 83 |
| Total | 100 |
| Share of types (varieties or uses) of potato in wholesalers' deals in 2010 (%; does not = 100% | |
| Table, fine quality | 93 |
| Table, common (middle) quality | 76 |
| Table, poor (low) quality | 66 |
| Processing potato (variety) | 0 |
| Seed potato | 0 |
| Specialty potato ("low pollution" or "Green Food," both labels used in the PRC only) | 0 |
| Share of wholesalers who traded in products other than potato (%) | 30 |
| Share of wholesalers who owned a cold storage (%) | 0 |
| Stall sections the average wholesaler operated in wholesale market | |
| Average number operated | 0.9 |
| Share of wholesalers who only owned stalls | 3 |
| Share of wholesalers who only rented stalls | 60 |
| Share of wholesalers who owned and rented stalls | 0 |
| Share of traders who owned or rented warehouse (%) | 3 |
| Share of traders who operated a van or truck (%) | 80 |
| Share of traders who rented a van or truck among all traders with vehicles (%) | 20 |
| Working capital | |
| Working capital at survey in 2010 | $7,487 |
| Average share of working capital that was own funds | 94 |
| Working capital at start of trading business | $4,533 |

PRC = People's Republic of China.

First, the traders tended to be in their 30s–50s. They were all male. The PRC and Indian traders were somewhat more educated than the Bangladesh traders. The South Asian wholesale market traders started business in the 1980s (soon after or during the formation of the produce markets, and when they got their licenses), and the village traders started in the 1990s, on average. By contrast, the PRC traders started in the 2000s, reflecting the rapid development of PRC produce wholesale markets starting in the 1990s.

Second, potato traders tended to be relatively specialized; few sold seed or processing potatoes, and all focused mainly on table potatoes. They had to muster substantial working capital to finance the inventory cycle. India's potato traders tended to be the largest, and Bangladesh traders second, with working capital of $12,000–$15,000 in the South Asia cases (and as much as $18,000 for the Delhi traders) versus about $8,000 in the PRC case. Bangladesh traders' business assets varied widely, from urban wholesalers (some owned several trucks and had assets running upward of $20,000) to village traders (with assets of only about $760). Clearly, the entry requirement was substantial in all cases, relative to traditional retailing or farming. As expected, the averages showed a steep rise in working capital requirements between village traders and rural and urban wholesale market traders.

Finally, while the working capital requirements were steep and the business assets could be substantial, especially in urban areas, the operating costs (fixed costs not related to variable costs of the transactions) were modest, about $4,800 per year in Bangladesh; $7,680 in India; and $8,900 in the PRC. Outlays on labor were additional, and were roughly the same as the operating costs. These costs were modest because the main activity was loading, unloading, and transporting, with a low capital base except for the vehicles.

## Seasonal Turnover of Potato Traders

Tables 8.14 and 8.15 show volumes that potato traders procured by season in the South Asia sites. The two sites are discussed together because of the importance of cold storage in these markets. Thus, potato availability in the urban areas is not expected to be seasonal but it is expected to be highly seasonal in rural areas. The study confirmed the expected seasonality in rural areas—and found that, in each of the cities, traders' turnover of potatoes dipped in the season just before harvest, when stocks, and thus stock drawdowns from CSFs, were lowest. This seems at odds with the study's finding that a number of CSFs were operating under capacity; it suggests that there was still a residual constraint of farms supplying the potatoes needed for the CSFs to supply the big cities year-round. Thus, the potato supply period could be extended with better storage technology or greater integration of markets spatially (such as greater sourcing from south India) to fill the gap in the year. Potato supply also might be augmented and stabilized if contractual arrangements are developed with farmers to supply fresh potatoes (as is common with growers in the much smaller segment of processing potatoes in other areas of India).

**Table 8.14 Potato Traders' Seasonality in Bangladesh: Quantities Procured per Day per Season** (tons)

| Season | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All (average) |
|---|---|---|---|---|
| Jan–Mar 2009 | 8.0 | 6.7 | 6.9 | 7.2 |
| Apr–Jun 2009 | 2.3 | 4.8 | 10.8 | 6.0 |
| Jul–Sep 2009 | 1.6 | 3.7 | 12.1 | 5.8 |
| Oct–Dec 2009 | 1.6 | 3.1 | 11.0 | 5.2 |

**Table 8.15 Potato Traders' Seasonality in India: Quantities Procured per Day per Season** (tons; mean values)

| Season and Year | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All (average) |
|---|---|---|---|---|
| Oct–Dec 2008 | 11.5 | 9.3 | 12.4 | 11.4 |
| Jan–Mar 2009 | 34.6 | 28.1 | 27.9 | 29.6 |
| Apr–Jun 2009 | 38.7 | 47.9 | 41.2 | 42.3 |
| Jul–Sep 2009 | 34.1 | 42.7 | 46.3 | 42.3 |

Tables 8.16 and 8.17 show traders' volumes of potatoes across seasons in Gansu and Beijing. The seasonal patterns were broadly similar to those in South Asia, but for different reasons. Whereas the rural traders in Gansu had sharp seasonality (with most activity in October–December, and then a rapid fall-off given the dearth of cold storage in Gansu), the Beijing potato trading activity was much smoother seasonally, except for a trough of about the same length as in Dhaka and Delhi. But the trough was differently timed, being in February–April. Rather than rely on cold store drawdowns from a few main areas of production (as in South Asia), the Beijing traders drew on Gansu and Inner Mongolia heavily at one time, and then other provinces (such as nearby Hebei) at other times. Still, Beijing did not yet source much from the south (just as Delhi did not); doing so might have closed the temporal gap, as would increasing cold storage.

**Table 8.16 Potato Traders' Monthly Volume in the Rural PRC** (tons per day)

| Item | 2009 | | | | | | 2010 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Purchase (tons) | 1.3 | 4.0 | 7.7 | 53.2 | 26.3 | 20.2 | 8.3 | 6.6 | 5.5 | 4.8 | 2.2 | 1.3 |
| Price ($/ton) | 190 | 160 | 160 | 190 | 240 | 260 | 280 | 310 | 320 | 340 | 340 | 360 |

PRC = People's Republic of China.

**Table 8.17 Seasonal and Geographic Procurement Patterns of Potato Wholesalers in Beijing**

| Quantity Procured | Aug–Oct 2009 | Nov 2009–Jan 2010 | Feb–April 2010 | May–July 2010 | Year: Aug 2009–July 2010 |
|---|---|---|---|---|---|
| Total (tons) | 986 | 792 | 532 | 1,023 | 3,337 |
| Average volume/day (tons) | 10.95 | 8.80 | 5.92 | 11.37 | 9.26 |
| Shares by sources (%): | | | | | |
| Gansu | 21 | 30 | 29 | 31 | 28 |
| Inner Mongolia | 36 | 40 | 30 | 15 | 30 |
| Main southern (Yunnan, Guizhou, Sichuan) | 1.67 | 0 | 0 | 0.17 | 0.46 |
| Hebei | 40 | 29 | 40 | 52 | 40 |
| Total | 100 | 100 | 100 | 100 | 100 |

# Conduct of the Potato Trader Segment

## Procurement

Table 8.18 shows traders' sources of potatoes, and tells a fascinating story of change. In South Asia, the traditional role of the village trader in sourcing potatoes had been greatly reduced (as in rice, but the disintermediation was even more extreme in potato). By 2009, the village trader was the source of only 2% of the potatoes entering the Agra–Delhi value chain and 16% of the Bogra–Dhaka chain. The rural wholesale market maintained a role, but it was limited, at about 20% in the two South Asian countries. The cold storage as a source of potatoes for traders in the value chain had emerged and become preponderant, providing 35% of the traders' potatoes in Bangladesh and 61% in India. Traders met farmers at the CSF and bought potatoes there. The CSFs had often facilitated the deals, and the rural wholesale market appeared to be marginalized.

In the Uttar Pradesh case, the shift was even more interesting. Because the APMC Act had not yet been repealed or amended in that state, in theory, all trade should have taken place at the licensed wholesale market. But traders in the area explained that the logic of the market had simply and quietly sidelined the regulation.

By contrast, in Gansu, the traders still mainly bought directly from farmers or other brokers. Direct purchase by brokers and wholesalers was moving 63% of the potatoes in the system. In provinces near Beijing, such as Hebei and Inner Mongolia, the Beijing wholesalers bought directly from farmers, using a transporter as a go-between.

**Table 8.18 Potato Traders' Suppliers** (share of volumes by source)

| Source | Percent |
|---|---|
| **Bangladesh** | |
| Directly from farmers in villages | 19 |
| Traders in villages | 16 |
| Farmers, but picked up from cold store | 18 |
| Other traders, picked up from cold store | 17 |
| Cold storage owners | 2 |
| Traders in wholesale market | 27 |
| Other sources | 1 |
| Total | 100 |
| **China, People's Rep. of** | |
| Directly from farmers in villages, then sold fresh (no storage) | 63 |
| Farmers, then put in own cold storage | 0 |
| Farmers, then put in other cold storage | 0 |
| Wholesalers in wholesale market in production area | 2 |
| Directly from other cold storage of traders in production area | 0 |
| Brokers/wholesalers coming from production area | 11 |
| Other wholesalers in Beijing | 20 |
| Other sources | 5 |
| Total | 100 |
| **India** | |
| Directly from farmers in Agra | 20 |
| Farmers, but deal arranged and potatoes picked up by CSF in Agra | 35 |
| Other traders, but deal arranged and potatoes picked up by CSF in Agra | 26 |
| Agra traders in wholesale market | 1 |
| Rural field brokers in Agra | 2 |
| Directly from farmers in Punjab | 4 |
| Other sources | 12 |
| Total | 100 |

CSF = cold storage facility.

Table 8.19 shows where the potatoes the traders sold were headed and the types of buyers. The patterns differed sharply across study zones. The salient points are as follows. In Bangladesh, traders sold about a third of their potatoes to other traders in Bogra, 40% to traders from other districts and Dhaka, and 25% directly to traditional retailers. They sold very little to processors or supermarkets, as expected. In the PRC, traders sold fully two-thirds of their volume directly to traditional retailers and only 3% to processors (only about 10% of potato in the PRC was processed). The PRC's food sector was modernizing, and the traders sold 22% of their potatoes to the modern food industry—8% to supermarkets and the rest to food services such as hotels and restaurants. In India, half of the traders' sales were to the urban wholesale market and 40% was sold to traders coming from other parts of Uttar Pradesh and other Indian states.

**Table 8.19 Potato Traders' Sales Destinations, with Shares of Volumes by Buyer Type and Destination**

| Zone and Destination | Percent |
|---|---|
| **Bangladesh** | |
| Wholesalers/traders in Bogra | 32 |
| Wholesalers/traders in Dhaka | 17 |
| Wholesalers/traders in other districts | 22 |
| Cold storage owners | 0 |
| Directly to traditional retailers outside Dhaka | 2 |
| Directly to traditional retailers in Dhaka | 25 |
| Directly to modern retailers | 1 |
| Processors | 0 |
| Total (with rounding error) | 100 |
| **China, People's Rep. of** | |
| Other wholesalers | 11 |
| Government buyers | 0.05 |
| Traditional retailers | 64 |
| Processors | 3 |
| Modern retailers | 8 |
| Restaurants, hotels, hospitals, etc. | 14 |
| Total | 100 |
| **India** | |
| Via Delhi wholesale market commission agent | 49 |
| To traditional retailer in Agra, directly | 9 |
| To modern retailers anywhere, directly | 1 |
| To processors | 1 |
| To brokers and wholesalers from other states or Uttar Pradesh–outside Agra (not Delhi) | 40 |
| To cold storage operators in Agra | 0.1 |
| Total | 100 |

## Potato Traders and Value-Chain Finance

Table 8.20 shows potato traders' engagement in value-chain finance. The following are the main findings.

First, and most surprising, is the limited value-chain finance traders provided to farmers as advances. This is at odds with the widely held belief that traders usually give advances to secure output delivery from farmers. The table shows that few traders provided advances to farmers—only 24% in Bangladesh, 15% in Gansu, and none in Beijing did so. In India, 44% of traders provided some advances, but the share of farmers receiving these advances was merely 4% of small-scale farmers, 9% of large-scale farmers, and 6% of other traders.

**Table 8.20 Potato Traders and Credit (%)**

| Trader and Credit | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
|---|---|---|---|---|
| **Bangladesh** | | | | |
| Suppliers | | | | |
| Suppliers paid with delay | 6 | 17 | 65 | 29 |
| Suppliers paid in cash (not check) | 93 | 93 | 100 | 96 |
| Suppliers paid in advance | 23 | 43 | 6 | 24 |
| Suppliers (of all traders) getting advances | 10 | 16 | 2 | 9 |
| Clients | | | | |
| Clients who paid with delay | 12 | 34 | 30 | 26 |
| Advance payments received from clients | 13 | 30 | 0 | 14 |
| Average share (of traders who received advances from clients) of the traders' clients who paid advances to the traders | 27 | 50 | | 43 |
| **China, People's Rep. of** | | | | |
| Supplier paid with delay | 70 | | … | |
| Gave advance to potato suppliers | 15 | | 0 | |
| Paid by clients with a delay | 70 | | 10 | |
| Received advance from clients | … | | 0 | |
| **India** | | | | |
| Traders who paid suppliers with delay | 95 | 10 | 60 | 56 |
| Traders who provided advances to suppliers | 30 | 68 | 47 | 44 |
| Rural brokers receiving advances from trader | 0 | 0 | 13 | 6 |
| Traders paid by their clients with delay | 93 | 95 | 57 | 76 |

… = no data available.

Second, many traders paid farmers with a delay, and thus de facto received credit from the farmers. This was so among 29% of traders (mainly urban) in Bangladesh, 70% in Gansu (mainly rural), and 56% in India (mainly rural). This goes against the conventional wisdom that traders pay "on the spot" without delay. In policy debates, this conventional view is invoked to show that traders must have an advantage with farmers, compared with modern retail and other modern actors, who are thought to always pay with a delay and thus extract de facto credit from their suppliers. In fact, the payment delay from traders is about a week, and so this system of credit during the transaction period is built on trust between trader and supplier.

Third, potato traders do not commonly receive advances from their clients—only 14% of traders in Bangladesh, none in Gansu, and 6% in India received such credit. It is more common for clients to delay payment to traders, who were thus de facto providing finance to the downstream client—this happened with 26% of clients in Bangladesh, 10% in the PRC, and 76% in India. However, the situation does not appear to have been onerous; rather, it was a regular and trusting finance relationship with a short transactional cycle. For example, a retailer got potatoes from a trader, took them to his stall, sold them over a few days, and then paid the trader for the previous lot while getting a new supply.

## Potato Traders and Other Services

Tables 8.21 and 8.22 show services other than intermediation that potato traders provided. The findings across the zones and trader types are notable primarily because of the lack of services. The services nearly all traders provided were weighing (the great majority done without an electronic scale) and sampling for quality.

**Table 8.21 Potato Traders and Other Services: Bangladesh and India**
(% of traders)

| Zone, Service | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
| **Bangladesh** | | | | |
| Picked up and delivered potatoes in own truck | 3 | 7 | 0 | 3 |
| Labeled product when sold to clients | 3 | 16 | 10 | 10 |
| Provided packing boxes/crates/bags to suppliers | 33 | 23 | 7 | 21 |
| Delivered products to buyer | 20 | 33 | 0 | 18 |
| Graded and sorted to sell to clients | 83 | 93 | 47 | 74 |
| Weighed potato when bought | 97 | 97 | 90 | 94 |
| If yes, weighed by electronic scale | 0 | 3 | 11 | 5 |
| Sampled potatoes for quality when bought | 100 | 100 | 93 | 98 |
| Weighed potatoes when sold | 100 | 97 | 93 | 97 |
| If yes, weighed by electronic scale | 0 | 3 | 4 | 2 |
| Clients sampled potatoes for quality when buying | 100 | 100 | 100 | 100 |
| **India** | | | | |
| Picked up potatoes and delivered in own truck | 79 | 53 | 0 | 48 |
| Graded and sorted potatoes for suppliers | 31 | 32 | 0 | 21 |
| Labeled potatoes | 5 | 0 | 0 | 2 |
| Provided packing boxes/crates/bags to suppliers | 58 | 16 | 0 | 30 |
| Delivered potatoes to clients' locations | 91 | 53 | 0 | 53 |
| Graded and sorted potatoes | 28 | 11 | 0 | 15 |
| Further sorted and graded supplier-graded potatoes for some clients | 2 | 5 | 0 | 2 |
| Weighed potatoes | 93 | 100 | 97 | 96 |
| If yes, share of traders who weighed on electronic scale | 75 | 26 | 31 | 49 |
| Sampled potatoes for quality | 93 | 100 | 100 | 98 |

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Table 8.21 *continued*

| Zone, Service | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
| Mean share of volume of potatoes per trader, through | | | | |
| Auction system | 3 | 15 | 7 | 5 |
| Direct sales | 97 | 86 | 94 | 95 |
| Total | 100 | 100 | 101 | 100 |
| For direct sales, mean share of volume sold per trader, through negotiations with buyers in | | | | |
| Suppliers' presence | 48 | 25 | 16 | 34 |
| Suppliers' absence | 52 | 75 | 84 | 66 |
| Total | 100 | 100 | 100 | 100 |

## Table 8.22 Potato Traders and Other Services: The PRC (% of traders)

| Location | Percent |
|---|---|
| **Gansu Traders** | |
| Used own truck to transport potato | 30 |
| Labeled potatoes before selling | 44 |
| Provided case/box to suppliers | 63 |
| Delivered potatoes to buyers | 63 |
| Sorted and selected potato before selling | 100 |
| Received potatoes already sorted by farmers and then further sorted for specific buyers | 48 |
| Marketed by auction | 0 |
| Marketed by direct sales | 100 |
| If direct marketing, was the supplier present when negotiating? | 23 |
| If the supplier was absent, share of traders who negotiated by cell phone with the supplier | 37 |
| **Beijing Wholesalers** | |
| Picked up or delivered in own truck | 90 |
| Labeled product sold to client | 3 |
| Provided packing boxes/crates/bags to suppliers | 97 |
| Delivered to the buyer's location | 40 |
| Graded and sorted potato | 80 |
| Weighed potato when bought | 100 |
| If yes, used electronic scale (share of wholesalers) | 30 |
| Sampled for quality when bought | 83 |
| Weighed potato when sold | 97 |
| If yes, used electronic scale (share of wholesalers) | 20 |
| Had clients who sampled for quality when buying | 100 |

PRC = People's Republic of China.

The other services were highly variable across trader types and sites. Picking up the potatoes from the supplier was done mainly by Beijing wholesalers and half of the Indian traders, but very little was picked up in the Bangladesh or rural PRC zones. Labeling was nearly absent except on bags of potatoes coming into

Beijing from rural PRC; there was nearly none in Bangladesh and India. In the PRC, but seldom in the South Asian zones, traders provided bags to suppliers. Grading and sorting were more commonly done except in the India case, where it was rare; in Bangladesh and the PRC, the traders often received the potatoes ungraded and graded them. Thus, the trader, rather than the farmer, captured the value differentiation profit.

In Bangladesh and the PRC, potatoes were directly marketed; in theory in India the auction system was supposed to be widely used. The Indian government introduced the auction system to provide more transparency (open price discovery). However, the survey found that the auction system was used in only 5% of the cases; in Uttar Pradesh and Delhi, direct marketing (without auction) was used for 97% of the village trader transactions, 85% of the rural wholesale market transactions, and 93% of the Delhi wholesale market (Azadpur) transactions. In 66% of the transactions, the farmer was not present during the transaction, which instead took place between intermediaries or the market-based broker, who sold the potatoes on behalf of farmers who sent their potatoes to the market by a transporter. Thus, market regulation was "on the books" but not enforced.

## Performance of the Potato Trader Segment

### Potato Traders and Quality Differentiation

Table 8.23 shows patterns across trader types and countries, and over time, in the trading of various varieties and qualities of potatoes. Several key points emerge.

**Table 8.23 Potato Traders: Variety and Quality Differentiation** (%)

| Variety and Quality | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
| **Bangladesh** | | | | |
| Traded white table potatoes (% yes ) | 83 | 100 | 100 | 94 |
| Traded red table potatoes (% yes ) | 93 | 100 | 36 | 77 |
| Traded processing potatoes (% yes ) | 47 | 40 | 20 | 36 |
| Traded seed potatoes (% yes ) | 53 | 87 | 7 | 49 |
| Change in trade in last 10 years (shares of volumes for those who sold): | | | | |
| Share of white potatoes in total sold at survey time | 65 | 66 | 98 | 76 |
| Share of white potatoes in all potatoes sold 10 years earlier | 14 | 21 | 87 | 42 |

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Table 8.23 *continued*

| Variety and Quality | Type/Location of Trader | | | |
|---|---|---|---|---|
| | Village Trader | Rural Wholesale Market | Urban Wholesale Market | All |
| **China, People's Rep. of** | | | | |
| **Gansu traders:** Average of traders' reported shares of trade volume in the last 5 years | | | | |
| Trade (not traders) in common (table) potato, 2009 | | | | 65 |
| Trade in processing potato, 2009 | | | | 20 |
| Trade in seed potato, 2009 | | | | 15 |
| Trade (not traders) in common (table) potato, 2005 | | | | 60 |
| Trade in processing potato, 2005 | | | | 18 |
| Trade in seed potato, 2005 | | | | 11 |
| **Beijing wholesalers:** (%; does not add to 100%) | | | | |
| Wholesalers that dealt in potato types in 2010 | | | | |
| Table (regular), fine quality | | | | 93 |
| Table, common (middle) quality | | | | 77 |
| Table, poor (low) quality | | | | 67 |
| Processing (variety) | | | | 0 |
| Seed potato | | | | 0 |
| Specialty potato ("Low pollution" or "Green Food") | | | | 0 |
| Wholesalers that dealt in potato types in 2005 | | | | |
| Table (regular), fine quality | | | | 87 |
| Table, common (middle) quality | | | | 77 |
| Table, poor (low) quality | | | | 60 |
| Processing (variety) | | | | 0 |
| Seed potato | | | | 0 |
| Specialty potato ("Low Pollution" or "Green Food") | | | | 0 |
| **India:** Share of traders trading in (multiple answers possible): | | | | |
| Table varieties | 100 | 100 | 100 | 100 |
| Processing variety | 2 | 10 | 50 | 22 |
| Seed potato | 39 | 5 | 0 | 9 |

First, the dramatic shift from red to white potatoes that had occurred during 1999–2009 at the level of the urban traders also occurred in the Bogra zone, but somewhat more slowly than at the national level. Thus, variety and quality changes can diffuse quickly at the urban market level, which draws on diverse zones, each changing at a different pace.

Second, the engagement of rural traders in seed potato markets varied sharply across the zones studied, apparently indicating different degrees of seed market development. Fully 87% of the traders in rural wholesale markets in Bangladesh also sold seed potatoes; the share was 39% in India and 15% in the PRC.

Third, a minority of rural traders dealt in processing potatoes: 40% in Bangladesh, 20% in the PRC, and 10% in India. This reflected the meager share of processing in the total potato economy of the economies studied (less than 5% in South Asia, about 10% in the PRC).

Fourth, several notable changes occurred during the 5-year recall period in the PRC survey. The share of traders dealing in both fine and poor quality potatoes had increased modestly, while the share dealing in common (quality) potatoes had held steady. This suggests that the consumption of potatoes was spreading into poorer consumer strata as part of the general increase in vegetable consumption and that consumers whose incomes were rising were demanding better quality potatoes.

In Gansu, the share of traders dealing in table potatoes increased from 60% in 2005 to 65% in 2009. Some of this shift may have been at least partly driven by government policy. The government-protected minimum price for potato went up on average by 84% during the period—for table potato, by 162%; for seed potato, by 55%; and for processing potato, by 100%. In 2000, the table potato price was just at the protected (minimum) price; a decade later it was 49% above the protected price. The processing potato price was 70% of the table potato price in 2000; by 2009, it was at 50% of the table potato's price. These trends may indicate why the study observed farmers and traders shifting from the processing to the fresh table potato market. Also, the premium for seed potato shrank—the ratio of the seed to the table potato price went from 2.2 to 1 in 2000, to only 1.25 to 1 in 2009.

Moreover, Gansu traders who stored table potatoes realized better prices for them than for processing potatoes. The traders' sales price of table and processing potatoes was similar during the harvest season, but then the table potato price rose more quickly than the processing potato price during the ensuing months. A lower grade may have been sold to processors later in the season. Yet despite the price premium for storing table potatoes, three times more table potatoes were sourced fresh than from storage. Interestingly, the share of processing potatoes sourced from storage was a third higher than the share of table potatoes sourced from storage, reflecting perhaps lower demand in quality by the processor firms. The lower share of sourcing table potatoes from storage could also reflect a lack of good storage facilities, as the local traders used cellars and not modern CSFs.

## Wastage among Potato Traders

Table 8.24 shows physical wastage traders reported for their last transaction, from the purchase of a lot to its full sale. Given the importance of the trader segments in the overall supply chain and the formation of food prices, the low levels of wastage are a significant finding. Moreover, this finding contradicts the conventional wisdom that wastage rates are very high in produce supply chains. The shares of wastage in the table variety form a simple average of 1.5%. An important reason for the low wastage rates is that the great majority of the potatoes were marketed in bags and bought and sold in transaction cycles of 3–7 days, so long storage at ambient temperature was avoided. As noted in the section on cold storage, even when the potatoes were stored for a long period, the loss rate was low.

**Table 8.24 Potato Wastage** (%, last transaction; all averages are means unless otherwise noted)

| Item | Type/Location of Trader | | | |
|---|---|---|---|---|
| | **Village Trader** | **Rural Wholesale Market** | **Urban Wholesale Market** | **All** |
| **Bangladesh** | | | | |
| Share of wastage | 1 | 2 | 0.29 | 1 |
| **China, People's Rep. of** (most recent full transaction of potato) | | | | |
| Gansu potato traders' share of wastage | | | | 3 |
| Beijing potato wholesalers' share of wastage | | | | 1 |
| **India** | | | | |
| Fresh potato | 0.03 | 0 | 0.2 | 0.1 |
| Potato from cold storage | 3 | 2 | 3 | 3 |

## Potato Trader Costs

Table 8.25 shows transaction costs for potato traders. Three key points emerge. First, the costs in dollars per ton roughly clustered into two sets. In Bangladesh, India (fresh and from cold storage), and rural PRC, controlling for transaction distances (20–120 kilometers), the cost per ton clustered around \$6–\$10. However, the Beijing potato trader's cost was \$45/ton, due to a fourfold greater distance (at 450 kilometers; as this was the last transaction and the survey was held in September, it was the cost of a transaction from a province close to Beijing, not from Gansu).

## Table 8.25 Variable Costs of Potato Wholesalers (last transaction)

| Cost Item | Type/Location of Trader | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Village Trader | | Rural Wholesale Market | | Urban Wholesale Market | | All | |
| **Bangladesh** | | | | | | | | |
| Distance between sales and purchase (km) | 118 | | 120 | | 28 | | 89 | |
| Cost ($/ton; % of total in parentheses) | | | | | | | | |
| Bagging | 0.88 | (11) | 0.44 | (7) | 0.15 | (4) | 0.44 | (7) |
| Loading and unloading | 0.74 | (9) | 0.44 | (7) | 1.18 | (32) | 0.74 | (12) |
| Transport of potatoes | 4.26 | (51) | 3.09 | (50) | 2.21 | (60) | 3.24 | (54) |
| Payments at checkpoints | 0.29 | (4) | 0.00 | (0) | 0.00 | (0) | 0.15 | (2) |
| Personal transport | 0.59 | (7) | 0.74 | (12) | 0.15 | (4) | 0.44 | (7) |
| Fee at market | 1.18 | (14) | 0.59 | (10) | 0.00 | (0) | 0.59 | (10) |
| Weighing fees | 0.44 | (5) | 0.74 | (12) | 0.00 | (0) | 0.44 | (7) |
| Total cost | 8.38 | (100) | 6.18 | (100) | 3.68 | (100) | 6.03 | (100) |
| **China, People's Rep. of** | | | | | | | | |
| **Gansu traders:** Cost ($/ton; % of total in parentheses) | | | | | | | | |
| Bagging and stitching at farm | | | | | | | 2.09 | (21) |
| Loading at farm | | | | | | | 1.69 | (17) |
| Transport to wholesale market | | | | | | | 1.06 | (11) |
| Payments at checkpoints or roadblocks | | | | | | | 0.00 | (0) |
| Personal transport to wholesale market | | | | | | | 0.17 | (2) |
| Fee for transaction at wholesale market | | | | | | | 0.60 | (6) |
| Weighing fees at wholesale market | | | | | | | 1.32 | (13) |
| Loading/unloading at wholesale market | | | | | | | 0.88 | (9) |
| Fee for cellar | | | | | | | 0.05 | (0.46) |
| Other expenses | | | | | | | 2.09 | (21) |
| Total | | | | | | | 9.95 | (100) |
| **Beijing Wholesalers** | | | | | | | | |
| Distance between purchase and sale (km) | | | | | | | 419.06 | |
| Time between purchase and sale (days) | | | | | | | 3.17 | |
| Cost ($/ton; % of total in parentheses) | | | | | | | | |
| Bagging and stitching | | | | | | | 7.12 | (16) |
| Loading/unloading charges | | | | | | | 2.12 | (5) |
| Transport costs | | | | | | | 32.80 | (73) |
| Road tolls | | | | | | | 1.92 | (4) |
| Personal transport | | | | | | | 0.03 | (0.06) |
| Cold storage | | | | | | | 0.00 | (0) |
| Transaction fees at the market | | | | | | | 0.00 | (0) |
| Other expenses | | | | | | | 1.23 | (3) |
| Total | | | | | | | 45.22 | (100) |

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Table 8.25 *continued*

| Cost Item | Type/Location of Trader | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Village Trader | | Rural Wholesale Market | | Urban Wholesale Market | | All | |
| **India** (% of toal in parentheses) | | | | | | | | |
| Fresh potato: Mean cost | | | | | | | | |
| Bagging | 3.78 | (30) | 0.22 | (8) | 0.22 | (4) | 1.11 | (15) |
| Loading and unloading | 0.67 | (5) | 0.67 | (25) | 3.56 | (57) | 2.22 | (30) |
| Transport of potatoes to wholesale market | 0.02 | (0.2) | 0.02 | (0.8) | 0.02 | (0.4) | 0.02 | (0.3) |
| Payments at checkpoints | 0.00 | (0) | 0.00 | (0) | 0.00 | (0) | 0.00 | (0) |
| Personal transport | 5.11 | (40) | 0.44 | (17) | 0.00 | (0 | 1.33 | (18) |
| Fee at market | 1.78 | (14) | 0.89 | (33) | 2.44 | (39) | 2.00 | (27) |
| Weighing fees | 1.11 | (9) | 0.22 | (8) | 0.00 | (0) | 0.44 | (6) |
| Other expenses | 0.22 | (2) | 0.22 | (8) | 0.00 | (0 | 0.22 | (3) |
| Total | 12.67 | (100) | 2.67 | (100) | 6.22 | (100) | 7.33 | (100) |
| Potato from cold storage: Mean cost | | | | | | | | |
| Transport of potatoes to wholesale market | 0.02 | (0.1) | 0.00 | (0) | 0.00 | (0) | 0.02 | (0.2) |
| Transport to cold storage | 0.07 | (0.3) | 0.02 | (0.2) | 0.00 | (0) | 0.02 | (0.2) |
| Fee at wholesale market | 2.89 | (13) | 4.22 | (45) | 1.56 | (70) | 2.67 | (30) |
| Fee at cold storage | 5.56 | (26) | 4.44 | (48) | 0.00 | (0) | 2.44 | (28) |
| Weighing fees | 0.22 | (1) | 0.22 | (2) | 0.22 | (10) | 0.22 | (3) |
| Other expenses | 0.89 | (4) | 0.22 | (2) | 0.22 | (10) | 0.44 | (5) |
| Loading and unloading | 5.11 | (24) | 0.00 | (0) | 0.22 | (10) | 1.33 | (15) |
| Personal transport | 6.89 | (32) | 0.22 | (2.4) | 0.00 | (0) | 1.78 | (20) |
| Total | 21.56 | (100) | 9.33 | (100) | 2.22 | (100) | 8.89 | (100) |

km = kilometer.

Second, the share of transport in total costs was more variable than the total cost. It was about 60% in Bangladesh; 13% in Gansu, but 77% for Beijing traders (given the greater distance of the average transaction); and about 20%–40% for India.

Third, the lower share of transport in India's total cost was due to a higher share of labor costs for bagging and loading (which, key informants anecdotally noted, were performed informally by strongly organized groups in the markets), and a higher share, about 30%–40%, went to market fees, versus about half that in the other zones. The market fees were relatively high in India due to the systems of licensed trader commission fees and high market taxes.

## Potato Traders' Profit Rates

Table 8.26 shows profit rates for the categories of potato traders. The rates are gross of capital amortization, which may be substantial for the more capitalized urban traders. Thus, the results overstate the truly realized profit rates of urban traders. There are few other studies to compare with these findings: one is for rice trading in Bangladesh, by Chowdhury (1992) and based on a survey in 1989/90 by the International Food Policy Research Institute (IFPRI) that focused on profit rates (and provided figures gross of capital amortization due to the difficulty of figuring amortization in this setting). The IFPRI study reported profit rates of 35% for traders in dynamic, competitive zones, and 61% for hinterland zones where competition is lower. Chowdhury (1992) argued that profit rates were relatively high to compensate for the highly risky and variable nature of returns to trading.

**Table 8.26 Potato Traders' Profit Rates (%)**

| Item | Village Traders | Rural Wholesalers | Urban Wholesalers |
|---|---|---|---|
| **Bangladesh** | | | |
| Fresh | 16 | 38 | 80 |
| Cold stored | 22 | 48 | 73 |
| **China, People's Rep. of** | | | |
| Gansu | … | … | 40 |
| Beijing | … | … | 48 |
| **India** | | | |
| Fresh | 6 | 40 | 4 |
| Cold stored | 23 | 52 | 16 |

… = no data available.

The profit rates for potato traders were thus similar, but with two exceptions. (1) Urban potato traders in Bangladesh achieved "excessive" profits compared with Beijing and Delhi potato traders (as the authors found for Delhi rice traders and Chowdhury [1992] found for hinterland traders in Bangladesh). This was possibly because, of the three megacities, Dhaka had the least developed off-season potato supply flow. In India, cold storage was more developed, and in the PRC, Beijing sourced potatoes from a number of provinces with different growing season profiles. (2) The profit rates of Delhi potato traders were relatively low, possibly because the well-developed CSF sector increased supply during the off-season and facilitated competition among traders.

# Conclusions

**Cold Storage.** The seven key messages regarding potato CSFs are as follows:

First, especially in the 1990s and 2000s, CSFs diffused rapidly in the Bangladesh and India zones. In Gansu, use of CSFs had been much more modest and recent. In India, rapidly growing potato demand from nearby Delhi, and subsidies and investment in the Agra power grid were key factors encouraging investment by the business sector (given the large investment per CSF). The PRC had a cold storage subsidy policy but it played a minor role.

Second, the farmers' rapidly increasing use of CSFs, particularly in India (Agra), and secondarily in Bangladesh, suggests that there were limited or no barriers to accessing cold storage, regardless of farm size.

Third, the survey showed strong seasonality in the use of the CSFs, and significant underuse of capacity, at only 51% in India and 84% in Bangladesh.

Fourth, while traders' value-chain financing of suppliers had largely disappeared over time, cold storage businesses were becoming important suppliers of value-chain finance to farmers.

Fifth, CSFs were becoming important points for facilitating potato exchange, supplanting wholesale markets in the India case. This is particularly interesting in a policy context in Uttar Pradesh, where the APMC Act had not been amended. The APMC Act required farmers to sell via the regulated wholesale markets, but in fact they had substantially shifted their exchanges to the CSFs. Market forces trumped the regulation.

Sixth, energy costs are very important in the CSF sector. Investment in the electricity grid was a major factor facilitating the growth of the cold storage sectors in the Bangladesh and India zones. In the future, cold storage may be vulnerable to energy cost shocks.

Seventh, the capacity of a portion of the cold storage in the South Asian sites was underused, and such facilities are likely to be nonviable. The cause appears to be overbuilding and some inefficient usage. With increasing competition in the potato market, some of the facilities may fail, and a trend toward consolidation may be apparent.

**Potato Traders.** The five key messages regarding potato traders are as follows:

First, potato traders had made substantial investments and employed significant labor. Trading had become somewhat concentrated, with the rise of large potato traders, particularly in the cities and especially in India.

Second, wastage rates were much lower than conventionally asserted.

Third, tied credit as a form of trader value-chain finance was far less important than is conventionally assumed—traders made advances to only 3% of suppliers in the PRC and 7% in India, but the share was 24% in Bangladesh. Many traders paid suppliers with a delay after the purchase, rather than all on the spot, and thus were deriving value-chain finance from farmers (rather than the other way around).

Fourth, potato traders' profit rates were similar across zones, but somewhat higher in urban and rural towns and lower in villages. The two exceptions were high profits for urban potato traders in Bangladesh and lower-than-usual profits for urban potato traders in Delhi. Both exceptions appear to be explained by the use of cold storage, which was low in Bangladesh and more developed in the India case.

Fifth, in the Bangladesh and India study zones, traders sold most of their potatoes to the nearby large cities—Dhaka and Delhi. Thus, transport costs (the bulk of marketing cost) were modest in the two zones. The costs were of course much higher in the PRC urban wholesale case, as the potato zones were much farther away from the major market.

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# 9 | Downstream—Potato Retail Transformation

For products such as potato, the conventional image of the retail sector in developing Asia is that it comprises only traditional shops, pushcarts, and wet markets. That is, it is seen as mainly in the "early stage" of retail evolution. Like food traders in general, food retailers are usually seen as charging higher prices to consumers than costs warrant. The retail sector is also evoked as offering little quality differentiation in staple products.

The food retail sector is certainly not held up as a champion of food security by finding ways to cut costs in the supply chain through inducing supply chain modernization. For example, in India, food retailing is accused of being inefficient and traditional and adding costs to food consumers; it is also seen as a key source of employment and slow to change its performance or importance. Although the emergence of supermarkets is recognized, they appear to be seen as marginal to retail in general and to food security in particular.

The study's detailed survey results examine to what extent the foregoing assumptions remain valid. The survey results explore the degree to which retail modernization, quality differentiation, and evolution of retail practices among traditional retailers had begun to emerge in potato retail in the three megacities—Beijing, Delhi, and Dhaka. This chapter discusses in detail the survey findings.

## Structure of Potato Retail

### Structure of Traditional Potato Retail

Table 9.1 shows characteristics of traditional potato retailers. These retail outlets were nearly all owned by middle-aged males, and were started on average only about a decade ago. They were typically a mix of small shops, stalls in wet markets, and pushcarts. The retailers in the study had low-to-moderate levels of education. Nearly all of them sold other food products, typically other fruits and vegetables; they did not typically sell processed foods (such as rice, noodles, and oil) along with potatoes and other vegetables. In the South Asia sites, potatoes comprised only about half of their retail sales, and in the People's Republic of China (PRC), only a fifth.

Table 9.2 shows potato sales by various measures. Daily sales were limited but differed widely across zones due to the modest differences in average scale across retailers and differences in the share of potatoes in total sales. Beijing potato retailers sold 5–10 times more per shop than did the Delhi and Dhaka potato retailers. Delhi traditional potato stalls sold about twice as much as their Dhaka counterparts.

The South Asian stores tended to have about 70–90 clients. Only a quarter to a third of the potato stalls' buyers were regular clients; this could be because the product is seasonal and perishable, so the price fluctuated over time and among sellers. The customers bought very small amounts, less than 1 kilogram (kg) in Delhi and 4 kg in Dhaka. So the trade entailed many small transactions with a fluctuating clientele.

### Table 9.1 Characteristics of Traditional Potato Retailers

| Characteristic | Bangladesh | PRC | India |
|---|---|---|---|
| Gender (% male) | 100 | … | 95 |
| Age (mean) | 37 | … | 38 |
| Education (%) | | | |
| No schooling | 15 | … | 11 |
| Primary (1–5 years) only | 41 | … | 24 |
| More than 5 years but not more than 9 | 22 | … | 25 |
| More than 9 years | 22 | … | 40 |
| Year started food retail business | 2000 | 2003 | 1997 |
| Year started potato retail business | 1999 | 2003 | 1997 |
| Also sold other food products (%) | 100 | 96 | 88 |
| Share of potato in his/her total retail sales (%) | 54 | 21 | 44 |

… = no data available, PRC = People's Republic of China.

### Table 9.2 Turnover of Traditional Potato Retailers (average)

| Turnover | Bangladesh | PRC | India |
|---|---|---|---|
| Sales per day (kg) | 26 | 256 | 53 |
| Size of last transaction (lot bought and retailed, kg) | 220 | 476 | 51 |
| Number of buyers sold to | 91 | … | 71 |
| Number of regular buyers sold to | 22 | … | 25 |
| Average quantity sold to a buyer (kg) | 3.6 | … | 0.7 |

… = no data available, kg = kilogram, PRC = People's Republic of China.

Traditional potato retailers appeared to be in close competition with their fellows. For example, in Beijing, an average potato retailer competed with 12 others in the same market or neighborhood, up from nine 5 years ago.

Table 9.3 shows measures of retail scale, in labor used, working capital, and value of retail assets. The ratios of these variables across zones and of turnover were not parallel, indicating differences in operations. All the retailers were very small operations with a few people minding the stall or shop, but the labor/turnover ratio was higher in Dhaka than Beijing, and the working capital/turnover and asset/turnover ratios were higher in Delhi. Except for India, the scale measured in terms of working capital and assets for potato stalls was only about a half to a third of those of the retail shops. (Rice retailing tended to be part of shops selling a number of other products and having more fixed installations than was the case of potato and other vegetable retailers, which usually used only a table or tarp to display the produce.) Most of the retailers in Beijing had electronic scales, a cell phone, and a business vehicle.

**Table 9.3 Labor and Capital Use per Traditional Potato Retailer**

| Labor and Capital | Bangladesh | PRC | India |
|---|---|---|---|
| Average number of people working in the business | 1.6 | 2.0 | 1.3 |
| Average amount spent on hired labor ($/month, mean) | 15.6 | 0 | 89.0 |
| Current working capital ($) | 786 | 1,433 | 6,518 |
| Retail assets in 2009 ($) | 218 | … | 2,341 |
| Share of retailers who had (%) | | | |
| Electronic scale in 2009 | … | 92 | … |
| Electronic scale at start of business | … | 65 | … |
| Mobile phone in 2009 | … | 96 | … |
| Mobile phone at start of business | … | 83 | … |
| Business vehicle | … | 89 | … |

… = no data available, PRC = People's Republic of China.

The scale of the retailers, as measured by labor, working capital, and assets, was well below that of the urban potato traders and the cold stores discussed in Chapter 8. The traditional value chain in potatoes has many small- and medium-scale farmers on one end, larger (than farmers) wholesalers and cold stores in the midstream, and many small-scale retailers at the other end. Presumably, barriers for new entrants roughly reflected the scale in each segment.

## Modern Retailers' Participation in the Potato Market

Modern retail had started to enter the food markets in the cities, and was increasing quickly (see Chapter 5). In the case of Delhi, Minten, Reardon, and Sutradhar (2010) calculated from the survey data that modern retail had about 3.3% of the potato market. While the penetration in the Beijing potato market was not measured by the current study, the survey by Goldman and Vanhonacker (2006) showed that supermarkets had about 22% of vegetable retail (versus 79% of processed and packaged retail) in 2005.

Historically, in the United States and Western Europe, modern retailing first handled processed products; fresh produce was introduced at a later stage. Supermarkets in the United States did not even sell vegetables for the first 30–40 years of their existence; the same lag was seen in Latin America in the 1990s–2000s (Reardon and Timmer 2007). Demand-side reasons for the lagged penetration of fresh produce into modern retailing include that the consumer habit of purchasing daily from wet markets wanes slowly, and supply-side reasons include that it is a slow and difficult process to improve fresh produce supply chains and marketing in order to create competitive advantages over traditional retailers who source from traditional wholesale markets. Minten and Reardon (2008) show that modern retailers start to gain price advantages over traditional retailers in fresh produce only after the supermarket sector has been developing for a number of years.

Hence for example, Mexican supermarkets in the 1990s sold very little produce and had prices well above the wet markets; this began to change only in the mid-2000s, when modern retailing started to make significant inroads into retailing fresh produce. Ho (2005) tells a similar story for Hong Kong, China (with a food culture like that of the PRC and similar to that of other Asian countries), in which supermarkets had little role in fresh produce markets in the 1980s but, by the mid-2000s, had 55% of vegetable retail.

Thus, in 10–20 years, the urban retail markets of the study zones are likely to converge with those of economies with more modernized food markets, such as Japan and Hong Kong, China. In the meantime, modern retailers will have a minor role in fresh produce markets such as for potato. During the study, the modern retailers' sales of potato were still modest. The Dhaka survey found that sales per day of fresh table potatoes by modern retail outlets were about 127 kg, the equivalent of half a wet market's daily potato sales.

# Conduct of Potato Retail

## Procurement Methods of Traditional Potato Retailers

Table 9.4 shows procurement practices of traditional potato retailers. In all study cities, the potato retailer bought potatoes directly from the wholesale market. In the PRC, 10% of the retailers bought potatoes directly from Heibei farmers who came to the Beijing markets; retailers were not buying directly from the study zone farmers in faraway Gansu.

Table 9.5 shows the transaction cycle of the retailers (from buying a lot to selling it all), the time they spend at the wholesale market, and the transport they used to get to the market and back. The time spent at the market was brief, but repeated every 1.5 days. The short transaction cycle minimizes working capital and waste, which is important in a perishable product that is not cold stored at the retail site. With transport time plus time at the market, an average potato retailer used about a day a week to buy inventory.

**Table 9.4 Procurement by Traditional Potato Retailers (%)**

| Procurement | Dhaka | Beijing | Delhi |
|---|---|---|---|
| Share bought on the wholesale market | 100 | 94 | 95 |
| Share bought from traders operating between the retailers and wholesale market or other retailers (also called semi-wholesalers) | 0 | 3 | 1 |
| Share bought directly from farmers | 0 | 10 | 0 |

PRC = People's Republic of China.

**Table 9.5 Traditional Potato Retailers' Procurement Methods**

| Procurement Information | Bangladesh | PRC | India |
|---|---|---|---|
| Time between purchase and complete sale (days) | 1.40 | 4.41 | 1.50 |
| Total time at place of purchase (minutes) | 65 | 136 | 117 |
| Means used for transport and share (%) | | | |
| Motorized transport | 36 | 0 | 79 |
| Bus | 0 | 3 | 0 |
| Car | 0 | 74 | 0 |
| Motorbike | 0 | 11 | 0 |
| Animal-drawn cart | 0 | 5 | 4 |
| Motorcycle/bike | 8 | 0 | 17 |
| On foot/with cart | 56 | 7 | 0 |
| Share of retailers who paid (third party) for transport (%) | 71 | 41 | 81 |

PRC = People's Republic of China.

Many small-scale Dhaka retailers bought potatoes by walking or going by animal-drawn cart to the wholesale market. Beijing retailers mainly used a car, and Delhi retailers primarily used motorized tricycles.

About 12% of potato retailers in Bangladesh arranged for the price and quality of their purchase by cell phone; in the PRC it was 15%, and in India, 63%. This provided a rough measure of potential price arbitrage and price discovery, and of the importance of cell phones. The use of the cell phone to arrange a deal was relatively low in rice (Chapter 5), and was low in Dhaka and Beijing for potato, but high in Delhi. As the retailers (and traders) usually had cell phones, it appears odd that deals were not arrived at in advance. The most probable explanations are that (1) potato freshness and quality can vary significantly, and the retailers may have needed to see the quality of the potato and negotiate the price; and (2) retailers bought frequently, and negotiating prices and delivery each time would be costly per transaction, but the frequent visits to the wholesale markets (nearly two dozen per month for the Delhi and Dhaka retailers) would keep retailers apprised of prices as they evolved.

Table 9.6 shows retailers' assessments of quantity information available during their last purchase of potatoes from a wholesaler. Most of the retailers in Delhi and Dhaka reported getting enough information, but very few did in Beijing. In all three cities, most of the retailers reported knowing the quantity, and usually the lot was weighed in front of them, on an electronic scale. However, retailers (in Beijing and Dhaka, but not in Delhi) generally felt they were being cheated by the seller using a rounding off tactic to charge a little bit more than the quantity in the bag.

Table 9.7 shows that most of the retailers in Dhaka, but only half in Delhi, felt they had sufficient information on potato quality before the transaction. The data show that most retailers checked at least part of the lot.

**Table 9.6 Traditional Potato Retailers: Information and Quantity Assessment in the Last Transaction** (% of retailers)

| Retailers' Information | Bangladesh | PRC | India |
|---|---|---|---|
| Felt they had enough information on quantity of produce in the lot, before buying | 68 | 3 | 63 |
| Felt they knew the exact weight of the lot | 99 | 86 | 88 |
| Lot weighed in front of them | 79 | 99 | 82 |
| Bought from seller using electronic/mechanical scale | 91 | 66 | 73 |
| Felt seller used "rounding off" tactic to charge more than was in the bag | 64 | 92 | 11 |

PRC = People's Republic of China.

**Table 9.7 Traditional Potato Retailers: Information and Quality Assessment in the Last Transaction** (% of retailers)

| Retailers' Information | Bangladesh | India |
|---|---|---|
| Had sufficient quality information before the transaction | 73 | 53 |
| Had checked quality | 87 | 94 |
| Checked only part of the lot | 100 | 83 |
| Believed the part checked was representative of the lot | 100 | 95 |

## Traditional Potato Retailers and Value-Chain Finance and Home Delivery

Table 9.8 tests two common assumptions about traditional produce retail—that potato retailers often allow clients to buy on credit, and that retailers often deliver purchases to clients' homes. The survey results show that potato retailers provided little credit to consumers, except in Dhaka, and there only half of the retailers provided credit. The survey did not gather information on what share of the clients got this credit, but if the situation was like that of rice, then only a subset of the clients would have been allowed to pay later, and the share of consumers getting credit would have been a minority. In Beijing and Delhi, only a minority of retailers provided credit to consumers, and very few consumers could avail of it. Few retailers got de facto credit by paying suppliers late, except in Dhaka.

The last row of Table 9.8 negates the common assumption that potato retailers delivered to consumers' homes. Very few retailers did so in Delhi or Dhaka, and only a third of retailers did in Beijing. Because the Beijing retailers were doubtless delivering only to a portion of their clients, the practice was limited.

**Table 9.8 Traditional Potato Retailers' Credit with Suppliers and Customers, and Home Delivery** (%)

| Credit and Delivery | Bangladesh | PRC | India |
|---|---|---|---|
| Suppliers paid by retailer with delay (on credit) | 67 | 1 | … |
| Retailers that paid suppliers later (on credit) | … | 6 | 17 |
| If credit was provided, share of payment on credit | 64 | … | … |
| Retailers giving credit to consumers (for delayed payment by consumer) | 53 | 28 | 16 |
| Share of all customers that paid on credit (paid later) | … | 1 | … |
| Retailers that home-delivered | 0 | 34 | 5 |

… = no data available, PRC = People's Republic of China.

# Performance of Traditional Potato Retail

## Costs and Wastage of Traditional Potato Retailers

Table 9.9 shows variable costs for the last transaction and operating costs that are fixed over the year (exclusive of amortization of capital). The two largest items for the traditional potato retailer were transport (at 61% in Dhaka, 36% in Beijing, and 32% in Delhi), and fees and commissions (9% in Dhaka, 16% in Beijing, and 36% in Delhi). The figure that stands out is the high share of fees in Delhi. The Agricultural Produce Marketing Committee Act (known as the APMC Act) that regulated the wholesale market made mandatory several fees: the fee for market use, the commission to the licensed wholesaler, weighing fees paid to inspectors at the market who observed the weighing of the product and gave a chit against that, and fees for using the retail space. This set of fees and mandated commissions were more than traditional retailers in Dhaka and Beijing paid—but the services received by Delhi retailers in the market exchanges did not appear to be commensurately more in return. The differences in variable costs per ton for the last transaction of potato in Dhaka, Beijing, and Delhi ($9, $22, and $50) were of roughly the same order as the variable costs of retailers in those cities for their last transaction of rice. Given that distances and transaction waiting times were roughly similar across the cities, and all three were congested, it appears that the differences in cost were due to the costs of transport. (In Dhaka, only 36% of transport was by motor vehicle versus 88% in Beijing and 79% in Delhi, as indicated in Table 9.5). Transport (including fuel) was the most important cost in the midstream and downstream portions of the food value chains. Because fuel costs are directly linked to food security, this may be an important area for future policy analysis.

**Table 9.9 Traditional Potato Retailers' Costs**

| Cost Element | Bangladesh | PRC | India |
|---|---|---|---|
| Variable costs in last transactions (%) | | | |
| Bagging | 0 | 6 | 2 |
| Labor to load/unload | 24 | 6 | 27 |
| Transport from supplier to retailer | 54 | 14 | 28 |
| Personal transport from place of purchase to retailer | 7 | 22 | 4 |
| Fee at wholesaler in market or to broker that brought from source | 1 | 16 | 11 |
| Commission to wholesaler | 4 | 0 | 9 |
| Weighing fees | 3 | 0 | 7 |
| Fee at retail place | 1 | … | 5 |
| Transformation fees | … | … | 4 |
| Miscellaneous | 5 | 17 | 3 |
| Total variable costs | 100 | 100 | 100 |
| Variable cost per ton ($) | 9.34 | 21.50 | 50.00 |
| Operating costs per year ($) | 407 | 2,813 | 1,234 |

… = no data available, PRC = People's Republic of China.

Contrary to the strongly held assumption that there are high rates of wastage in produce value chains in Asia, the survey data showed that the retail segment entailed very low wastage rates—2% in Bangladesh, 5% in the PRC, and 3% in India. Reasons include that the retail lots were small, were not stored long at ambient temperature, and were moved in short transaction cycles.

Retailers informed the survey that little of the potato had to be discarded due to damage from handling or reduced in quality from storage to sale. Some value could be lost due to declining freshness or surface damage from rough handling, but this value reduction was minor. Retailers in Delhi and Dhaka reported that loss of quality in potatoes unsold in about a week forced them to reduce the price by about 10% toward the end of each transaction cycle so they could sell the remaining potatoes.

## Potato Quality Differentiation and Dynamics among Traditional Retailers

Table 9.10 shows dynamics in quality, variety, and packaging as shares of sales. In Dhaka, the share of white potatoes rose rapidly to dominate sales in 2009. White potatoes had displaced red ones due to a significant yield advantage. In the production zone under study, the choice of variety had shifted toward diamond from granola for disease resistance, but at the national level the shift had been in the opposite direction, for taste reasons.

In Beijing, the share of fine grade potatoes rose modestly, from 9% to 14% of sales, but the middle grade of potato remained the most common type available. While rice retail had shifted from loose to packaged, almost all

**Table 9.10 Traditional Potato Retail: Quality, Variety, and Packaging**
(% of type of potato in all potatoes sold)

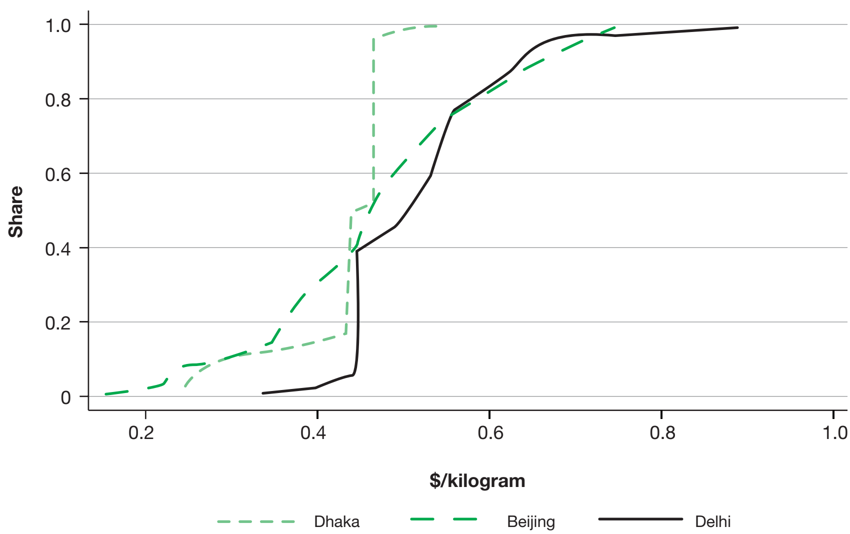
| Zone, Type, Quality, and Packaging | Earliest Year | Latest Year |
|---|---|---|
| **Bangladesh** | **1999** | **2009** |
| Share of white potatoes in all potatoes | 73 | 95 |
| Share of diamond variety in all white potatoes sold | 69 | 84 |
| **China, People's Rep. of** | **2004** | **2009** |
| Fine (grade) | 9 | 14 |
| Middle (grade) | 87 | 78 |
| Poor (grade) | 4 | 8 |
| Loose | 96 | 95 |
| Packaged with company name | 0 | 0 |
| Packaged without company name | 4 | 5 |

potatoes were sold loose. Potatoes are not likely to be packed (except in wide mesh) even in the medium term, as consumers are used to inspecting and choosing each potato from bulk bins or tables in the wet markets.

Potato prices varied significantly in all three zones, often linked with quality differentiation. To determine the variation, retailers were asked about prices and quality indicators pertaining to the grade, variety, and appearance of the potatoes they were selling and whether they were packaged or loose. These prices were then converted to United States dollars using the official exchange rates at the time.

Figure 9.1 shows cumulative density functions for the prices. The figure shows that price variation was much lower in Dhaka than either Beijing or Delhi. Only 4% of the potatoes in Dhaka sold for more than $470/ton, versus 44% in Beijing and 61% in Delhi. The slope of the distribution is much steeper in Dhaka than in the other two cities, reflecting less variation in Dhaka. This might be driven by the greater quality differences in Delhi and Beijing. In Dhaka, only red and white potatoes from cold storage were in the market at the time of the survey, with little price difference between them. The Delhi market had higher-priced fresh potatoes, supplied by hill states, in addition to potatoes from storage.

**Figure 9.1 Potato Price Variation in Beijing, Delhi, and Dhaka: Cumulative Density Functions of the Traditional Retail Price of Potato**



## Seasonal Prices and Margins of Traditional Potato Retailers

Table 9.11 shows significant seasonal variation in the absolute and relative margins traditional potato retailers achieved. In general, the relative margins varied inversely with the amount of potato being sold on the market; thus, retailers had lower margins for cold-stored potatoes during the off-season and higher margins at the lower volume time before the fresh harvest.

The relative margins varied in India from a high of 41% during the Agra harvest period (when volume was lower, see the trader results discussed earlier), to 24%–27% during the higher volume quarters of April–September (when potatoes were being withdrawn from cold storage). When the volume waned, the relative margin returned to 40% in October–December. That is, the margin varied positively with scarcity. The findings for Bangladesh and the PRC were similar, but the patterns were less pronounced for the PRC case, because potatoes came into Beijing from different regions during most of the year.

**Table 9.11 Margins of Traditional Potato Retailers** ($/ton)

| Zone, Season/Month | Absolute (sales price–purchase price in $/ton) | Relative ([sales price/purchase price] [100}-100, in %) |
|---|---|---|
| **Bangladesh** | | |
| Oct–Nov 2008 | 29.4 | 21.0 |
| Dec–Jan 2009 | 37.4 | 15.9 |
| Feb–Mar 2009 | 26.7 | 15.3 |
| Apr–Jun 2009 | 33.4 | 15.9 |
| Jul–Sep 2009 | 33.4 | 11.7 |
| Oct–Nov 2009 | 36.0 | 10.5 |
| **China, People's Rep. of** | | |
| Jun–Jul 2010 | 64.2 | 17.3 |
| Apr–May 2010 | 43.3 | 10.7 |
| Feb–Mar 2010 | 55.8 | 14.1 |
| Dec–Jan 2010 | 61.4 | 15.9 |
| Nov 2009 | 36.3 | 10.9 |
| Oct 2009 | 51.6 | 17.4 |
| Aug–Sep 2009 | 60.0 | 21.3 |
| Average | 53.0 | 15.4 |
| **India** | | |
| Oct–Dec 2008 | 58.4 | 39.7 |
| Jan–Mar 2009 | 50.4 | 41.4 |
| Apr–Jun 2009 | 62.4 | 27.2 |
| Jul–Sep 2009 | 84.6 | 23.5 |

Table 9.12 shows profit rates for traditional potato retailers. Because capital amortization could not be included, the profit rates are somewhat overstated. That bias was smaller for the small retailers than for traders and cold storages, which had a much higher capital/labor ratio. The profit rates in Delhi and Dhaka were a bit higher for potato than was the case for rice and were higher than in Beijing, where the profit rates for potato and rice were the same. Retailers' profit rates were somewhat lower than traders' profit rates, and much lower than the rice retail profit rates calculated by Chowdhury (1992) from survey data in 1989–1990 by the International Food Policy Research Institute. There is a dearth of case studies with which to compare these findings, but they appear reasonable relative to the other findings in this study and the Chowdhury study.

**Table 9.12 Traditional Potato Retailers' Profit Rates**

| Location | Profit (%) |
|---|---|
| Dhaka | 37 |
| Beijing | |
| Overall (all qualities) | 20 |
| Fine quality | 36 |
| Medium quality | 5 |
| Poor quality | 10 |
| Delhi | 32 |

## Potato Price Comparisons between Modern and Traditional Retailers

Table 9.13 compares potato prices of modern and traditional retail in Delhi. In Delhi, potato prices were lower at modern retail outlets than from pushcarts (their nearest competitor) and wet markets. This is an important result, as modern retailing in Delhi was still at an early stage of marketing the most important vegetable staple in India. The implication is that modern retailing can bolster the food security of the urban poor. However, in Beijing, supermarkets sold medium (quality grade) potatoes at a higher price ($653 per ton) than did traditional stalls ($447 per ton).

**Table 9.13 Potato Price Difference: Modern versus Traditional Retail, India**

| | | | | Price Difference with Modern Retail | | | |
|---|---|---|---|---|---|---|---|
| | Observations | Mean ($/ton) | Std. Error | Mean ($/ton) | Std. Error | t-Value | Pr (\|T\|>\|t\|) |
| Modern retail | 84 | 139 | 0.13 | | | | |
| Pushcarts | 158 | 156 | 0.13 | 17 | 0.20 | 3.922 | 0.000 |
| Wet markets | 289 | 168 | 0.17 | 29 | 0.32 | 4.185 | 0.000 |

… = no data available, Pr = probability, Std = standard.

Table 9.14 reports hedonic price regressions for modern versus traditional potato retail in Delhi. The hedonic price regression methodology was used to regress the retail price per kilogram on categorical variables for the type of retail outlet, the quality of the product, the ward (which controls for both location and time, as the survey was rolled out over a month across wards), a wealth indicator of the colony (a subdivision of a ward) to control for local potential demand factors, and a branding dummy. The hedonic price regression shows that both private sector modern retail and cooperative modern retail were cheaper than the traditional shops.

**Table 9.14 Hedonic Potato Price Regression Results: India**

| Condition | Value |
|---|---|
| Dependent variable (Rs/kg) | |
| Version 1* | |
| Modern retail dummy | |
| Coefficient | -0.44 |
| t-value | -1.72 |
| Wet market dummy | |
| Coefficient | 0.51 |
| t-value | 2.57 |
| Number of observations | 522 |
| $R^2$ | 0.25 |
| Modern retailers versus pushcarts, F test, 2.95, probability > F = 0.09 | |
| Modern retailers versus wet markets, F test, 11.05, probability > F = 0.00 | |
| Version 2* | |
| Private–Modern retail dummy | |
| Coefficient | -0.28 |
| t-value | -1.11 |
| Cooperative–Modern retail dummy | |
| Coefficient | -0.89 |
| t-value | -1.50 |
| Wet market exit interview dummy | |
| Coefficient | 1.45 |
| t-value | 4.79 |
| Wet market trader interview dummy | |
| Coefficient | -0.36 |
| t-value | -2.11 |
| Number of observations | 522 |
| $R^2$ | 0.32 |
| Private–Modern retailers versus pushcarts, F test, 1.24, probability > F = 0.27 | |
| Private–Modern retailers versus exit interview wet markets, F test, 24.16, probability > F = 0.00 | |
| Private–Modern retailers versus wet market trader interview, F test, .09, probability > F = 0.76 | |
| Private–Modern retailers versus exit interview wet markets, F test, 1.08, probability > F = 0.30 | |
| * P in Rs/kg = f(retail outlets, quality/branded indicators, ward dummy, wealth colony dummy) | |
| Only retail outlet coefficients are reported. | |
| Pushcart prices are the default. | |

kg = kilogram, Rs = Indian rupees.

Table 9.15 further explores the price differences using propensity score matching probit regressions; these were run with dummy variables of potatoes sold in supermarkets coded as 1 and potatoes sold in traditional retail outlets coded as 0, as dependent variables. The controls included measures for quality, labeling, quantities sold, ward dummy variables, wealth dummy variables per colony, and an intercept. Using the results of these regressions to construct a propensity score, the table shows the propensity score matching impact estimates on prices for potato comparing modern retail (treated) with traditional markets (control). The table presents the results of the unmatched sample and the average treatment effect for the treated (ATT).

**Table 9.15 Propensity Score Matching Results of Potato Price Comparisons: Modern versus Traditional Retail in India**

| Sample | Treated (modern) | Controls (traditional) | Difference | Std. Error | t-Statistic |
|---|---|---|---|---|---|
| Unmatched | 6.23 | 7.31 | -1.07 | 0.27 | -3.98 |
| ATT | 6.27 | 6.77 | -0.50 | 0.49 | -1.03 |
| Number of observations | 41 | 431 | | | |

ATT = average treatment effect for the treated.

The table shows that that potatoes were less expensive in modern retail in unmatched samples, but that modern retail was not significantly less expensive for similar products, i.e., the matched samples, as shown by the smaller t-values for the ATT compared with unmatched sample. The price differences of similar products in modern compared with traditional retail was 7% for potato. In sum, after controlling for confounding factors, potatoes were not more expensive in modern retail no matter which method is used.

# Conclusions

First, as revealed by the detailed survey, actual traditional potato retailing was somewhat different from the traditional images and assumptions, although not to the same extent as for rice retail. Traditional potato retailing was evolving toward greater quality differentiation; however, unlike rice, there was still nearly no packaging or brand development.

Second, several common assumptions about potato retailer services were proven wrong. Traditional retailers provided very little value-chain finance by letting customers buy on credit, and they did little home delivery. In that sense, they did not have advantages over modern retailing. Traditional retail had locational advantages, which are likely to wane over time as modern retail outlets spread.

Third, modern retail had just started to market potatoes in the urban study zones. While supermarkets still charged more for potatoes in Beijing, they did not charge more than traditional retailers in Delhi. This suggests that, for price and food security reasons, modern retail will probably make inroads into the potato markets in these economies during the next decade or so.

Fourth, governments had generally not played a direct role in transforming the retailing of potatoes in the study zones. The exception was government facilitation and initial leadership for promoting modern cooperative retailing in India (Reardon and Minten 2011), which is now gradually penetrating the potato retail market.

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* ADB recognizes this member by the name People's Republic of China.
** ADB recognizes this member by the name Hong Kong, China.

# 10 | Performance of the Potato Value Chain—Rewards, Costs, and Margins

This chapter presents findings on the distribution of costs, rewards, and overall margins across the value-chain segments, and the composition of value-chain costs in terms of functional categories (such as labor, transport, and wastage).

## Costs, Rewards, and Overall Margins in the Potato Value Chain

Tables 10.1–10.3, for Bangladesh, the People's Republic of China (PRC), and India, show value-chain segments' shares in total costs and rewards in the overall potato value chain. The chains for Bangladesh and India include harvest and off-seasons because of the significant amount of potato cold storage in these two study zones. Only the harvest season is shown for Gansu in the PRC, because little of the potato was stored in that zone.

Rewards are calculated as gross price less costs per kilogram. For farmers, the rewards are further divided into rewards to farm operation and to cold storage. The assumption is that, had farmers not stored their potatoes, they would have received the same rewards during harvest and off-harvest periods. The additional rewards earned in the off-harvest period were thus due to cold storage. For wholesalers and retailers, the rewards are the difference between the sales and purchase prices per kilogram of potato. For farmers, traders, and retailers, costs comprise nonlabor (purchased) operational costs, wage (hired) labor costs, all costs incurred in marketing, and physical wastage per kilogram of potato produced and distributed. Storage costs for rural traders are subsumed in their nonlabor operational costs. For farmers, the storage costs are broken out as a separate category of costs. Storage costs paid by farmers are the gross income of cold stores. Total gross income (per kilogram) is calculated as the sum of rewards and costs.

In general, the tables show that the farmers' share in the potato value chains' total value added was higher than typically viewed, (1) partly due to disintermediation in the potato chain with a reduction of the role of village brokers, a rise in the role of sales at cold stores to traders, and increased sales directly to wholesale markets and interprovince or interstate traders; and (2) partly as a result of farmers storing potatoes. However, cold stores, traders, and urban retailers had gained shares in the value chain transformation process relative to traditional value chains, where farmers sold directly to local consumers and rural markets. Results by country are discussed below and then compared.

**Bangladesh.** In both seasons, the Bogra farmers took the preponderant share of the urban retail price (total margins), reaching 69% in the harvest season and 77% in the off-harvest season (Table 10.1). The main reason for the increase in the off-season was the farmers' rewards for storage, which were substantial—the farmers captured 43% of rewards in the total value chain just from selling in the off-harvest season after storing. They also bore 23% of the value chain's costs by their storage expenditure.

**Table 10.1 Shares of Rewards, Costs, and Total Margins in the Potato Value Chain from Bogra to Dhaka in Bangladesh, Harvest and Off-Season Periods**

| Item | Harvest (March) | | | Off-Season (October) | | |
|---|---|---|---|---|---|---|
| Average retail price of potato in Dhaka (in $/ton) | 233 | | | 359 | | |
| **Share of rewards, costs, and total margins accruing to** | **Rewards** (% of total rewards in VC) | **Costs** (% of total costs in VC) | **Total Margins** (% of retail price in Dhaka) | **Rewards** (% of total rewards in VC) | **Costs** (% of total costs in VC) | **Total Margins** (% of retail price in Dhaka) |
| Farmers (%) | | | | | | |
| For production | 54 | 85 | 69 | 30 | 64 | 43 |
| For storage | 0 | 0 | 0 | 40 | 25 | 34 |
| Total | 54 | 85 | 69 | 70 | 89 | 77 |
| Wholesalers (%) | | | | | | |
| Rural wholesalers | 9 | 7 | 8 | 5 | 5 | 5 |
| Urban wholesalers | 17 | 4 | 11 | 9 | 3 | 6 |
| Urban traditional retailers (%) | 20 | 4 | 12 | 16 | 3 | 11 |
| Total % (parentheses show % of Dhaka retail price) | 100 ( 55) | 100 (45) | 100 (100) | 100 ( 62) | 100 ( 38) | 100 (100) |

VC = value chain.

By contrast, the wholesalers' share of total margins was only 19% in the harvest season and 11% in the off-season. Urban retailers had only 12% of the total margin in the harvest season and 11% in the off-season. Thus, their combined share of the total margin for the postharvest segments was 31% in the harvest season and 22% in the off-season. The cold storage cost borne by the farmers was also the income share of the cold storage segment. The share of total margins can be approximated as the share of costs in the total margin (about 38%) multiplied by the cold stores' share in costs (23%), or about 9%. Hence, all the postharvest actors captured about 30% of the total margins in the off-season and 31% in the harvest season.

**The People's Republic of China.** In Gansu (Table 10.2), during the harvest season (when the great majority of potato is sold), the farmers' share in the urban retail price (total margins) was 60%. By contrast, the wholesalers' share of total margins was 26%, and their share of costs was 27%. The share of urban retail in the total margin was 14%. The postharvest share of the Gansu–Beijing potato value chain was thus about 40%.

**Table 10.2 Shares of Rewards, Costs, and Total Margins in the Potato Value Chain from Gansu to Beijing, Harvest Season**

| Item | Rewards | | Costs | | Total Margin | |
|---|---|---|---|---|---|---|
| Farmers | | | | | | |
| For production | 73 | | 56 | | 60 | |
| For storage | 0 | | 0 | | 0 | |
| Total | 73 | | 56 | | 60 | |
| Wholesalers | | | | | | |
| Rural wholesalers | 5 | | 11 | | 9 | |
| Urban wholesalers | 19 | | 16 | | 17 | |
| Urban traditional retailers | 3 | | 18 | | 14 | |
| Total (parentheses show shares of Beijing retail price) | 100 | (25) | 100 | (75) | 100 | (100) |

Note: The assumption is that farmers sell immediately after harvest with barely any storage in the cold storages. Margins received by each agent across the value chain add up to the final retail price, which is equal to CNY2.9/kilogram.

**India.** In both seasons, the Agra potato farmers' share in the urban retail price (total margins) was just over half (57% in the harvest season and 52% in the off-season) (Table 10.3). Thus, the farmers got a little less and the wholesalers and retailers slightly more of the margin during the off-season than during the harvest season. The farmers captured 49% of rewards in the total value chain in the off-season, just from selling after storing. The farmers also bore 19% of the value chain's costs by so doing.

**Table 10.3 Shares of Rewards, Costs, and Total Margins in the Potato Value Chain from Agra to Delhi, Harvest and Off-Harvest Periods**

| | **Harvest Season** (Jan–Mar 2009) | | | **Off-Harvest Season** (Jul–Sep 2009) | | |
|---|---|---|---|---|---|---|
| **Average retail price of potato in Delhi ($/ton)** | 149 | | | 478 | | |
| **Share of rewards, costs and total margins accruing to** | **Rewards** (% of total rewards in value chain) | **Costs** (% of total costs in value chain) | **Total Margins** (% of average retail price in Delhi in this period) | **Rewards** (% of total rewards in value chain) | **Costs** (% of total costs in value chain) | **Total Margins** (% of average retail price in Delhi in this period) |
| Farmers | | | | | | |
| For production | 66 | 49 | 57 | 15 | 21 | 18 |
| For storage | 0 | 0 | 0 | 49 | 19 | 34 |
| Total | 66 | 49 | 57 | 64 | 40 | 52 |
| Wholesalers | | | | | | |
| Rural wholesalers | 13 | 11 | 12 | 10 | 14 | 12 |
| Urban wholesalers | 11 | 8 | 9 | 12 | 11 | 12 |
| Urban traditional retailers | 10 | 32 | 21 | 15 | 35 | 24 |
| Total rewards costs and total margins in the value chain (parentheses show share of Delhi retail price) | 100 (45) | 100 (55) | 100 (100) | 100 (61) | 100 ( 39) | 100 (100) |

Rural and urban wholesalers' combined share of total margins was 21% in the harvest season and 24% in the off-season. Urban retailers in Delhi had similar percentages, at 21% of the total margin in the harvest season and 24% in the off-season. Thus the postharvest segments' share of the total margin was about 42% in the harvest season and 48% in the off-season. (This increased to about 60% if the cold stores' share was added, weighted by half the share of costs in margins.)

**The Three Zones.** In general, farmers' shares of the margins ranged from just over half in India to almost three-quarters in Bangladesh. Wholesalers' shares (combined rural and urban) ranged from about 15% in Bangladesh to 26% in the PRC. Traditional retailers' shares ranged from about 10% in Bangladesh to 23% in India. In addition, several specific points stand out.

First, farmers in both India and Bangladesh earned rewards for storage of potatoes when selling in the off-season. That effect was strong: for example, in India, through storage, farmers captured fully 49% of all the rewards in the value chain during the off-season. Farmers' cold storage costs comprised a major share of total value chain costs in the off-season: 23% in Bangladesh and 19% in India. The counterpart of these costs was, of course, gross incomes for cold storage facilities.

However, there is a difference between how cold storage affected farmers' shares of the total margins in Bangladesh and in India. In India, in both seasons, the farmers received only just over half of the urban retail price (total margins)—57% during the harvest season to 54% in the off-season. By contrast, the farmers in Bangladesh gained a slightly higher share of total margins in the off-season than during the harvest season.

Second, the wholesalers had a larger share of total margins in the PRC case (at 26% during the harvest season) compared with Bangladesh (20% in the harvest season, and 12% in the off-season) and to a lesser extent with India (21% in the harvest season, 23% in the off-season). This is primarily because the supplying zone, Gansu, is 4–5 times farther from the urban retailers in Beijing than the Bangladesh and Indian supply zones are from Dhaka and Delhi. Yet the PRC potato-chain costs were only about twice those in Bangladesh ($25/ton from Gansu to Beijing versus $13/ton from Bogra to Dhaka). Thus, the cost per ton per kilometer in the PRC was actually half that in Bangladesh.

Third, potato retailers in Delhi had a much greater share of total margins (23%) than did those in Dhaka (at only 12% in the harvest season and 8% in the off-season) and Beijing (at only 14%). This may be evidence that Delhi potato retailers exert market power (that is, the ability to influence the price of potato due to their control over its supply). It could also be evidence of relative inefficiency, but the potato retail operation in all three cities was performed in a similar way, with short periods of several days of inventory cycles, short distances to procure potatoes, and similarly small scales of operation.

## Cost Items in the Potato Value Chain

Tables 10.4–10.6 show cost items in the potato value chains in the three zones studied.

**Bangladesh.** Table 10.4 shows several striking findings about the composition of costs in the Bangladesh potato value chain. As costs made up roughly 40% of the margins of the potato value chain, the share of a particular cost item, multiplied by 40%, gives a rough idea of that item's impact on the cost to the potato consumer.

### Table 10.4 Shares of Cost Items in the Total Cost of the Potato Value Chain in Bangladesh, Harvest and Off-Season Periods

| Cost Item | Harvest (March) | Off-Season (October) |
|---|---|---|
| Producer's input purchases (all purchased inputs other than land and labor; Tk3.96/kg) | 44 | 34 |
| Producer's rental costs (Tk0.53/kg) | 6 | 5 |
| Producer's wage labor costs (Tk1.60/kg) | 18 | 14 |
| Costs for cold storage (Tk2.40/kg) | . . . | 21 |
| Wastage cost for the whole chain (Tk0.56/kg at harvest; Tk0.89/kg during off-season) | 6 | 8 |
| Transport costs in whole chain (Tk0.88/kg) | 10 | 8 |
| Trader's wage labor costs (Tk0.28/kg) | 3 | 2 |
| Market Fees (Tk0.16/kg) | 2 | 1 |
| Weighing fees (Tk0.05/kg) | 1 | 0.43 |
| Operational costs of trader (Tk0.80/kg) | 9 | 6 |
| Other costs borne by trader (Tk0.09/kg) | 1 | 0.6 |
| Total | 100 | 100 |

. . . = no data available, kg = kilogram, Tk = taka.

### Table 10.5 Shares of Cost Items in the Total Cost of the Potato Value Chain in the PRC, Harvest Season

| Cost item | Percent |
|---|---|
| Producer's inputs (all purchased inputs other than land and labor; CNY0.47/kg) | 35 |
| Producer's wages (for hired labor)[a] | 0 |
| Wastage costs in the whole chain (CNY0.10/kg) | 7 |
| Wage costs of traders (CNY0.15/kg) | 11 |
| Transport costs for the whole chain (CNY0.42/kg) | 31 |
| Market fees (CNY0.10/kg) | 7 |
| Weighing fees (CNY0.01/kg) | 1 |
| Traders (wholesalers and retailers) operational costs (includes electricity, telephone/fax, and stall rents but not transport; CNY0.10/kg) | 8 |
| Total (CNY1.36 /kg) | 100 |

CNY = yuan, kg = kilogram, PRC = People's Republic of China.
[a] Hired labor is only 2% of the level of family labor, so this was assumed to be near zero.

The highest single cost item was the farmers' purchased inputs, at about 40% of value-chain costs and thus with a rough impact of 16% on the consumer price.

Next was the cold storage, at 21% of costs in the off-season. Chapter 8 noted that about two-thirds of potatoes in Dhaka came from cold stores and that energy comprised fully 63% of the cold storage operating costs. Thus, 15% of the potato value-chain costs and about 6% of the potato price was directly

**Table 10.6 Shares of Cost Items in the Potato Value Chain from Agra to Delhi, Harvest and Off-Season**

| Cost Item | Harvest (March) | Off-Season (October) |
|---|---|---|
| Producer's inputs (all purchased inputs other than land and labor; Rs1.07/kg) | 26 | 14 |
| Producer's rental (rented-in land; Rs0.56/kg) | 14 | 7 |
| Producer's wages (hired labor; Rs0.23/kg) | 6 | 3 |
| Storage (Rs2.40/kg) | . . . | 32 |
| Wastage (Rs0.76/kg for off season; Rs0.09/kg for harvest season) | 2 | 9 |
| Transport (Rs0.40/kg ) | 10 | 5 |
| Wage costs of traders (hired labor; Rs0. 50/kg) | 12 | 7 |
| Market Fees (Rs0.50/kg) | 12 | 7 |
| Weighing fees (Rs0.20/kg) | 5 | 3 |
| Traders (wholesalers and retailers) operational costs (electricity, telephone, fax, permanent employees; Rs0.35/kg) | 9 | 5 |
| Other costs of traders (Rs0.16/kg) | 4 | 2 |
| Total | 100% | 100% |

. . . = no data available, kg = kilogram, Rs = rupees.

affected by energy costs in cold storage. This applies to two-thirds of the potatoes consumed in Dhaka and is an important fact, given the recurrent energy crises.

The third-ranked factor was the wage of hired labor. In the whole system, wages comprised roughly 18%–20% of costs (excluding cold storage labor costs), and thus had about an 8% impact on prices. In Bangladesh, rising wages, improved incomes, and demand pressure from the nonfarm sector will affect labor costs in the potato value chain, probably leading to a continued drive for farm mechanization to reduce the labor demand.

Transport ranked fourth, with only 9% of total costs (and an impact of about 3% on retail prices). This is relatively modest because of Bogra's proximity to Dhaka. Trucks leaving Bogra around midnight reach Dhaka wholesale markets in the early morning for the prime sales time. Transport costs were equivalent to $13/ton, which was relatively low, given that the potato price was about $233/ton in the harvest season and $359/ton otherwise.

Fifth, physical wastage was 7% from harvest to retail. This was well below the levels of 30%–40% often asserted in food policy circles (Mattoo, Mishra, and Narain 2007). The lower importance of wastage and transport costs that the study found may be due to the development over time of better infrastructure (cold storage and road infrastructure) in the area studied and the spread of the mobile phone to allow better coordination of transactions.

**The People's Republic of China.** Table 10.5 shows several interesting findings. Because costs made up roughly 75% of total margins in the potato value chain, the share of each cost item, multiplied by 75%, gives a rough idea of that item's impact on the cost of potatoes to consumers. The first ranked item, the cost of farmers' external inputs, was about 35% of the value-chain costs (thus with a rough impact of 26% on the consumer price). Next was transport, which consumed 14% of total costs and comprised 10% of consumer prices. Third, physical wastage was only 7% in the potato value chain, from harvest to sale at retail at least 1,000 kilometers away, strongly contravening the usual assumptions of high wastage rates.

**India.** In the India potato value chain, costs were about 50% of the total margins, so the share of a cost item, multiplied by 50%, gives a rough idea of its impact on the consumer's price (Table 10.6).

First was the set of farm costs, including 19% (averaging over the seasons) from external inputs used by farmers, 11% from land rental, and 10% from wage labor. With increasing pressure on land markets in areas around large cities such as Delhi, the land-related costs of staple food prices will be an increasing factor in food costs.

Second was cold storage, with 21% of costs in the off-season (similar to those in Bangladesh). The cold storage share of potato chain costs exceeded the external input costs of farmers but the food security debate focuses mostly on the farm-level costs. About two-thirds of potatoes in Delhi came from cold stores, and 71% of the cost of operating cold storage was for energy (Chapter 8). Therefore, 21% of the potato value chain costs—and thus about 11% of the potato price—were directly affected by energy costs in cold stores for two-thirds of the potatoes.

The third-ranked item was market fees, at 5% of total costs and with about a 2% impact on potato prices. Market fees' impacts on potato prices were much more modest than assumed in the public policy debate, where they are pointed to as an important cause of food price inflation.

Fourth, transport contributed a modest 8% of costs in the harvest season and 11% in the off-season, with an average low impact of about 5% on potato retail prices. This modest impact is because the Agra zone is only 200 kilometers from Delhi, and the great majority of Delhi potatoes were from nearby zones. The transport rate was a mere $8/ton, about 60% of the Bangladesh rate (for a similar distance traversed).

Fifth, physical wastage from farm to purchaser accounted for about 6% of costs. Cutting wastage rates in half would be an important achievement, but would reduce potato prices to consumers by less than 3%.

**The Three Zones.** In all three zones, farmers' inputs ranked among the most important cost items in the value chains, at roughly 40% (averaged across zones) of total costs in the chains in the harvest season. Therefore, the efficiency of input supply chains to farmers and of input use has an important impact on potato prices.

Second, cold storage costs were about one quarter of total costs. About two-thirds of cold storage costs were for energy alone, and formed 17% of chain costs. Thus, making the cold stores as energy-efficient as possible is very important to consumer prices.

Third, transport costs were also a significant item, at about 9%–10% of costs in South Asia and 14% in the PRC. These costs, however, differed greatly over the economies in absolute terms (due to the different distances in the value chains from farmer to retailer) and in cost per ton per kilometer. The PRC transport costs per ton per kilometer were substantially lower than those in Bangladesh, and somewhat lower than those of India. This suggests the importance of an improved transport sector as a significant factor in supply chain efficiency.

Fourth, with increasing pressure on land and labor markets in all three economies due to urbanization and a rapidly developing local nonfarm and migration labor market (in particular in the PRC and India), the costs of land rental and labor hire will loom increasingly large in forming potato (and other food) prices. Consequently, food will likely be sourced farther from the cities (in areas with lower land and labor prices), and potato farming is likely to become more mechanized (such as for land preparation and harvesting) and to use more chemical treatment of weeds. Indeed, the study documented the increasing use of herbicides.

Finally, wastage rates (at about 6%–7% of total supply chain costs) were much more modest than the rates posited in current debates in the region. Postharvest handling is important, but many of the needed practices and investments may have been put in place so that wastage has already become modest.

## Potato Market Prices

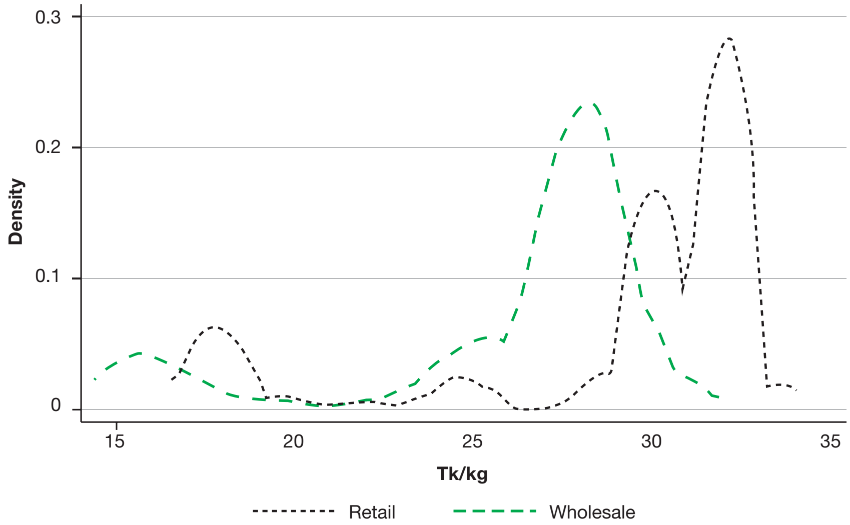
The potato markets were changing, transforming, and restructuring; however, they were not yet well integrated, arbitrage was incomplete, and significant seasonality was still an issue. Prices varied substantially even at the same time across transactions in a segment of the potato value chain, and between seasons. This was true even in India, where cold storage was well established, potato production was the most commercialized, and the market was the largest among the zones studied. Despite the ready availability of cold storage in South Asia, prices and absolute margins varied considerably with the seasons.

There is a significant price variation at any point in time in any segment of the potato value chain. This is reflected in Figures 10.1 and 10.2 for Bangladesh and India, where the price variation of potato is shown for each segment at the time of the survey. Retail and wholesale prices vary significantly, depending primarily on quality and location. For example, in the case of Bangladesh in Figure 10.1, while the average margin between sales and procurement price is about Tk2.5/kg and the wholesale price distribution shows a parallel shift to the left, prices at each trade level vary significantly. Retail prices differed by 100% between the lowest and the highest levels, i.e., Tk17/kg and Tk34/kg, respectively, at the time of the survey.

Moreover, the study's findings concerning the links between value-chain margins and potato price inflation refute the accusation that traditional retailers' margins are driving the food price inflation. In India, the study examined the extent that price inflation was linked to increasing margins of agents in the value chain. For this analysis, only the time series of potato price data at the wholesale and retail levels in Delhi were available from secondary sources (the government), thus limiting the discussion on potato price inflation to the relative impact of retail margins and wholesale prices.

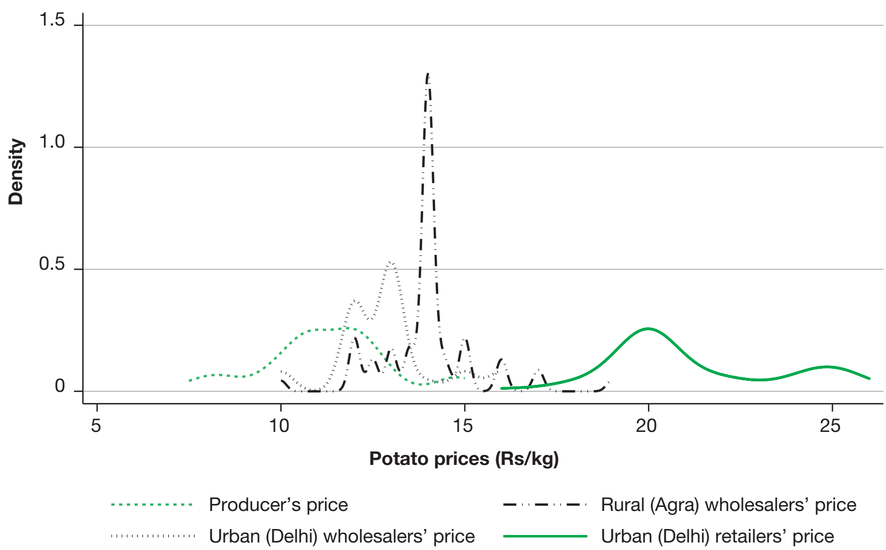
Figure 10.3 plots the monthly nominal wholesale and retail price during 2000–2010 (Fcainfoweb online n.d.). The figure demonstrates that nominal prices of both indicators trended upward, thus indicating nominal inflation in potato prices in both the wholesale and retail segments. To determine the different extents to which wholesalers and retailers benefited from or caused this upward trend, the ratio and the difference between the two series are examined in detail. Figure 10.4 plots the share of the wholesale price over the retail price in that period, and shows significant variability of this ratio through time but no clear upward or downward trend. Figure 10.5 plots nominal and real retail margins, which were obtained by dividing the prices by the consumer price index for industrial workers (Labour Bureau online n.d.), where the index in 2009 is equated to 1. The real retail margin is defined as the absolute difference between wholesale and retail prices over time. The nominal price went up over time (with significant variability); however, there seems to be no evidence that real margins increased over time.

**Figure 10.1 Potato Prices in Dhaka**



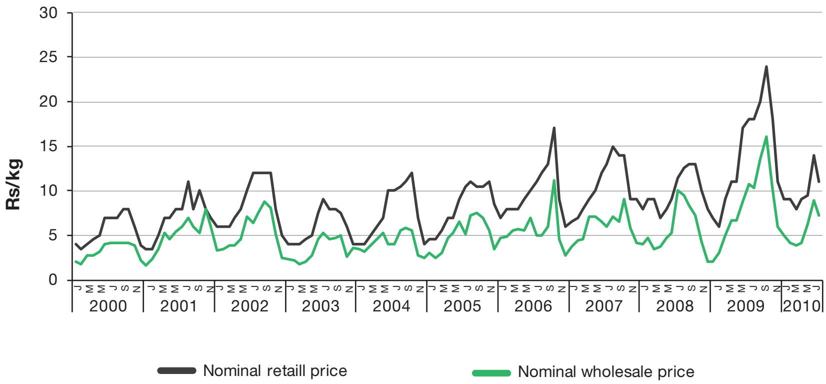

kg = kilogram, Tk = taka.

**Figure 10.2 Price Variation in the Potato Value Chain from Agra to Delhi**

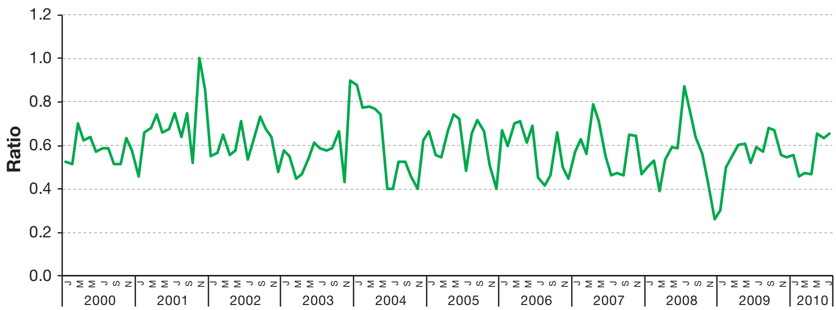



kg = kilogram, Rs = Indian rupees.

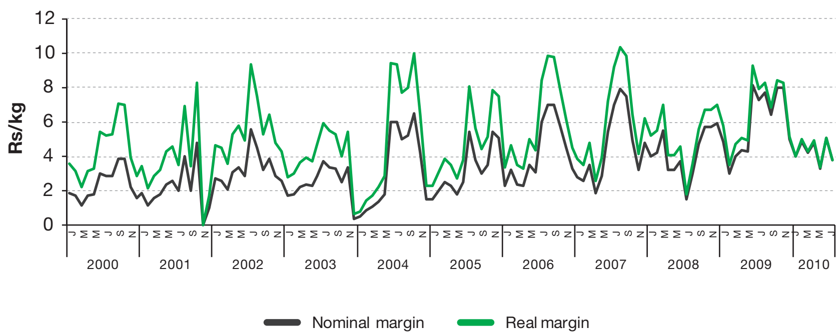
## Figure 10.3 Potato Wholesale and Retail Prices in Delhi




## Figure 10.4 Ratio of Wholesale to Retail Potato Prices in Delhi




## Figure 10.5 Real and Nominal Potato Retail Margins in Delhi




kg = kilogram, Rs = rupees.

To statistically test how nominal potato prices had changed over time and what the contributing factors had been to that inflation, the authors ran several regressions of the form where the price of potato (expressed in rupees/kilogram) is linked with quarterly dummies, to capture the seasonal variation in prices, and yearly dummies, to capture nominal inflation in prices (Table 10.7). Several important insights emerged.

**Table 10.7 Potato Regressions in India: Nominal Wholesale and Retail Prices and Margins**

| Explanatory Variables | Dependent Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Nominal Wholesale Price (Rs/kg) | | Nominal Retail Price (Rs/kg) | | Nominal Retail Margin (Rs/kg) | | Real Retail Margin (Rs/kg) | |
| | Coefficient | t | Coefficient | t | Coefficient | t | Coefficient | t |
| Intercept | 1.39 | 2.50 | 2.72 | 3.98 | 1.33 | 3.20 | 4.52 | 6.46 |
| April–June | 1.87 | 4.46 | 2.43 | 4.72 | 0.57 | 1.82 | 0.51 | 0.97 |
| July–September | 3.37 | 7.88 | 5.55 | 10.53 | 2.17 | 6.78 | 1.44 | 2.68 |
| October–December | 2.20 | 5.08 | 3.70 | 6.92 | 1.49 | 4.59 | 0.99 | 1.82 |
| 2001 | 1.80 | 2.58 | 1.51 | 1.77 | -0.28 | -0.54 | -0.66 | -0.75 |
| 2002 | 2.12 | 3.04 | 3.01 | 3.52 | 0.90 | 1.73 | 0.19 | 0.22 |
| 2003 | 0.20 | 0.29 | 0.31 | 0.36 | 0.11 | 0.21 | -1.17 | -1.34 |
| 2004 | 0.94 | 1.35 | 1.89 | 2.21 | 0.94 | 1.82 | -0.68 | -0.78 |
| 2005 | 1.80 | 2.58 | 2.64 | 3.08 | 0.84 | 1.62 | -0.56 | -0.64 |
| 2006 | 2.37 | 3.41 | 4.18 | 4.88 | 1.81 | 3.47 | -0.05 | -0.06 |
| 2007 | 2.75 | 3.95 | 4.89 | 5.71 | 2.14 | 4.11 | 1.22 | 1.39 |
| 2008 | 2.38 | 3.42 | 4.18 | 4.88 | 1.82 | 3.50 | 0.89 | 1.02 |
| 2009 | 4.98 | 7.16 | 8.51 | 9.94 | 3.54 | 6.80 | -1.03 | -1.18 |
| 2010 (till July) | 2.94 | 3.60 | 5.36 | 5.32 | 2.41 | 3.94 | 0.14 | 0.14 |

kg = kilogram, Rs = Indian rupees.

First, there were important seasonal movements in the prices and margins. Prices and margins were both significantly higher during the latter part of the year (the off-harvest period). Potato retail prices in the third and fourth quarters were Rs5.6/kg and Rs3.7/kg higher, respectively, than in the first quarter. Because of the structure of the regressions and the dependent variables, the sum of the coefficients of wholesale and retail price regressions allow an estimation of their relative contribution to this seasonal price hike. About 40% of the higher retail price during the off-season was driven by higher retail margins, possibly due to a "thin markets" effect (where prices are volatile due to few sales), and 60% of the seasonal movement was explained by wholesale price movements.

Second, the coefficients of the yearly dummies indicate how prices had changed over time, on average. Potato prices in 2009 were estimated to be Rs8.5/kg higher than in 2000. Again, about 40% of that increase is explained by higher nominal retail margins and 60% by higher wholesale prices. As the coefficients of the yearly dummies in the retail margin regression were always smaller than those in the wholesale price regression (except for 2004), increases in retail margins always contributed less to retail price inflation than did wholesale price inflation.

Third, the last two columns present the results of a regression of the real retail margin on time dummies. None of the time dummies is significant during the period studied, suggesting that margins in the food retail sector had not increased in real terms.

The results thus indicate that 40% of seasonal and yearly inflation of potato prices was explained by increasing retail margins and 60% by increasing wholesale prices. However, the increasing retail margins were in line with the rest of the economy as, using a general economy-wide deflator, they had not significantly increased or decreased over time. Of inflation in nominal potato prices, 60% was explained by increased wholesale prices. Unfortunately, the lack of consistent data on farm gate price precluded an analysis of the extent to which wholesale price rises were captured by the farmers or by agents in the value chain that operated between them and wholesale markets.

## Conclusions

This overview of the distribution of costs and rewards in the potato value chains in Bangladesh, the PRC, and India, and the composition of the costs, brings to light several main points.

First, potato farmers "captured" most of the total margins (retail prices). In Bangladesh, the farmers had 69% of the margins in the harvest season and 77% in the off-season (34% of which came from margins from cold storage and selling the potatoes later when prices were higher). In the PRC, farmers got 60% of the harvest season retail price in Beijing. In India, farmers had 57% of the retail price during the harvest season and 52% in the off-season, but with about 34% coming from cold storage margins. Thus, the share of the postharvest segments of the value chain (wholesale, cold store, and retail) was about 40%–50% of the total price (with cold storage counted as a recipient of outlays by farmers). In Bangladesh and India, this varied a little by season, as farmers tended to gain from cold storage. Cold storage was much less used in the PRC study zone.

Second, the leading cost in the value chain was the external cost of potato farm inputs. These were 40% of the margins in Bangladesh, 56% in the PRC, and 20% in India, averaging about 40%. Improving efficiencies in farm input supply would thus redound to the benefit of potato consumers.

Third, cold storage, especially in Bangladesh and India, was an important cost component in the value chains—at about a quarter in each. About two-thirds of potatoes consumed in Delhi and Dhaka had been cold stored.

About two-thirds of the cold storage cost was for outlays on energy (electricity and diesel). Thus, about a fifth of potato value–chain costs were just from energy outlays in the cold storage segment. Consequently, potato prices are vulnerable to energy price shocks, and improving the efficiency with which energy is used will have a positive effect on the retail prices of potatoes.

Fourth, while transport costs are generally considered to comprise a very large share of potato prices, the study found the share to be modest—at about 9% of value–chain costs in both South Asian economies and 14% in the PRC (due to the much greater distance involved).

Fifth, wastage in the potato value chain, from harvest to the consumers, was about 6%–7% in all three zones studied. This contrasts with the 30%–40% wastage rates in food supply chains bandied about in public debates in the region. Reducing wastage will have a positive impact on value-chain costs and retail potato prices, but the impact is likely to be less than is commonly assumed.

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# PART D
# CONCLUSION

# 11 Summary and Policy Implications

Spurred by the food crisis in 2008, governments and multilateral institutions in Asia called for upgrading the food value chains in the region. At the same time, few hard data existed on how domestic staples value chains were structured and performing. The Asian Development Bank commissioned the International Food Policy Research Institute to collaborate with research institutions in the region on a detailed study of rice and potato value chains. The study comprised a survey in 2009–2010 (with recall of selected variables over 5 and 10 years). About 3,500 farmers, traders, millers, cold storage facilities (CSFs), and modern and traditional retailers were surveyed. The study was conducted in six zones (two in each economy, one being the area studied for potato and the other, the area studied for rice). The results for Bangladesh, the People's Republic of China (PRC), and India are reported in this book. The book's subtitle refers to three emblems: the tiger for Bangladesh, the dragon for the PRC, and the elephant for India. All three are large economies with a powerful impact on the emerging world food economy of the 21st century.

Three questions are addressed in the research: (1) Are staples value chains transforming structurally? (2) Is the conduct of staples value chains' actors transforming? (3) Is the performance of staples value chains leading to the inclusion of small-scale farmers, small-scale midstream actors, and workers, and is it leading (all else being equal) to lower food costs for consumers?

In addressing these questions, the focus of the research was on (1) domestic value chains, as they include 98% of the staples in the region; (2) rice and potatoes, which are the main grain and the main vegetable staple in the region; (3) the "market catchment areas" within 8–10 hours of the capital cities, Dhaka, Beijing, and Delhi, to understand the rural–urban staples value chains feeding the cities of Asia (urban areas constitute roughly two-thirds to three-quarters of food demand in the Asian region); (4) private sector action in input supply, farming, processing, storing, trading, and retailing, because the private sector (traditional and modern) is the most important direct actor in staples value chains in the region; and (5) the impacts of government policies and development strategies.

By way of a basis for comparison and identification of the current transformation under way, we note that traditional rice value chains are perceived in conventional wisdom (which was established in important works in the 1960s and 1970s such as Lele [1971]) as characterized by (1) farming being oriented toward subsistence; (2) the supply chain being oriented mainly toward local rural markets (and thus being geographically short); (3) in the rural-to-urban supply chain, there are "many hands" or market agents between farmers and consumers, what we term "intermediationally long"; (4) each segment of the chain being highly fragmented and dominated by small-scale actors; (5) each segment's conduct being characterized by the use of traditional technology and commercial practices; and (6) a prevalence of tied credit–output market relations between farmers and village traders.[1] This conventional image paints a picture of inefficient and static chains, forcing farmers into relations with few options, and consumers into purchasing from costly supply chains.

By contrast, the study found changes in the staples value chains that make today's chains very different from the traditional value chain. The study showed that changes in the staples value chains involve an important transformation that is a modern revolution, with modern retailing starting to market staples. It is also a quiet revolution in traditional value chains for two reasons. First, compared with the rise of modern supermarket chains, the avalanche of foreign direct investment (FDI) in processing, and changes in world food trading systems, the changes that are transforming traditional staples chains tend to be in the midstream, among traders, mills, and CSFs. These midstream changes are like the more visible and debated downstream modernization in that they involve consolidation and technological and organizational change in the segments, but they are unlike the modern food revolution in two ways beyond being in the midstream. They are generally not spurred by FDI, and they generally involve investments by small and medium midstream firms. Second, the midstream changes are "quiet," because they are grassroots in nature and are as yet generally unrecognized, and their importance is underappreciated, especially in policy circles.

In general, the above transformation appears to be transforming in a "V" shaped formation similar to that of flying geese, using the metaphor evoked

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[1] Lele (1971) found a surprising degree of integration and competition in India's national rice market, in terms of arbitrage among urban wholesalers. However, she also showed that (except in more advanced cases such as the Punjab) the more usual situation (for example, as in Uttar Pradesh) was characterized by the "traditional" (intermediationally long and inefficient) rice supply chains, with a preponderance of local retail markets, village traders, and small mills.

in Akamatsu (1935). In the rice value-chain transformation, the "lead goose" is the PRC, which appears to be changing faster or has transformed further, especially in the remarkable development of its milling sector. In the potato value chain, India is taking the lead, with the spectacular rise of potato CSFs in Agra. But value chains in each of the three economies studied were transforming, albeit at different speeds.

This chapter summarizes the main findings and draws implications as to governments' roles in facilitating desirable transformations. The chapter notes the development strategies and policy paths that are likely to help economies to further transform their staples value chains so as to pursue growth, reduce poverty, and enhance food security.

## Structural Changes in Rice and Potato Value Chains: Macro View

### Rapid but Differentiated Transformations

The overall findings are that value chains in rice and potatoes in Bangladesh, the PRC, and India are transforming rapidly, and that modernized or disintermediated value chains coexist with, while apparently displacing, traditional value chains.

In general, the rice and potato value chains can be grouped into four types, varying in terms of geographical and intermediational length.

For the rice value chains in the zones studied (from Noagoan to Dhaka, Heilongjiang to Beijing, and Shahjahanpur to Delhi), the four types of value chains are as follows:

(1) The most traditional rice value chain, contained in the rural area, is "geographically and intermediationally short" and is the local supply chain of paddy grown by the farmer, dehusked in a local village mill, and consumed by the farm household or sold to the local village market for local consumption.

(2) The rural–urban traditional rice value chain is "geographically long and intermediationally long" and features sale of paddy to local brokers (village traders), who sell it as paddy or have it milled in village

mills, which sell it to rural wholesale markets, where wholesalers from the cities buy it. The rice is then sold to semi-wholesalers (who sell to retailers) and/or traditional retailers.

(3) The intermediate (or transitional) rice value chain, which is "geographically long and intermediationally medium," entails the rice farmer selling paddy directly to mills. The mills then sell rice to city wholesale market traders, or sell paddy to rural or city wholesale market traders, who have it milled and then sell the rice in the city wholesale market. At the city wholesale market, traditional retailers buy the rice directly.

(4) The modern rice value chain is "geographically long and intermediationally short," with the farmer selling paddy directly to mills that then sell rice to supermarkets and/or urban wholesale markets to sell to supermarkets and traditional urban retailers.

The surveys showed that in the Bangladesh study value chain (Noagoan to Dhaka), the rural–urban traditional value chain still dominated, but the intermediate (or transitional) value chain was emerging quickly, with direct sales to mills. In the PRC study (Heilongjiang to Beijing), the intermediate (or transitional) and modern value chains dominated. In India (Shahjahanpur to Delhi), the intermediate (or transitional) value chain strongly dominated, with the continued use of village traders and rural wholesale markets upstream, but direct sale from mills to urban traders downstream. The most traditional value chain no longer had a significant presence—in fact, it had a very minor presence—in any of the study zones. The PRC rice value chain stood out as being the most advanced in the transformation of the rice value chains, and only in the PRC had the modern value chain emerged in a significant way.

The four types of potato value chains that were evident in the areas studied were as follows:

(1) The most traditional potato value chain, contained in the rural area, is "geographically short and intermediationally short," and is the local supply chain of potato from the farmer sold, fresh at harvest or within a few months after traditional on-farm storage, to the local village market for local consumption.

(2) The rural–urban traditional potato value chain, which is "geographically long and intermediationally long," includes selling potatoes, fresh at harvest or after a few months of traditional on-farm storage, to

local brokers (village traders), who then sell the potatoes to rural wholesale markets, where wholesalers from cities buy the potatoes, then resell them to semi-wholesalers (who in turn sell to retailers) and/or traditional retailers.

(3) The intermediate (or transitional) potato value chain, which is "geographically long," features the potato farmer selling both fresh at harvest and after storage in modern CSFs directly to city wholesale market traders.

(4) The modern potato value chain, which is "geographically long and intermediationally short," features the potato farmer selling, both fresh at harvest and after modern cold storage, directly to processing firms or supermarkets.

The surveys in the Bangladesh zone showed that the rural–urban traditional value chain still predominated, but the intermediate or transitional value chain was emerging quickly, due mainly to the proliferation of CSFs, and was already important. In the PRC, the rural–urban traditional value chain still dominated, with little use of modern cold storage by farmers in Gansu Province. In the India study zone, the intermediate (or transitional) value chain strongly predominated after the rapid development of modern CSFs in the last decade. The most traditional (meaning confined to rural areas from farmer to consumer) value chain had only a minor presence in any of the study areas, and the fully modern value chain had not emerged in a significant way. India stood out as the most advanced in the transformation of the potato value chains.

Important drivers of the transformation of rice and potato value chains were the increase in scale and change in technology of rice milling and potato storage. Mill and storage changes were in turn functions of demand- and supply-side forces, and other factors.

On the one hand, there was a huge surge in the demand for potatoes and other vegetables with the increase in incomes and populations of the megacities such as Beijing, Delhi, and Dhaka. This created in turn a demand for off-season supply of potatoes and for higher-quality rice.

On the other hand, there was a large increase on the supply side, of medium–large mills, with modernized technologies, and of modern CSFs. Both the diffusion of CSFs and the modernization of mills were favored by direct government subsidies, as well as indirect government support through major investments in road improvement and the installation of energy grids so crucial to milling and cooling. Moreover, private investment was attracted, as the demand-side factors favored profitability of these investments, and by the supply of investable funds due to growth in the three economies. The investments were further encouraged by deregulation and privatization in the food sectors of all three economies. In India, regulations limiting the size of processing entities were removed. Constraints on FDI were relaxed. For example, in the processing sector in the PRC, giant agribusinesses such as Wilmar were allowed to enter the milling business.

## Conduct and Performance

Several key conduct and performance findings accompany and derive from the structural changes just noted.

**Distribution of Value Added.** First, averaging across seasons and product quality grades (such as fine versus common or coarse rice) and the value chains in the three economies, rice farmers captured 60% and potato farmers 64% of the total margins (measured by the urban retail price) of the value chains.

The corollary is that the off-farm components of the value chains are important—they accounted for about 40% of the total margins in the rice chain and 36% in the potato chain. Despite the importance of the postharvest segments, the food security debates in the Asian region focus on farm, and even just on rice farm, yields. Rather, the productivity of processing, storage, and distribution merits nearly equal weight with the productivity of farms in the Asian food security debate.

Second, the share of farmers in the value chains varied by the length of the chain. Transport costs explained a large part of the differences in the farmers' share of the total margin across study sites. In the South Asian rice chains, farmers averaged 65% of the total margin, versus 48% in the PRC's geographically much longer chain. Bangladesh potato farms derived 75% of the total margin, versus only 60% in the PRC (from the distant Gansu to Beijing). The outlier was the potato chain in India, which was geographically relatively short compared with the PRC's, but where the potato farmers' share averaged 55%. This appears to be due to traders and retailers being larger and fewer in Delhi compared with those in Dhaka, and apparently from their having "market power" (that is, being able to at least partly control the price and thus earn higher than normal margins), at least partly offsetting the advantage the farmers had by using cold storage to avail of higher prices in the off-season.

Third, the share of farmers in the value chains varied by the quality of rice and the season of potato sales.

On the one hand, rather than a higher quality of rice bringing the farmer a higher share of the total margin, in all the economies it brought a lower share. The effect was slight in India, moderate in the PRC, and strong in Bangladesh, where farmers captured 79% of the total margin for coarse rice but only 52% for fine rice. The greater shares of the off-farm segments in Bangladesh and the PRC could be due to their adding value by branding and packaging, polishing and reshaping the kernels, and perhaps, in the case of the midstream actors, to their scale and strategic position in the value chain.

On the other hand, farmers chose to store their potatoes in CSFs, which earned profits for them because of higher prices off-season and provided urban consumers with potatoes outside the harvest season. The demand for this supply is huge: The study estimated that two-thirds of the potatoes consumed in Delhi and Dhaka were from cold storage rather than fresh from harvest. As a reward for storage, the price was higher in the postharvest seasons, and farmers in both countries earned substantial rewards from using modern CSFs. In Bangladesh this actually allowed farmers to capture more of the total margin of the chain (from 69% in the harvest season to 80% in the off-season).

**Farmers' Empowerment and Consumers' Benefit in Transforming Value Chains.** The structural change in value chains has multiplied the market options that farmers have. From the traditional situation of selling directly to rural consumers or to a village trader, intermediate and modern value chains have opened the doors to a host of other buyers: rural town and urban wholesale market traders, CSFs, mills, and supermarket chains. The surveys showed that farmers seldom chose village traders and instead sold to these new actors. Farmers gained from these options. An example is their selling to or at the CSFs in India, eschewing village traders and regulated markets and selling to urban traders that went to the CSFs.

While the conventional image is of tied credit–output relations between farmers and village traders, thus reducing the farmer's market options, the farm surveys showed that only a very small share of farmers received advances from rice or potato traders. This was also corroborated by the surveys of traders. Traders and farmers explained that during the last decade or two the advent of cell phones, better roads, many more rural wholesale markets, new credit sources such as CSFs and Kisaan Credit Cards (in India), and major growth in off-farm income as a source of cash had displaced the need for farmers to rely on traders for financing. By contrast, value-chain financing between retailers and traders, traders and millers, and CSFs and farmers had become significant.

Cell phones empowered farmers, as these had become an important linkage between segments in the value chains, conveying information about market options and requirements.

Consumers also appeared to be benefitting from the structural change in value chains. The transitional and modern chains were reducing the seasonality of potato supply, differentiating the quality of rice, and introducing packaging and branding to communicate quality and thus opening the door to traceability. In some cases, such as in Delhi, the survey showed that rice and potatoes were sold more cheaply in supermarkets than in traditional shops, implying that structural transformation can improve the food security of the urban poor.

**Cost Formation in the Value Chains.** Three cost components (waste, transport, and market fees) loom larger in food security debates in the region than their impacts merit. By contrast, three other costs (farm inputs, labor, and energy costs post farm gate) receive inadequate attention but are already major cost components with important effects on staples prices. They comprise costs that are likely to increase in the future and merit particular attention.

First, there is a current debate in food policy circles in Asia and elsewhere concerning food wastage, which is often asserted to consume about 30%–40% of the costs in the food supply chain (Mattoo, Mishra, and Narain 2007). The survey's finding of only about 7% physical wastage in the potato value chain (from harvest on the farm to retail sale in the city) strongly contradicts this assertion. Furthermore, wastage in the rice chains was found to be only about 1%–2%.

The lower importance of wastage and transport costs that the study found may be due to the development over time of better infrastructure (cold storage and road infrastructure in the areas studied, which tend to be close to rapidly developing big cities) and the spread of mobile phones, which may enhance market coordination. The low wastage rate also suggests that individual actors in all segments of the value chains were attempting to minimize costs. There may still be ways to reduce waste, such as through more cold storage in rural areas of Bangladesh, but dramatic gains in the value chains' efficiency should not be expected through waste reduction strategies.

Second, rice transport costs had less than a 4% impact on retail rice prices in Bangladesh, less than 7% in India, and less than 12% in the PRC. However, the

Indian rice zone studied is 200–400 kilometers from Delhi, about a quarter of the distance that the PRC rice zone is from Beijing. Even though transport costs are a modest share of the Indian rice value chain from Shahjahanpur to Delhi, note that the Indian costs were about twice the PRC costs measured per ton of rice per kilometer. This means there is still room for further reduction of the transport cost component of food prices by road improvement, vehicle stock upgrading, and reduction of nonofficial payment requests from transporters in India. The figures and points are roughly similar for the potato value chain, except that PRC costs per ton per kilometer to move potatoes from hinterland Gansu were commensurate with those in South Asia.

Third, although market fees figure prominently in the Indian debate in particular, the survey showed these to have less than a 1.5% impact on rice prices in India, and less than 1% in the other economies' rice chains. The market fee shares in total potato value-chain costs in Bangladesh and India were somewhat more (2% and 1% for harvest and off-season shares, respectively, in Bangladesh, and 3% and 7%, respectively, in India) but were still modest. The attention paid to market fees in the policy debate is disproportionate to their real effect.

Fourth, farm inputs (outside labor and land rental) had a large impact on the price of rice to the consumer—17% in India, 14% in Bangladesh, and 12% in the PRC. The impacts on consumer prices were 10%, 16%, and 26%, respectively, in the potato value chains in the three economies. Therefore, efficient input supply chains to farmers and correct use of inputs are important to reduce value-chain costs. Reducing farm input and machine costs would have a significant effect on rice prices.

Farm input supply chains were already overwhelmingly in the private sector in the study zones. Governments had a minor role as direct purveyors of subsidized inputs (in comparison with the overall aggregate of inputs used). Thus, the efficiency and costs in the provision of inputs depended mainly on hundreds of thousands of private wholesalers and small retailers of chemicals, fertilizers, seeds, and machines, and of thousands of factories and repair shops involved in this supply. Finding ways to encourage investment, reduce transaction costs through better infrastructure, increase scale, improve commercial practices, and modernize technology in these input supply segments could reduce farm costs.

Fifth, labor was an important cost in the rice value chain in Bangladesh and India. Hired labor was a third of total value-chain costs in Bangladesh and a quarter in India, and thus had a substantial impact on the consumer price of about 17% and 12%, respectively, in the two countries. The rising cost of labor, under pressure from the developing rural nonfarm and urban labor markets, will translate into increasing pressure on rice prices and will induce mechanization, as has transpired in the PRC and appears to be happening in Bangladesh and India.

Sixth, energy costs are significant along the supply chain. The survey showed that energy had about 20% of the total costs in the postharvest segments of the rice value chain in the PRC—equal to the share of external inputs used by farmers. Another estimated 5%–10% of value-chain costs comes from farming (for irrigation in India and Bangladesh, and machine and vehicle use in all three economies). Thus, the direct uses of energy along the value chain exceeded the cost of farm external inputs.

In potato chains in South Asia, significant energy costs came from just cold storage. About three-quarters of the cold storage operational costs were attributable to energy, and cold storage costs were fully 21% of total potato value-chain costs in Bangladesh and 32% in India. Energy costs in potato value-chain costs were 13% and 23% in those two economies, respectively.

The importance of energy costs in transport, milling, cold storage, and farming in the rice and potato value chains of the three economies indicates that food prices are vulnerable to energy cost shocks. Consequently, energy costs in the food supply chain should be as important a food security debate topic as is farm productivity per se. Adding indirect use of energy (such as fuel and oil used in production of fertilizer as well as for pumping tube wells) strengthens this point.

## Meso Perspective of the Transformation in Each Segment of the Value Chains

The individual segments of the rice value chains had transformed, albeit at widely different rates across the study zones and economies, conditioned by differences in economic context and regulations.

### Upstream

First, in the policy debate, there is often a view that the rural areas have millions of tiny, homogeneous grain farmers with similar land and nonland assets. The survey showed instead, in both the rice and potato areas, great heterogeneity in farm sizes and distribution of nonland assets. The behavior and nonland assets of the marginal farmers were often quite different from those of the small and medium farmers. This heterogeneity of farmers implies the need for differentiated policy approaches for different strata of farmers, in particular for marginal versus other farmers.

Moreover, especially in the PRC rice and the India potato and rice areas, the medium and semi-medium strata were a minority of farmers but often they supplied the lion's share of staples to the value chains feeding the great cities, while the more numerous marginal farmers provided a small share.

Second, farmers have been increasing commercialization and use of external inputs per hectare.[2] The start of these trends was signaled by Pingali and Rosegrant (1995) in Asian farming, and the findings in the present book demonstrate how far the trends have proceeded. The ubiquity and intensity of farmers' engagement in output and input markets was striking. The survey showed that farmers' marketed surplus rates (sales divided by output) tended to exceed 90% in all sites in both rice and potatoes, and in all strata (except for marginal rice farmers in Bangladesh, who marketed only about 70% of their rice). Farmers have undertaken capital-led intensification, with widespread participation (even among marginal farmers) in fertilizer, insecticide, herbicide, and seed markets. Varietal use underwent waves of change (high-yielding varieties and hybrids), facilitated by actions of the national agricultural research centers and the Consultative Group on International Agricultural Research.

Moreover, farmers became highly engaged in nonfarm labor markets (especially in the PRC and India, and to a limited extent in Bangladesh). Farmers were also engaged in a variety of other factor markets—in farm machine markets (machine-traction rental or outsourcing was widespread), water markets among farmers in India and Bangladesh, and land rental markets.

Third, however, in Bangladesh in particular, and to a lesser extent in the PRC and India, the farm gate price for better quality rice was only slightly higher than that for the lower quality rice, and the labor rewards for growing high- and low-quality rice were not significantly different. The survey results showed that farmers were not benefiting from the relatively higher retail prices and the increased willingness-to-pay for quality staples, which is what one would expect if farmers can easily switch from one to the other, as seemingly was the case.

Fourth, very few farmers in any of the economies received advances from traders or mills and then had to sell them their output at harvest. This practice, common several decades ago, had disappeared over time as farmers found

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2 Termed "capital-led intensification" of agricultural technologies by Lele and Stone (1989).

new cash sources (mainly nonfarm income) and other credit sources (such as Kisaan Credit Cards in India). Better roads and the advent of cell phones opened up more options for receiving price information and contacting buyers.

## Midstream

**Rice Mills and Traders.** First, the rice mill segment has been modernizing rapidly, in ways paralleling the changes in retail, but starting somewhat earlier and being more widespread across sites.

On the one hand, consolidation (the increase in average scale of mills along with increased market share of medium and large mills) coupled with technological change had occurred in the mill sector as medium and large mills had emerged rapidly starting in the mid-1990s. This was driven mainly by the private sector in all three economies, but the PRC differed somewhat by also having state-owned enterprises participating, and by having FDI from huge agribusinesses such as Singapore's Wilmar. In India, the concentration was initiated after deregulation in the late 1990s allowed investment by medium and large companies instead of reserving the sector for small-scale millers. At the same time, the number of small village mills declined rapidly, particularly in the PRC and India. In India, the government subsidized technological upgrading of mills during the last several decades.

Especially in the PRC and to some extent in Bangladesh, rice mills had changed their procedure and were buying directly from farmers, selling directly to their agents in wholesale markets, and branding and packaging the rice. These changes may make the chain more efficient, and certainly help in quality differentiation and traceability. India's mills had advanced far less in these changes, as they were constrained by the Agricultural Produce Marketing Committee (APMC) Act, which was still in force in many states, including the study state of Uttar Pradesh.

Second, the rice and paddy wholesale segment had also been transforming rapidly, especially in the PRC and Bangladesh, and somewhat in India. The roles of village traders linking farmers and rural wholesale markets or mills, and of semi-wholesalers linking rural mills and urban wholesale markets or supermarket chains, had diminished.

Traders in wholesale markets had made important investments in warehouses and trucks and on average increased their scale. In some cases, the survey also identified profit rates that were outliers, such as among rice traders in rural Bangladesh and urban India. This may indicate situations of market power possibly produced by entry constraints.

**Potato Cold Storage Facilities and Traders.** First, the study found a rapid spread of modern potato CSFs, especially in the India study zone and second in Bangladesh. The CSF development in Agra, India is simply amazing. Farmers rapidly took up using cold storage, dropping their traditional storage methods, and massive investments went into CSFs of all sizes. The scale had been rising over time, and thus a process of consolidation was occurring. Investment in CSFs was encouraged by partial government subsidies and by government investment in the electricity grid, which is very important to CSFs, given that the majority of their costs are for energy.

In India, the CSFs have "re-intermediated" the market system so that most of the trading shifted to the CSFs from the government-mandated wholesale markets, against the APMC Act. Farmers, even small-scale ones, ubiquitously used the CSFs and gained significant price advantages from storing. Consumers gained the advantage of greater year-round access to potatoes. The surveys found that two-thirds of the potatoes sold in Delhi and Dhaka had been cold stored.

Second, potato trading was transforming in ways similar to rice trading. The trend of disintermediation was similar (with the decline of village traders particularly under competitive pressure from CSFs and urban traders who used the CSFs as exchange venues). The survey showed abnormally high profit rates for urban potato wholesalers in Bangladesh, which may indicate some informal entry barriers. Wholesalers were making substantial investments in vehicles to facilitate direct purchase.

## Downstream

The retail segments had started to transform in several ways.

First, supermarkets had penetrated urban rice retail, most deeply and widely in Beijing, where they had about half the market. This is similar to the situation in Hong Kong, China in the early 1990s (Ho 2005). Delhi supermarkets had only started to penetrate the rice market, with about 7% of sales, and in Bangladesh, supermarkets had barely started to enter the market. In the PRC, this was driven by large and small, domestic and foreign supermarket chains. In India, it was mainly by domestic chains, as regulations constrained FDI in multibrand retail in India until September 2012, when India's central government removed them (Mehdudia 2012). Supermarkets have been slower to penetrate the urban market for potatoes, as well as for other fresh produce. However, this is expected to pick up gradually following the penetration of the processed and semiprocessed food markets, as occurred in other developing countries in the last 2 decades, and historically in Western Europe and the United States (Reardon and Timmer 2012).

Second, supermarkets and traditional rice shops and stalls had been shifting from loose, unbranded rice to packaged, branded rice. This had progressed furthest and fastest in the PRC, driven by the practices of modernizing rice mills. Branding allows traceability in the supply chain for rice in particular (but not yet for potato)—an important development. Packaging also helps signal quality differentiation.

Traditional retailers in Beijing tended to buy rice from wholesale markets, where an important percentage of traders were agents of large mills, and wholesalers sold rice packaged with mill brands. Supermarket chains bought some rice from the wholesale markets, and directly from large mills. These trends had gone far and fast in the PRC, and had just barely begun in the South Asian sites. Potato retail had not yet followed this path in a significant way, with sales of loose, bulk, unbranded potatoes persisting.

Third, as noted above, while the governments in Bangladesh and the PRC no longer directly engaged in rice retail, the government still did so in India. The survey showed that the share of the Fair Price Shops was only about 15% in Delhi (only twice that of the incipient supermarket chains).

## Government Roles in Transforming Value Chains

### Direct Market Operations of Government

While much policy debate centers on direct government operations in food value chains, buying and selling agricultural products and inputs (what we call direct market operations), such operations were in general quite small in the value chains and economies studied.

In the output market, the government was a major direct purchaser only in the rice chain; only in the study zone in India;[3] and mainly from mills, from which the government bought 59% of the rice sold. In the rice chains in the other two study zones and in all the potato chains, governments had from a very minor to no involvement in the purchase or sale of the products studied. In all three economies, the government had little or no direct role in cold stores, wholesale trade, or retail, with the exception of a minor share of urban rice markets in India's Fair Price Shops.

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3 India's direct involvement in the market is an anomaly in Asia, where most countries (including Bangladesh and the PRC) have reduced to very minor levels direct rice purchase by the government (Rashid et al. 2007).

In the input markets in the survey areas for this book, governments were involved in only a few areas (for rice seed, 40% of farmer purchases in the PRC and 25% in Bangladesh; for fertilizer, 28% in India). For chemicals, potato seed, fertilizer, and rice seed except as just noted, the government share in the input market was very minor, from nil to 9%.

Rather, the rice and potato value chains were overwhelmingly private sector. Thus, a great deal of emphasis should be placed on enabling the private sector's involvement and providing it with the incentives to assist in attaining national food security objectives.

Where governments were involved in direct sale of rice to consumers or of inputs to farmers, the survey revealed neither efficiency nor equity in these actions. This raises the issue of whether such sales should continue—if yes, in what form; and whether they are cost-effective and beneficial or necessary to overall food security. The survey showed that Fair Price Shops in Delhi were seldom open during business hours (in two-thirds of the cases in the survey, they were not), consistent with extensive literature critiquing the efficiency of the public distribution system. The survey also showed, particularly for India, that the great majority of the subsidized inputs and equipment such as tube wells ended up with medium–large farmers, rather than marginal or small ones. Equity problems in government input supply were less evident in the PRC and Bangladesh, where the incidence of such sales was also much smaller except in a few cases (such as rice seed in Bangladesh).

## Important Enabling Roles of Government in Value-Chain Transformation

The governments have played important enabling roles in the transformation—providing private players in the value chains' incentives to transform (such as via subsidies or reduction of regulatory constraints) and developing capacity (such as by improving roads and building wholesale markets) for the private sector (traditional and modern) to respond to market and government-provided incentives.

First, governments have spurred transformation by investing in rural areas through (1) research and development, and distribution of seed; and (2) investments in irrigation canal systems, road and railway systems, rural wholesale markets, and power grids—these were major investments in the 1990s and 2000s, and all were essential to the transformation in the midstream the study observed; and (3) investment in extension, which was important overall, but the data suggest a limited impact and availability of extension services in some areas, particularly in the Uttar Pradesh study zone in India. For example, in the rice zone in Uttar Pradesh, 33% of the farmers used some extension services, but only 14% of farmers used government-provided extension services. There is a need to redress constraints on the provision of extension.

Second, government subsidies had important effects, but evidence of accessibility to and the impact of the services was mixed. Subsidies for rice seed and fertilizer in all the study countries, for private tube wells in Bangladesh and India, for CSFs in India, and for mill upgrading in all the zones, all appear to have encouraged use of and investments in all these productive items, and all the items played important roles in transforming the value chains. However, the survey results show that sometimes the subsidies were not directed to the target beneficiaries. For example, tube well, fertilizer, credit, and seed subsidies in India were taken up mostly by medium and large farmers, with little going to marginal farmers. And in the PRC, on-farm storage construction subsidies reached very few farmers, although a number of traders used subsidies for cooling-tunnel construction. A key policy implication is that, if large subsidies are distributed, great care should be taken to assure that they are properly targeted and delivered.

Third, the findings of the study point to the great importance of farm input supply chains upstream from farmers and of midstream and downstream postharvest activities such as logistics and wholesale, cold storage and milling, and retailing. Little empirical research work has been done on these areas but is needed for the policy debate and the systematic evaluation of policy impacts.

There needs to be a concerted public policy debate on how to enable and encourage input supply chains to become modernized, and midstream and downstream businesses to invest in upgrading equipment and expanding. The PRC has in fact enshrined that objective in its 12$^{th}$ 5-year plan for the food processing sector. A multipronged approach to that encouragement seems warranted by

(1) reviewing and revising the provision of subsidized inputs, which have in some cases flowed to the wrong recipients;

(2) selectively subsidizing or providing tax incentives for upgrading equipment and plant with energy-saving equipment;

(3) addressing the need for reliable power grids and warehouse facilities;

(4) reducing or eliminating remaining limitations on FDI, which is needed in logistics and retail;

(5) reducing or eliminating unnecessary direct government intervention in the value chains (for example, by rethinking India's public distribution system and reforming or eliminating the APMC Act) to encourage as much competition and investment as possible across a wide set of actors;

(6) preparing food supply chains for the increasing need to ensure food safety by encouraging or rewarding traceability measures (e.g., by streamlining regulations to label and brand products and by providing incentives for using monitoring and tracing equipment along the supply chain); and

(7) instituting intellectual property rights and other investment protection and incentives to maximize and harness private sector investment in segments of all value chains.

## Strategies for Transforming the Agrifood Economy and for Food Security

The study has several broad strategic implications.

First, there is no "silver bullet" for the challenges facing staples value chains in the region, although individual changes like technology changes can have powerful knock-on effects in the chain. Rather, a suite of policy and program measures is needed at various levels of the supply chain in order to stimulate the efficiency and competitiveness of expanding staples markets. Even small reductions in margins can lead to large benefits for producers and consumers. The most effective government interventions occurred with a cluster of activities that supported various parts of the value chain in an integrated way.

A good example is that of CSF development in Agra, India, where government research and development in potato varieties and extension services for the new varieties were combined with tube well and CSF subsidies and major investments in road improvements, power grid, and communications networks. Individually, these actions may have been relatively fruitless; taken together, they were successful. Businesses were thus eager to invest in CSFs, farmers were eager to store in the CSFs, traders from cities came to buy from farmers at the CSFs, and consumers in Delhi welcomed the greater availability of potatoes beyond the harvest season.

Second, different policies are needed for the widely different zones and farm strata within them. Asian staples-producing farm areas are not homogeneous, composed only of millions of tiny farms with similar nonland assets. Rather, there is a wide degree of heterogeneity across rice and potato areas, and major differences across farmer strata in the study zones for this book and between them and other zones for which like information is available.[4] This implies that "one size does not fit all" and that government strategies need to be tailored to different situations. In particular, marginal farmers (versus even small farmers, and certainly compared with semi-medium and medium–large farmers) are at a disadvantage in these transformations, as are more hinterland zones (which are endowed with less private and public infrastructure, are farther from markets, and have less favorable climates for agriculture).

Third, growth, market modernization, and agribusiness and food industry themes and debates are often held at arm's length from policy discussions on poverty reduction and food security. This study has shown that value-chain transformation is important to farmers' incomes, rural employment, and access to and affordability of staples for urban consumers. This is especially important, given that Asia's urban areas are home to half of Asia's population and account for two-thirds to three-quarters of its food demand. Harnessing the value-chain transformation for food security should be front and center in the policy agenda of the 21st century.

Lastly, the successes in dynamic areas feeding major cities documented in this study may provide lessons that could be applied elsewhere. The study found much evidence of success, of ferment of change and transformation, and in many cases of improved performance. Thus, many of the implications will be based on what the authors saw that governments and the private sector did well in these zones and that could be extended to other nearby zones and, if possible, to the poorest and hinterland areas. Lessons from dynamic zones today can be important for allowing today's poor zones to join the ranks of the dynamic areas tomorrow.

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4 This is also in comparison with other similar surveys in hinterland zones such as in eastern Uttar Pradesh or Bihar in India, see Minten et al. (2010) and Reardon et al. (2011).

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**The Quiet Revolution in Staple Food Value Chains: Enter the Dragon, the Elephant, and the Tiger**

Major changes have been occurring almost unnoticed in staple value chains in Asia. *The Quiet Revolution in Staple Food Value Chains* documents and explains the transformation of value chains moving rice and potatoes between the farm gate and the consumer in Bangladesh, the People's Republic of China, and India. The changes noted are the rapid rise of supermarkets, modern cold storage facilities, large rice mills, and commercialized small farmers using input-intensive, mechanized technologies. These changes affect food security in ways that are highly relevant for policymakers across Asia—the rise of supermarkets provides cheaper staples, more direct relations in the chains combined with branding have increased traceability, and the rise of cold storage has brought higher incomes for potato farmers and all-season access for potato consumers. The book also joins two debates that have long been separate and parallel—food industry and agribusiness development and market competitiveness—with the food security and poverty alleviation agenda.

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